This document was too large to scan as a single document. It has been divided into smaller sections.

Section 1 of 14

Document Information			
Document #	**SD-WM-SAR-067**	**Revision**	**1**
Title	TWRS FSAR		
Date	**10/08/1999**		
Originator	**GOETZ TG**	**Originator Co.**	**LMHC**
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Other Information	Vol 1 Chapter 1 PAGES 1 THRU T1-44		

S

ENGINEERING CHANGE NOTICE

1. ECN 649157

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	T. G. Goetz, Licensing, R1-49, 373-4818	[X] Yes [] No USQD TF-99-0710, Rev. 0	10/04/99
	6. Project Title/No./Work Order No. RPP	7. Bldg./Sys./Fac. No. RPP	8. Approval Designator SQD
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-SAR-067, Rev. 0 HNF-SD-WM-TSR-006, Rev. 0-U	10. Related ECN No(s). N/A	11. Related PO No. N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

This ECN transmits complete revisions of HNF-SD-WM-SAR-067, Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR), and HNF-SD-WM-TSR-006, Tank Waste Remediation System Technical Safety Requirements. DOE approved Revision 0 of the FSAR through letter 99-ORP-002 [J. C. Hall, Approval of the Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) (letter to R. D. Hanson, Fluor Daniel Hanford, Inc., March 31, 1999)]. In letter 99-TSD-034 [M. A. Hunemuller, Guidance for Preparations for Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) Approval (letter to R. D. Hanson, Fluor Daniel Hanford, Inc., February 2, 1999)], DOE directed the Contractor to update the FSAR, which had been "frozen" in March 1997, to capture the technical changes made to the BIO over the past two years. In the same letter (i.e., 99-TSD-034) DOE also directed the Contractor to revise the TSR document so that it is compatible with the FSAR.

Also, a revision to AC 5.13, "Encasement Seal Loop Controls," has been incorporated into the TSR document, as authorized per letter 98-SCD-036 [J. D. Wagoner, Contract Number DE-AC06-96RL13200 - Approval of Engineering Change Notice (ECN) Package Number 605039 (letter to H. J. Hatch, Fluor Daniel Hanford, Inc., April 15, 1998)].

Detailed descriptions of the changes made to the two documents are included with USQD TF-99-0710.

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

As described above, the changes to HNF-SD-WM-SAR-067 and HNF-SD-WM-TSR-006 were authorized by DOE in letters 98-SCD-036, 99-TSD-034, and 99-ORP-002.

15. Distribution (include name, MSIN, and no. of copies)

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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 649157

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[X]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[X]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[X]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
For checklist addressing affected documents, see Interoffice Memo #79E00-99-009 dated 09/24/99, from TWRS Nuclear Reg. Compliance Support.		

21. Approvals

	Signature	Date		Signature	Date
Licensing Eng. TG Goetz R1-49	Thomas G Goetz	10/7/99	FDH/ESHQ N/A		
Cog. Mgr. RC Cash R1-44	RWJohnson for RJC	10/7/99			
QA N/A					
Safety Services N/A					
Environ. N/A					
TWRS NS&L CE Leach R1-43	CE Leach	10/7/99			
NS&L Licensing JE Meacham R1-49		10/8/99			
NS&L Nuc. Safety Svcs RG Stickney R1-49		10/7/99	DEPARTMENT OF ENERGY		
TWRS Nuclear Reg. Compliance Spt C Difrango R2-50	P.C. Sill For C.D.	10/8/99	Signature or a Control Number that tracks the Approval Signature		98-SCD-036/ 99-TSD-034/ 99-ORP-002
			ADDITIONAL		

Tank Waste Remediation System Final Safety Analysis Report

T. G. Goetz
Lockheed Martin Hanford Corporation
Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-99RL14047

EDT/ECN: 649157 **UC:** 2030
Org Code: 74F00 **Charge Code:** 109310 / BA10 ja HMLM0161
B&R Code: N/A **Total Pages:** 3960

Key Words: Final Safety Analysis Report, FSAR, Authorization Basis, AB

Abstract: The Final Safety Analysis Report (FSAR) establishes the Authorization Basis for Tank Waste Remediation System (TWRS) facilities and operations required for the storage and management of high-level radioactive waste (current and future waste). The FSAR documents the basis for the conclusion that authorized TWRS facility operations can be conducted safely, which complies with the requirements of DOE 5480.23, *Nuclear Safety Analysis Reports*, and approval of the associated Technical Safety Requirements document, which complies with DOE 5480.22, *Technical Safety Requirements*.

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(2) Title
Tank Waste Remediation System Final Safety Analysis Report

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) New document released via EDT #621235 as a non-copy controlled document. No distribution was made on this version.	G. W. Ryan 4/22/99	G. W. Gault 4/22/99
1 RS	Complete revision of document via ECN 649157. Authorization for changes via DOE letter 99-TSD-034. Revised version of FSAR will be copy controlled through Unclassified Document Control.	G. L. Jones for GLJ 10/7/99	R. J. Cash, for RJC 10-7-99

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HNF-SD-WM-SAR-067
Revision 1
Volume I

Tank Waste Remediation System Final Safety Analysis Report

Volume I:
Chapters 1.0 through 3.0

Prepared for the U.S. Department of Energy

FLUOR DANIEL HANFORD, INC.
Richland, Washington

Hanford Management and Integration Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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Volume I

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Prepared by
Lockheed Martin Hanford Corporation

Date Submitted
October 1999

Prepared for the U.S. Department of Energy

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U.S. Department of Energy under Contract DE-AC06-96RL13200

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EXECUTIVE SUMMARY

This Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) documents the results of the safety analyses that establish and evaluate the adequacy of the safety basis for Hanford Site facilities and operations that support the safe interim storage of tank waste. The FSAR also establishes the envelope within which these TWRS facilities and operations can continue to operate safely.

This FSAR and its supporting Technical Safety Requirement (TSR) controls are prepared in accordance with DOE 5480.23, *Nuclear Safety Analysis Reports*; DOE 5480.22, *Technical Safety Requirements*; DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*; DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*; and DOE-EM-STD-5502-94, *Hazard Baseline Documentation*. The scope and content of this FSAR are as described in WHC-SD-WM-PLN-113, *Tank Waste Remediation System Final Safety Analysis Report Project Plan*. Approval of this FSAR and its associated TSR document will upgrade the Authorization Basis for TWRS facilities and operations to the standards established in DOE 5480.22 and DOE 5480.23.

To ensure that the information presented in the FSAR is current and remains applicable, it will be updated according to the requirements established by DOE 5480.23.

ES.1 FACILITY BACKGROUND AND MISSION

The 1,450 km^2 (560 mi^2) Hanford Site is located in south-central Washington State (Figure ES-1). Most of the Hanford Site is a limited-access area under the control of the U.S. Department of Energy (DOE). The TWRS facilities addressed in this FSAR primarily are located in the 200 East and 200 West Areas (Figure ES-2), near the center of the Hanford Site on a relatively flat terrace known as the 200 Areas Plateau. A cross-site transfer line, operated by TWRS, traverses the 600 Area and is used to transfer liquid wastes between underground storage tanks located in 200 East and 200 West Areas. The 200 East and 200 West Areas occupy approximately 16 km^2 (6 mi^2) of the 1,450 km^2 (560 mi^2) Hanford Site. Activities in the 200 East and 200 West Areas are inside security fences that limit general access.

Underground tanks were built to store radioactive and chemically hazardous wastes generated during the production of defense-related materials in various facilities at the Hanford Site through the late 1980's. Chemical processing of irradiated uranium fuels generated solutions and slurries containing heavy metals, organic solvents, inorganic compounds, uranium, mixed fission products, and low concentrations of plutonium. Initially, high-level radioactive waste was placed in large, steel-lined, underground single-shell tanks (SSTs) for temporary storage. Cooling water, condensates, and other low-level waste from processing operations were disposed of in cribs and by other means according to the prevailing health, safety, and environmental requirements. Over time, the waste was treated with various chemical compounds, which

produced the alkaline heavy metal solutions, slurries, and inorganic salts now in the tanks. Later, additional SSTs with improved designs and double-shell tanks (DSTs) were constructed to store the increasing volume of high-level waste. The tanks were constructed in groups called tank farms. Figure ES-3 is an aerial photograph showing a typical tank farm. Tanks within a tank farm are similarly designed.

As of January 31, 1997, approximately 228 million L (60 million gal) of waste were stored in the underground storage tanks. The tanks now contain a mixture of liquid, sludge, and salt cake waste with both radioactive and chemically hazardous constituents. Liquids in the tanks exist as supernate (liquid above solids) and interstitial liquid (liquid filling the voids between solids). Sludge consists primarily of solids (hydrous metal oxides) precipitated by the neutralization of acid wastes. Salt cake, when present, generally exists between the supernate and the sludge and consists of the various salts formed by the evaporation of water from the waste. These waste types do not necessarily exist as distinct layers but may be intermingled at the interface.

The overall mission of TWRS is the continuing management of highly radioactive tank waste; the retrieval, pretreatment, immobilization, interim storage, and disposal of tank waste; and the performance of operations necessary for closure of the tanks after removal of the waste. This FSAR addresses only the portion of the TWRS mission necessary to support the management and safe storage of tank waste.

Figure ES-4 illustrates how this initial FSAR continues improvement of the Authorization Basis of TWRS facilities and operations, replacing the TWRS Basis for Interim Operation (HNF-SD-WM-BIO-001, *Tank Waste Remediation System Basis for Interim Operation*). Figure ES-4 also shows that this FSAR establishes the basis for an integrated TWRS Authorization Basis that will ultimately incorporate TWRS projects not within the initial FSAR scope and future TWRS activities that are part of the broader TWRS mission. The process for the transition from the TWRS Basis for Interim Operation (HNF-SD-WM-BIO-001) to the FSAR and the specific plans for development of an integrated Authorization Basis for all TWRS facilities and activities will be formulated through negotiations with U.S. Department of Energy, Office of River Protection.

ES.2 FACILITY OVERVIEW

TWRS facilities equipment and operations within the scope of this FSAR are described briefly in the following paragraphs. Other TWRS facilities, activities, and projects identified in Chapter 2.0 (e.g., 242-S and 242-T Evaporators and rotary-mode core sampling activities) are the subject of separate Authorization Basis documents. These safety documents eventually will be incorporated into updates of the TWRS FSAR.

Single-Shell Tanks (Figure ES-5). Of the 18 TWRS tank farms, 12 are SST farms containing 149 of the 177 tanks. The SST farms, constructed between 1943 and 1964 in groups of 4 to 18 tanks, were divided equally between the 200 East and 200 West Areas. The original

SST design was a reinforced-concrete shell and dome with an internal liner (structurally independent from the reinforced-concrete tank) of mild carbon steel covering the bottom and sidewalls. The first SSTs were designed with operating volumes of 2 million L (530,000 gal). The succeeding generations of SSTs were built with operating volumes of 2.9 million L (758,000 gal) and 3.8 million L (1 million gal). Sixteen smaller tanks share the same design as the larger tanks, but have operating volumes of only 208,000 L (55,000 gal).

SSTs are considered out of service (i.e., no process wastes have been added to the 149 SSTs since November 1980). Based on tank surveillance data, 67 SSTs are considered assumed leakers (i.e., the carbon-steel tank leaks to the concrete shell, which in turn leaks to the soil). The SSTs are undergoing an interim stabilization process to prevent or reduce leaks to the environment by the removal of as much liquid as is practicable. Reduction of the liquid inventory reduces the quantity of material that could leak, thereby reducing the potential leakage hazard.

Double-Shell Tanks (Figure ES-6). To provide additional storage capacity, 28 DSTs were built in 6 tank farms between 1968 and 1986. Five of the tank farms are located in the 200 East Area, and one is located in the 200 West Area. All DSTs are similar in design and each has a storage capacity of approximately 3.8 million L (1 million gal).

Designed to minimize the potential for leaks of radioactive liquids to the environment, each DST consists of a carbon-steel primary tank and a carbon-steel secondary tank within a protective reinforced-concrete shell. The primary tank contains waste, is freestanding, and rests on an insulating concrete pad. The insulating pad rests on the secondary tank and was cast with air distribution and drain grids to provide for leak detection, to maintain a uniform tank bottom temperature, to facilitate heat removal, and to eliminate pockets of water condensation. The secondary tank is 1.5 m (5 ft) larger in diameter than the primary tank, providing an air space, or annulus, separating the two steel tank walls. The secondary tank serves as a barrier to the environment in case the primary tank leaks. No DSTs are known to have leaked.

Waste Transfer System. The waste transfer system provides the means for transferring liquid waste to and from tank farm storage, chemical processing facilities, and related operational units through a network of transfer pipelines and structures (e.g., process pits, valve pits, diversion boxes).

Catch Tanks. Catch tanks are underground storage tanks that collect small amounts of waste drained from waste transfer systems and equipment. Catch tank volumes range from 2,940 to 167,315 L (776 to 44,200 gal).

Double-Contained Receiver Tanks. A double-contained receiver tank, together with its related equipment, is an interim storage facility used during transfers of liquid waste. Double-contained receiver tanks typically contain 56,781 to 117,350 L (15,000 to 31,000 gal).

Miscellaneous Inactive Storage Facilities. Miscellaneous inactive storage facilities are inactive tanks and structures, both underground and aboveground, that contain low- or high-level radioactive waste/contamination or nonradioactive waste. Underground miscellaneous inactive

storage facilities are typically buried directly in the ground or contained in vaults. The aboveground miscellaneous inactive storage facilities may be contained within inactive TWRS facilities. Miscellaneous inactive storage facilities typically contain sludges or liquid heels and have volumes <189,270 L (<50,000 gal).

204-AR Waste Unloading Facility. The 204-AR Waste Unloading Facility permits rail tank cars or tank trailers carrying radioactive waste to be received into a fully enclosed, heated, and ventilated building for transfer of waste into TWRS. This facility also permits making chemical adjustments to waste before transfer into TWRS and for sluicing of tank cars to remove sludge.

Light-Duty Utility Arm. The light-duty utility arm system provides the capability to reach locations within the waste tank and waste surface that are not directly under the access risers.

244-AR Vault. The 244-AR Vault was designed to receive, treat, and transfer sludge from the Plutonium Uranium Extraction Facility to 221-B Plant for fission product removal; provide interim storage for acid waste feed going from the Plutonium Uranium Extraction Facility to 221-B Plant; and receive and distribute the neutralized high-level waste from 221-B Plant. The 244-AR Vault is being cleaned and readied for decontamination and decommissioning.

Cribs, Ditches, and Ponds. Cribs, which are all inactive, were subsurface liquid distribution systems. Their primary function was to dispose of liquid effluents so that low-level radionuclides (if any) were absorbed and held in the soil beneath the crib. Most cribs were gravel-filled trenches covered with a vapor barrier and soil. Gravel-lined ditches were used for transporting wastewater to the ponds. Pipelines are now used to transport wastewater to active ponds. Ponds receive the discharge of wastewater generated from operating facilities in the 200 East and 200 West Areas.

Push Mode Core Sampling. Push mode core sampling is used to obtain solid or supernatant liquid samples of the high-level waste materials in the underground waste tanks. Specially designed core-sampling trucks and sampling devices are used to obtain samples from the tanks.

209-E Storage Area. The 209-E Storage Area consists of a *Resource Conservation and Recovery Act of 1976* (RCRA) less than 90-day waste storage pad and an Intermediate Holding Area for low-level radioactive waste.

Vertical Storage Units. Vertical storage units, most of which are located in the 200 West Area SST farms, were used to store dry, radioactively contaminated equipment or soil within the tank farm. These facilities are now inactive.

2727-W Sodium Storage Facility. The 2727-W Sodium Storage Facility is used to store solid sodium in five horizontally mounted, insulated sodium storage tanks in a preengineered, self-framing metal structure.

213-W Dry Waste Compactor Facility. The 213-W Building was used to compact low-level waste and is referred to as the Dry Waste Compactor Facility. Compaction activities have ceased and will not be resumed. Contaminated instruments continue to be repaired in the 213-W Building.

Cone Penetrometer. The cone penetrometer soil sampling technique uses a portable platform to deploy small-diameter push rods (piping segments approximately 1 m [39 in.] long with screwed connections), or rods, to depths of up to 70 m (230 ft) for vadose zone characterization.

Operations. TWRS operations associated with safely managing tank farm waste are waste storage, waste transfers, waste characterization, and waste concentration. Tank waste storage includes interim stabilization of SSTs and caustic solution additions for corrosion control. Waste transfer operations include internal tank farm transfers and waste transfers from operating or transition facilities. Waste characterization includes the sampling and monitoring activities necessary to identify the type, form, and quantity of the tank waste. Because the 242-A Evaporator is not included in the scope of this FSAR, waste concentration only involves passive evaporation of water from radioactive decay heat or active tank ventilation. Waste storage and transfer operations include the monitoring, surveillance, and maintenance activities required to support these operations.

Supplemental information for projects previously outside the scope of the FSAR is provided in the designated addenda. Addendum 1, "Tank 241-C-106 Sluicing Safety Analysis," contains the FSAR specific to the Tank 241-C-106 waste retrieval sluicing system, Project W-320. Addendum 2, "Safety Analysis for the Replacement Cross-Site Transfer System," contains the FSAR specific to the replacement cross-site transfer system, Project W-058. Addendum 3, "702-AZ Ventilation System (241-AZ-702) Safety Analysis" contains the FSAR specific to the 241-AZ-702 ventilation system, Project W-030. Addendum 4, "Mixer Pump Test (241-AZ-101) Safety Analysis" contains the FSAR for the 241-AZ-101 mixer pump test, Project W-151.

ES.3 FACILITY HAZARD CLASSIFICATION

DOE 5480.23 requires the hazard classification of nuclear facilities and operations. Guidelines for hazard classification that meet the requirements of DOE 5480.23 are provided in DOE-STD-1027-92.

The initial hazard classification of TWRS facilities was performed in accordance with DOE-STD-1027-92. Based on estimated radioactive material inventories in these facilities that exceed the Hazard Category 2 thresholds in DOE-STD-1027-92, SSTs, DSTs (including the Aging Waste Facility tanks), and associated waste transfer systems are Hazard Category 2 facilities.

The final hazard classification of TWRS facilities was determined based on the requirements of DOE 5480.23, the methodology of DOE-STD-1027-92, and the hazard and accident analyses results. The hazard and accident analyses show that unmitigated releases of radioactive and hazardous material from SSTs, DSTs, Aging Waste Facility tanks, and associated waste transfer systems have the potential for significant onsite consequences. Even though the accident analysis results estimate unmitigated consequences that exceed offsite risk guidelines, the hazards of these TWRS facilities are judged not to pose significant offsite consequences considering the conservative bounding assumptions in the accident analyses and the levels of the risk guidelines. The hazard classification of these TWRS facilities, which includes the 204-AR Waste Unloading Facility and the 244-AR Vault, is therefore Hazard Category 2.

As permitted by DOE-STD-1027-92, TWRS facilities that are independent (i.e., hazardous materials in one facility cannot interact with hazardous materials in another facility) can be segmented and their individual hazard classifications determined. Applying the facility segmentation concept, cribs, ditches, and ponds; the 209-E Storage Area; vertical storage units; and the 213-W Dry Waste Compactor Building are Hazard Category 3 facilities because they are physically independent of other TWRS facilities and the hazard and accident analyses show the potential for only significant localized consequences. Although the miscellaneous inactive storage facilities can be segmented from other TWRS facilities, these facilities are not fully characterized and are assumed to be Hazard Category 2. The radioactive material inventory in the independent 2727-W Sodium Storage Facility does not exceed the threshold values for Hazard Category 3 which, therefore, classifies the facility as a Radiological Facility.

ES.4 SAFETY ANALYSIS OVERVIEW

ES.4.1 Risks of Normal Operations

The primary risks to the workers from normal operations involve radiation exposure and contamination, exposure to hazardous materials, and normal occupational hazards. The design of the TWRS facilities and requirements of the Radiation Protection Program ensure that radiation exposures from TWRS operations are maintained within prescribed limits and are As Low As Reasonably Achievable (ALARA). This is accomplished through the use of engineered controls and features, administrative controls, and personal protective equipment. Examples include shielding, access, and work controls. Occupational radiation exposure levels for the last 5 yr have been low, increasing only with increasing activity in the tank farms. Personnel contamination incidents also have been low: no internal depositions have been recorded since 1993, and no exposures exceeding regulatory limits have been recorded. The success of the Radiation Protection Program (i.e., no adverse radiological impacts to workers in terms of excessive exposure) indicates that future operations performed within the requirements of the Radiation Protection Program will maintain exposures well below the DOE guidelines.

The TWRS Hazardous Materials Protection Program which integrates industrial hygiene and other safety programs, provides protection from employee exposures to hazardous materials.

The goal of the Hazardous Materials Protection Program is to control employee exposures to chemical and physical agents to levels ALARA and within the limits prescribed by DOE and professional industrial hygiene practices and principles. The Hazardous Materials Protection Program uses the Occupational Safety and Health Administration permissible exposure limits (29 CFR 1910, "Occupational Safety and Health Standards") and American Conference of Governmental Industrial Hygienists threshold limit values (ACGIH 1996) to provide information on controlling exposures and for the protection of the workers.

Engineered controls and features, administrative controls, and personal protective equipment are used to mitigate the effects of hazardous materials. Examples of engineered features are physical barriers such as hazardous material containment, encapsulation and abatement (asbestos), barricades, and high-efficiency particulate air filters. In addition, monitoring and personal protective equipment are used, as required, to protect against overexposures during routine operations. Data shows employee exposure levels below the permissible exposure limits or threshold limit values for the chemicals monitored. In the past 5 yr no lost-time accidents were caused by exposure to chemically hazardous material.

Radioactive and hazardous wastes generated by TWRS are managed through the Waste Management Program. The Waste Management Program focuses on (1) protecting the workers, the public, and the environment; (2) ensuring proper management of waste from its point of generation within TWRS to its final disposition; (3) ensuring compliance with applicable federal and state regulations; and (4) ensuring that radioactive and toxicological material exposure is ALARA. TWRS manages radioactive (high-level, low-level, and transuranic), hazardous, and mixed waste from solid, liquid, and gaseous waste streams and sources. Radioactive waste is regulated under the *Atomic Energy Act of 1954*, as amended; hazardous waste is regulated by the *Resource Conservation and Recovery Act of 1976*. TWRS operations are not expected to generate any high-level waste or large volumes of transuranic waste.

TWRS also implements the applicable requirements of DOE 5400.5, *Radiation Protection of the Public and the Environment*, and DOE 5400.1, *General Environmental Protection Program*. Gaseous TWRS effluents are regulated by 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants"; the *Clean Air Act Amendments of 1990*; and 40 CFR 70, "State Operating Permit Programs." TWRS has discharge permits for its identified liquid effluent streams. These permits contain discharge limitations and monitoring requirements.

ES.4.2 Risks from Abnormal Events and Postulated Accidents

The risks from abnormal events and postulated accidents that can result in the uncontrolled release of radioactive or hazardous material were determined by performing a hazard analysis of TWRS facilities and operations. Occupational hazards, including common industrial hazards, are regulated by DOE-prescribed occupational safety and health standards. Specific analyses of those hazards are not required in the FSAR. The results of the hazard analysis were used to define representative accidents that were quantitatively analyzed. The risks from the identified abnormal events and postulated accidents are eliminated or managed through the

development and implementation of engineered and administrative controls. The hazard and accident analyses together form the technical foundation for the controls that are used to manage risk and protect the public, onsite workers, facility workers, and the environment.

HAZARD ANALYSIS

A systematic and comprehensive hazard analysis was performed for TWRS facilities and operations. The hazard identification portion of the analysis employed the following:

- Review of existing TWRS safety documentation
- Review of TWRS reportable events
- Review of historical records of similar operations
- Review of TWRS facility and operations descriptions
- Participation by knowledgeable current and former TWRS operations and engineering personnel in the hazard analysis effort
- Use of standard checklists for hazardous materials and energy sources
- Walkdowns of facilities
- Review of previous TWRS hazard analyses.

Standard industry hazard analysis techniques were used to identify over 1,200 potentially hazardous conditions at TWRS that could affect the public, onsite workers, facility workers, or the environment. Possible causes of each potentially hazardous condition were identified and qualitative estimates of the associated frequency and possible consequences were provided.

The hazard analysis results were used to derive representative postulated accidents that were quantitatively analyzed. Representative accidents selected for analysis satisfy one or more of the following criteria: (1) those that bound accidents of lesser but similar potential consequences; (2) those with higher risk estimates; and (3) those that, although not bounding, present some unique, important phenomenological challenge to the measures relied on to ensure safety.

The hazard analysis for Tank 241-C-106 waste retrieval sluicing system is presented in Addendum 1. The hazard analysis for the replacement cross-site transfer system is presented in Addendum 2. The hazard analysis for the 241-AZ-702 ventilation system is presented in Addendum 3. The hazard analysis for the 241-AZ-101 mixer pump test is presented in Addendum 4.

Controls necessary for protection of the public and onsite workers are based on the results of the hazard and accident analyses. Controls required to protect facility workers and the environment are based primarily on the qualitative hazard analysis.

Worker Safety

The results of the hazard analysis are used to identify specific controls required for protection of facility workers. Safety structures, systems, and components (SSCs), TSR controls, and Defense-in-Depth controls were identified for anticipated radioactive or hazardous material releases with a potential for serious injury or death. Generally, controls established for protection of the public and onsite worker safety also provide protection for the facility worker. Facility worker protection is also provided by the Radiation Protection and Industrial Hygiene Programs.

Environmental Protection

Environmental controls for protection of the environment from large, uncontrolled releases of radioactive or hazardous material are derived from the hazardous conditions identified in the hazard analysis. In many cases, these conditions are addressed by controls established to protect the public, onsite workers, and facility workers from exposure to radioactive or hazardous materials. However, in other cases the hazard analysis indicated that specific environmental controls were required. The environmental protection controls that were identified through the hazard analysis include the following:

- Use of high-efficiency particulate air (HEPA) filter systems and performance of annual aerosol testing
- Maintenance of a negative pressure in actively ventilated waste tanks to enhance confinement of radioactive material in the tanks
- Controls to prevent tank and pipe corrosion and to maintain tank and pipe integrity
- Leak detection systems
- Controls on in-tank operations.

These controls are implemented through TWRS operations programs and procedures. Environmental protection is ensured by compliance with applicable environmental regulations; siting and design features that prevent or mitigate releases of radioactive or hazardous material; and programs such as SST interim stabilization.

ACCIDENT ANALYSIS

Table ES-1 lists the quantitative accident analyses performed for representative accidents. The results of these analyses, coupled with the hazard analysis, were used to define necessary

preventive and mitigative controls to reduce the risks associated with these postulated accidents. TWRS risk guidelines established by RL were used to help guide the control selection process.

Estimates of the frequencies and consequences of the postulated accidents are calculated using models describing expected initiation and progression of the postulated accidents. Conservative models were used to develop bounding results in areas where the accident phenomena or initial conditions were uncertain or not well understood. This conservative approach simplified the analysis process and reduced the complexity of controls, thereby increasing reliability. The accident analysis includes estimates of radiological and toxicological exposures to the public and to onsite workers.

The accident analysis was first conducted taking no credit for controls or any other preventive mechanism. If the consequences or likelihood of the accident without controls were determined to be unacceptable, it was necessary to identify controls to reduce the risk of the postulated accident. The accident was then reevaluated taking credit for the controls to verify that sufficient risk reduction had been achieved.

Engineered controls that reduce the consequences to postulated offsite receptors are designated Safety-Class SSCs. Other engineered controls that reduce the consequences to postulated onsite receptors or are major contributors to Defense-in-Depth or worker safety are designated Safety-Significant SSCs. TSR controls include Safety Limits, Limiting Control Settings, Limiting Conditions for Operation, Surveillance Requirements and Administrative Controls. The purpose of designating safety SSCs as Safety-Class or Safety-Significant and imposing TSR controls is to maintain the safety function as derived from the hazard and accident analyses. For Safety-Class and Safety-Significant SSCs, TSR surveillance requirements are established to provide assurance that the safety function associated with the safety SSC is satisfied and protected.

The control selection process uses the following principles:

- Controls that prevent the postulated accidents are preferred to those that mitigate the potential consequences of accidents.
- Passive engineered controls are preferred to active engineered controls.
- Engineered controls are preferred to administrative controls.

Other criteria used in controls selection include the following:

- Reliability, availability, and maintainability of candidate controls
- Effects of candidate controls on facility workers
- Possible synergies and interferences among candidate controls

- Human factors considerations relating to the reliability or effectiveness of candidate controls

- Possible effects of candidate controls on the ability of TWRS to accomplish its overall mission

- Cost and benefits of candidate controls.

Once a suite of controls had been established for a representative accident, the hazard analysis data was used to ensure that corresponding controls were established for the entire topography where the accident could occur and for all hazardous conditions that were represented by the accident analyzed.

The accident analysis for the waste retrieval sluicing system and the associated consequences and control requirements are contained in Addendum 1. The accident analysis for the replacement cross-site transfer system and the associated consequences and control requirements are contained in Addendum 2. The accident analysis for the 241-AZ-702 ventilation system and the associated consequences and control requirements are contained in Addendum 3. The accident analysis for the 241-AZ-101 mixer pump test and the associated consequences and control requirements are contained in Addendum 4.

Summary of Accident Analysis Results

The accident analysis results, together with the results of the hazard analysis, form the basis for control decisions that defined a suite of safety SSCs and TSR controls to eliminate or reduce the risk of identified potential hazardous conditions and postulated accidents for TWRS facilities and operations. With the exception of four accidents, the selected safety SSCs and TSR controls are shown by the accident analysis results to manage the risk below the TWRS risk guidelines. Additional TWRS design and operational features identified as Defense-in-Depth controls further enhance safety.

For postulated flammable gas deflagrations, organic solvent fires, organic salt-nitrate reactions, and seismic events, the conservative accident analysis results exceed the TWRS risk guidelines even with the identified controls. Some of these postulated accidents involve phenomena that are not well understood and, therefore, are modeled conservatively. Significant unknowns and uncertainties that require bounding accident assumptions, including waste tank and transfer system structural response to accident conditions, also exist. Likewise, the estimated consequences of all the postulated accidents are sensitive to the detailed contents of the waste tanks, which are not well characterized and have been modeled quite conservatively. Therefore, the conservative accident analysis results are believed to significantly overestimate the actual risk from these four accidents.

Even though conservative, accident analysis results that exceed the TWRS risk guidelines are a matter of concern and require additional safety assessment. The TWRS risk management strategy for each of the four accidents that exceed the risk guidelines and the strategy for

responding to the waste surface level increase in Tank 241-SY-101 is described in the FSAR and is summarized here. This strategy ensures immediate or planned implementation of cost-effective controls that minimize risk based on the best available information. The strategy also provides commitments for continued safety assessments to better understand these accidents and to serve as the basis for examining additional control options, if necessary.

Flammable Gas Deflagrations—The generation of flammable gas by the waste present in TWRS facilities and the potential for its deflagration or detonation is the subject of a Safety Issue and Unreviewed Safety Questions. The flammable gas hazard exists in TWRS facilities where tank waste is stored or is present in a condition that permits generation, accumulation, retention, and release of flammable gas. Facilities where this hazard exists include SSTs, DSTs (including Aging Waste Facility tanks), double-contained receiver tanks, catch tanks, inactive miscellaneous underground storage tanks, and supporting waste transfer facilities such as the 244-AR and 244-CR Vaults. Accident analyses for a number of postulated flammable gas deflagration/ detonation scenarios were performed. The results show that offsite/onsite radiological and toxicological consequences could be above the TWRS risk guidelines even with controls.

The controls established and implemented to manage the risk of the flammable gas hazard at TWRS facilities are identified in the FSAR and, except for Tank 241-SY-101, are based on Appendix K, *Flammable Gas Hazards and Controls in Hanford Waste Storage Tanks and Waste Transfer Facilities*. Flammable gas controls for Tank 241-SY-101 are based on HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*. Except for Tank 241-SY-101, the controls consist of ventilation controls, ignition source controls, and gas monitoring requirements. Ventilation controls are the primary means of preventing the steady-state accumulation of flammable gas in a concentration above the lower flammability limit. Gas monitoring and ignition controls are graded by the flammable gas hazard in the different TWRS facilities and are defined to reduce the risk of a deflagration/detonation that could result following a significant gas release event. Gas monitoring and ignition controls also reduce the risk of a flammable gas deflagration/detonation from steady-state accumulation if ventilation flow is inadequate. For Tank 241-SY-101, a mixer pump is used to prevent significant episodic gas release events by mixing the tank contents, which limits the quantity of gas retained in the waste. However, an unexplained waste surface level rise in Tank 241-SY-101 required the declaration of an Unreviewed Safety Question and the development of new controls for Tank 241-SY-101 remediation activities and operations. See discussion below titled, "Waste Surface Level Increase in Tank 241-SY-101."

The strategy for resolution of the Flammable Gas Safety Issue for SSTs and DSTs is first to develop a flammable gas accident analysis model that provides quantification of the technical uncertainty of the risk associated with flammable gas hazards. After the model is developed, it will be used to complete a refined safety analysis that will include an evaluation to ensure that the controls are consistent with the flammable gas hazard and that control strategies are optimized for continued safe operation of the TWRS facility. The strategy for resolution of the Flammable Gas Unreviewed Safety Question that remains open for other TWRS ancillary facilities includes

obtaining flammable gas sampling data and performing additional engineering and safety analyses to provide a basis for assessing, and potentially revising, the existing control strategies.

Waste Surface Level Increase in Tank 241-SY-101. An Unreviewed Safety Question has been declared related to the unexplained waste surface level growth in Tank 241-SY-101. This situation was not evaluated in LA-UR-92-3196 *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*. RL declared the Unreviewed Safety Question on February 26, 1998 (Kinzer 1998). A revision to the Unreviewed Safety Question was approved by DOE in April 1999 to reflect the results of waste characterization and analysis performed to understand level growth mechanisms and potential hazards (French 1999). The safety analysis and controls for all Tank 241-SY-101 operations and activities, including storage, level growth investigation, and remediation are described in HNF-3737. These controls have been approved and implemented (Allen 1999).

Organic Solvent Fire—This accident could result from a fire in the waste tank that burns organic solvent present in the tank. For some analyzed cases, the onsite radiological and toxicological consequences could be higher than the risk guidelines even with controls. A sufficiently energetic heat source, such as lightning, vehicle fuel fire, or hot slag from flame cutting, could cause the organic solvent to ignite and cause the release. Restrictions on tank farm activities when lightning activity is within 48 km (30 mi) reduce the likelihood of lightning-initiated ignition. Vehicle access and fuel system protection reduce the potential for ignition from a vehicle accident. Ignition controls on flame cutting prevent this ignition source. These actions provide reasonable assurance that operations can be conducted safely.

Data from head space vapor sampling is now available and is being evaluated. An improved model for consequence calculations is being developed. It is anticipated that when this work is completed it will show that the accident consequences do not exceed the risk evaluation guidelines.

Organic Salt-Nitrate Reaction—This accident could result from an ignition of dry, solid organic salt waste. The offsite and onsite radiological and toxicological consequences could pose significant risk. Three dependent criteria are important to understanding the risk posed by organic-nitrate waste. In the order of importance they are the total organic carbon in percent, the moisture level in the waste in percent, and energetics required to initiate or propagate in J/g (measured by calorimetry). If a tank waste can be shown, with the appropriate confidence levels, to contain total organic carbon levels below an established limit, moisture and energetics are not important. Ignition and propagation are not possible if tank waste is shown to contain adequate moisture even if the total organic carbon levels are greater than established limits. Moisture eliminates ignition and propagation. Energetics are still being evaluated to determine if a limit can be established, below which propagation cannot occur, even if adverse total organic carbon and moisture levels exist. Tanks are identified as either safe (insufficient total organic carbon), conditionally safe (moisture above criteria), or unsafe (based on total organic carbon and moisture measurement and analysis). For all of the tank waste sample data collected thus far, no waste measurements have exceeded the conditionally safe criteria. Less than 10 tanks fall into the conditionally safe category because of fuel content. On the basis of sample tank analyses and

process information, none of the unsampled tanks is expected to contain average total organic carbon concentrations above the fuel criterion. TWRS continues testing with surrogate and actual waste samples to determine if the conditions assumed in the analysis are possible. Tank characterization is prioritized to sample tanks scheduled for interim stabilization and tanks with the highest reaction potential.

Controls are required to reduce the frequency of the accident. To protect against the organic salt-nitrate reaction hazard, high moisture conditions are maintained in the waste, if possible, and medium strength (>10 J) ignition sources are prevented from contacting the waste.

A program of tank sampling and testing of tank waste and simulants is nearing completion. It is anticipated that the results of this work will show that the risk of the hazard is significantly less than that shown in the current analysis.

Natural Phenomena (Seismic)—Seismic events can initiate an accident or initiate multiple accidents from a common cause. Three types of seismically induced accidents would dominate the consequences of the event: spray leaks and pool leaks from an underground pipe break and seismically induced gas release events followed by deflagrations of flammable gas. These accidents were selected as the evaluation basis seismic event. Although the postulated damage to TWRS facilities from seismic events is uncertain, tank failures or collapse of major structures would not be expected from an evaluation basis earthquake.

The consequences of the seismically induced spray leaks, pool leaks, and deflagrations are estimated to be above the offsite and onsite TWRS risk guidelines even with controls. Emergency response actions, including shutdown of waste transfer pumps, would serve to mitigate the consequences of a seismic event.

Because the potential risk of a seismic event remains above the TWRS risk guidelines even with existing controls, several additional safety assessments are planned to further manage the seismic risk.

The benefits (risk reduction) and the costs of installing seismic monitors or switches will be assessed. Seismic monitors would provide a positive indication to TWRS operators and emergency response personnel to terminate waste transfer pump operation and to take other emergency actions. Seismic switches would immediately terminate waste transfer pump operation in the event of a significant seismic event. Evaluations of the feasibility of seismic monitors and seismic switches are ongoing.

A comprehensive seismic vulnerability study is also planned to assess the ability of TWRS SSCs to survive seismic events. The results of the seismic vulnerability assessment would be used to identify which existing SSCs likely would survive a seismic event and to identify potential further safety improvements to control the risk from a seismic event. The comprehensive seismic vulnerability study is not currently a funded activity.

The results of the analyses of representative accidents identified for the waste retrieval sluicing system and the associated consequences and control requirements are contained in Addendum 1. The results of the analyses of representative accidents identified for the replacement cross-site transfer system and the associated consequences and control requirements are contained in Addendum 2. The results of the analyses of representative accidents identified for the 241-AZ-702 ventilation system and the associated consequences and control requirements are contained in Addendum 3. The results of the analyses of representative accidents identified for the 241-AZ-101 mixer pump test and the associated consequences and control requirements are contained in Addendum 4.

Beyond Evaluation Basis Accident Results

Beyond evaluation basis accidents are operational accidents with more severe conditions or failures than postulated for the evaluation basis accidents. Beyond evaluation basis accidents also include natural phenomena more severe than the evaluation basis event. The analysis of beyond evaluation basis accidents are performed to provide perspective of the residual risk associated with TWRS facilities and operations.

The analysis of beyond evaluation basis accidents included evaluation basis accident scenarios with the postulated failure of safety SSCs and TSRs and three accidents with phenomena or conditions more severe than the evaluation basis accidents (i.e., a seismic event, a flammable gas detonation, and an organic salt-nitrate reaction). The analysis of these beyond evaluation basis accidents did not suggest any additional design features or controls that could prevent or reduce consequences beyond those described for evaluation basis accidents. The analysis also identified no sharp increase in consequences from the evaluation basis to the beyond evaluation basis accidents.

ES.4.3 Safety Management Programs

The TWRS Integrated Safety Management System includes safety management programs that ensure implementation and maintenance of the TWRS Authorization Basis and technical baseline documentation. Key safety management programs provide the administrative framework for the safe operation of TWRS facilities. These safety management programs range from radiation and hazardous material protection to disciplined conduct of operations. Following are the essential characteristics of key safety management programs.

Prevention of Inadvertent Criticality—The Criticality Safety Program ensures that sufficient controls are in place to prevent inadvertent nuclear criticality accidents. The Hanford Site Criticality Safety Program complies with the requirements of DOE 5480.24, *Nuclear Criticality Safety*; industry standards; and accepted safety practices.

Radiological Protection—The radiological protection program for TWRS facilities provides for the protection of the workers during normal operations. Radiological protection activities at the Hanford Site implement the requirements of 10 CFR 835, "Occupational

Radiation Protection," as directed by the HSRCM-1, *Hanford Site Radiological Control Manual*. This program also establishes radiological protection standards and procedures; provides for independent review and evaluation of the program; provides for radiological and dosimetry support; develops and implements training; and coordinates the ALARA Program.

Hazardous Materials Protection—The Hazardous Materials Protection Program is designed to protect workers from exposures to hazardous physical, chemical, and biological agents. The program provides the basis for an effective industrial hygiene program that preserves worker health and well being following the requirements of DOE 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, and DOE 5480.10, *Contractor Industrial Hygiene Program*. These DOE orders implement 29 CFR 1910, "Occupational Safety and Health Standards," and 29 CFR 1926, "Safety and Health Regulations for Construction."

Radioactive and Hazardous Waste Management—Criteria for confinement, safe handling, and disposal of solid, liquid, and gaseous waste implement the requirements of the DOE 5400 series orders, with emphasis on DOE 5400.5. Discharges to ground and surface water are in accordance with WAC 173-216, "State Waste Discharge Permit Program," and 40 CFR 141, "National Primary Drinking Water Regulations." Radioactive airborne effluents are regulated in accordance with 40 CFR 61 and WAC 173-401, "Operating Permit Regulation."

TWRS procedures, which follow DOE 5820.2A, *Radioactive Waste Management*, establish requirements for waste acceptance programs. These waste acceptance requirements ensure that waste is properly identified and characterized before being shipped or transferred to TWRS facilities. Each hazardous and radioactive waste generator that delivers waste to TWRS facilities is required to comply with the TWRS waste acceptance program requirements.

Initial Testing, In-Service Surveillance, and Maintenance—A program is in place to require initial testing, in-service surveillance, and maintenance programs at TWRS to ensure the integrity and operability of safety SSCs. The initial testing program for safety SSCs requires the development of testing procedures and the review, evaluation, and approval of test results.

In-service surveillance, inspections, and maintenance are conducted based on applicable DOE directives. Surveillance requirements for Safety-Class and Safety-Significant SSCs ensure that the necessary operability of SSCs is maintained. The TWRS maintenance program tracks maintenance history and includes preventive maintenance, corrective maintenance, spare parts control, measuring and test equipment control, and maintenance training. Requirements for the maintenance program reflect the relative importance of facility SSCs in protecting the public, workers, and the environment.

Conduct of Operations—Conduct of operations requirements at TWRS are in accordance with DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*. Procedures provide detailed requirements for communications, training, shift operations, and facility operations. Work activities at TWRS are controlled through formal work control and design configuration management programs.

Fire Protection—The TWRS fire protection program meets the requirements of DOE 5480.7A, *Fire Protection*. Fire hazards analyses have been performed for TWRS facilities as required by DOE 5480.7A.

Procedures—Approved, verified, and validated procedures, appropriate to the tasks to be performed, ensure disciplined maintenance and operation of TWRS facilities. Procedures define the requirements for management approval of activities within TWRS to maintain facility safety.

Training—The training program for TWRS addresses the requirements of DOE 5480.18B, *Nuclear Facility Training Accreditation Program*, and DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, and ensures that the facility is operated and maintained by personnel who are well qualified and competent to carry out their job responsibilities.

Human Factors—Human factors considerations are graded on the basis of project risk, complexity, and level of involvement of the operator at the facility. Although TWRS does not have a formal human factors program, human factors are addressed at various organizational levels. Engineering, operations, and safety organizations ensure human factors are considered in the modification of TWRS facilities, systems, or equipment that may affect safety. Supporting organizations provide expertise for industrial safety, industrial hygiene, hazardous material and radiological control, maintenance, procedures, and training.

Quality Assurance—Activities affecting quality, safety, or reliability of TWRS operations, products, and services are performed following documented and approved procedures appropriate for the task. The TWRS procedure manuals are used to ensure that quality assurance requirements of 10 CFR 830.120, "Quality Assurance," and DOE 5700.6C, *Quality Assurance*, are implemented systematically.

Emergency Preparedness—The TWRS Emergency Preparedness Program establishes planning, procedures, and training programs to effectively prepare, manage, and respond to emergencies and incidents affecting the health and safety of the workers and the public. Emergency planning addresses those accidents analyzed in this FSAR. The emergency management program implements the DOE 5500 series orders; DOE/RL-94-02, *Hanford Emergency Response Plan;* and DOE/RL-93-75, *Hanford Facility Contingency Plan*.

Decontamination and Decommissioning—A formal decontamination and decommissioning plan has not been prepared for TWRS. Detailed plans will be prepared, as required, to support the final decontamination and decommissioning of TWRS. Decontamination and decommissioning are considered during the design of new facilities or major modifications to existing systems.

Configuration Management—The TWRS Configuration Management Program provides for the identification and control of physical, functional, and operational requirements of configuration-controlled SSCs, including Defense-in-Depth SSCs. A hierarchy of contractor-generated documents identifies all requirements for configuration-controlled SSCs as

technical baseline documents. A subset of the technical baseline documents that establishes the requirements for safety SSCs, including Defense-in-Depth SSCs, is identified as safety basis documents. The safety basis documents include Authorization Basis documents and require DOE approval. Authorization Basis documents include DOE-prepared documents.

Occurrence Reporting and Processing—The occurrence reporting and processing system is designed to alert TWRS management and DOE officials to events, conditions, or concerns that may have safety, health, quality assurance, security, operational, or environmental implications. TWRS occurrence reporting program is based on the requirements of DOE 5000.3B (superseded by DOE O 232.1), *Occurrence Reporting and Processing of Operations Information*.

Unreviewed Safety Questions—Proposed changes to TWRS facilities and operations are subject to an Unreviewed Safety Question determination according to DOE 5480.21, *Unreviewed Safety Questions*. The determinations are performed in accordance with established procedures by trained Unreviewed Safety Question evaluators.

ES.5 ORGANIZATIONS

Fluor Daniel Hanford, Inc. (FDH), is the Project Hanford Management Contractor. FDH is supported by six major subcontractors that manage the various Hanford Site projects and activities. The organizational relationship and responsibilities of FDH, its major subcontractors, and other Hanford Site enterprise companies are shown in Figure ES-7. FDH is the integration contractor and is ultimately responsible for TWRS operation and safety. Lockheed Martin Hanford Corporation is the subcontractor responsible for day-to-day management and operation of the TWRS project. Lockheed Martin Hanford Corporation also provides engineering services and is responsible for the TWRS safety basis and Authorization Basis, including the development of this FSAR. Numatec Hanford Corporation provides project design and implementation support. Waste Management Federal Services of Hanford provides analytical, waste management, and environmental services to TWRS. Other support services important to safe TWRS operations are provided by B&W Protec, Inc.; Fluor Daniel Northwest, Inc.; Lockheed Martin Services, Inc.; and DynCorp, Tri-Cities Services, Inc.; as shown in Figure ES-7.

In addition to the major contractors and supporting service organizations discussed above, a significant number of outside organizations provide technical advice, oversight, and input to the cleanup activities performed on the Hanford Site. These organizations include independent technical advisory panels, the DOE's system of national laboratories, the Hanford Advisory Board, and the Washington State Department of Ecology.

ES.6 SAFETY ANALYSIS CONCLUSIONS

The TWRS FSAR, together with the TSR document derived from the FSAR safety analysis, establish (for the TWRS facilities and operations analyzed) an acceptable safety basis and Authorization Basis for managing the risk. The safety analyses of TWRS facilities and operations documented in this FSAR provide a comprehensive and systematic identification of hazards; describe and analyze the adequacy of measures taken to eliminate, control, or mitigate identified hazards; and analyze and evaluate postulated accidents and their associated risks. Based on the hazard and accident analyses, safety SSCs, TSR controls, Defense-in-Depth design and operational features; and specific environmental controls are identified to protect the health and safety of the public, workers, and the environment. Safety management programs are described for TWRS that include the elements essential to implementation and maintenance of the safety envelope defined by the safety analysis.

Specific conclusions of the FSAR are:

1. The risk to the public, workers, and the environment from normal operations is acceptably managed by the TWRS radiation protection, hazardous material protection, and radioactive and hazardous waste management programs.

2. The risk to the public, worker, and the environment from potential hazardous conditions and postulated accidents is acceptably managed by engineered and administrative controls and safety management programs.

3. For postulated flammable gas deflagrations, organic solvent fires, organic salt-nitrate reactions, and seismic events, the conservative assumptions used in accident analyses because of physical and phenomenological uncertainties and unknowns, result in calculated accident consequences and likelihood that exceed risk evaluation guidelines established for the TWRS FSAR by DOE. For these postulated accidents, risk is acceptably managed by (a) selected preventive and mitigative controls, (b) planned operational safety improvements (i.e., lightning protection) and (c) planned safety assessments to improve the understanding of the risk and define, if necessary, the basis for possible additional controls.

4. The risk from beyond evaluation basis accidents, which include the potential for failure of safety SSCs and TSR controls, do not suggest the need for additional controls.

5. The Integrated Safety Management System assures that TWRS facilities and operations are managed safely.

This TWRS FSAR and associated TSR document, HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, represent an improvement to the safety basis of TWRS facilities and operations and bring the TWRS safety basis into compliance with the requirements of DOE 5480.23 and DOE 5480.22. This FSAR also provides the basis for future

updates to develop an integrated TWRS safety basis which includes (1) TWRS facilities, activities, and projects not within the scope of the initial FSAR; and (2) TWRS mission activities required for retrieval, pretreatment, immobilization, interim storage and disposal of tank waste, and performance of operations necessary for closure of the tanks after removal of the waste.

The project-specific supplemental conclusions are included in the designated addenda to the Final Safety Analysis Report (FSAR). The conclusion of Addendum 1 to the FSAR is that the waste retrieval sluicing system activities can be conducted safely following implementation of the controls and requirements identified in Addendum 1. The conclusion of Addendum 2 to the FSAR is that the replacement cross-site transfer system can be operated safely following implementation of the controls and requirements identified in Addendum 2. The conclusion of Addendum 3 to the FSAR is that the 241-AZ-702 ventilation system can be operated safely following implementation of the controls and requirements identified in Addendum 3. The conclusion of Addendum 4 to the FSAR is that the 241-AZ-101 mixer pump test can be conducted safely following implementation of the controls and requirements identified in Addendum 4.

ES.7 SAFETY ANALYSIS REPORT ORGANIZATION

This safety analysis of TWRS facilities and operations addresses the 21 safety analysis report topics required by DOE 5480.23 in a 17-chapter format that follows the guidelines of DOE-STD-3009-94. Table ES-2 shows the correlation of the TWRS FSAR organization with the DOE 5480.23 safety analysis report topics. Detailed information that supports the TWRS safety analysis is given in the appendixes.

Most of the controlled manuals (e.g., WHC-CM-X-XX) referenced in this safety analysis report have been superseded by FDH procedures (e.g., HNF-PRO-XXX). A cross-reference table has been provided in Appendix G to guide the reader in locating the equivalent current FDH procedure(s).

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29 CFR 1926, "Safety and Health Regulations for Construction," *Code of Federal Regulations*.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*.

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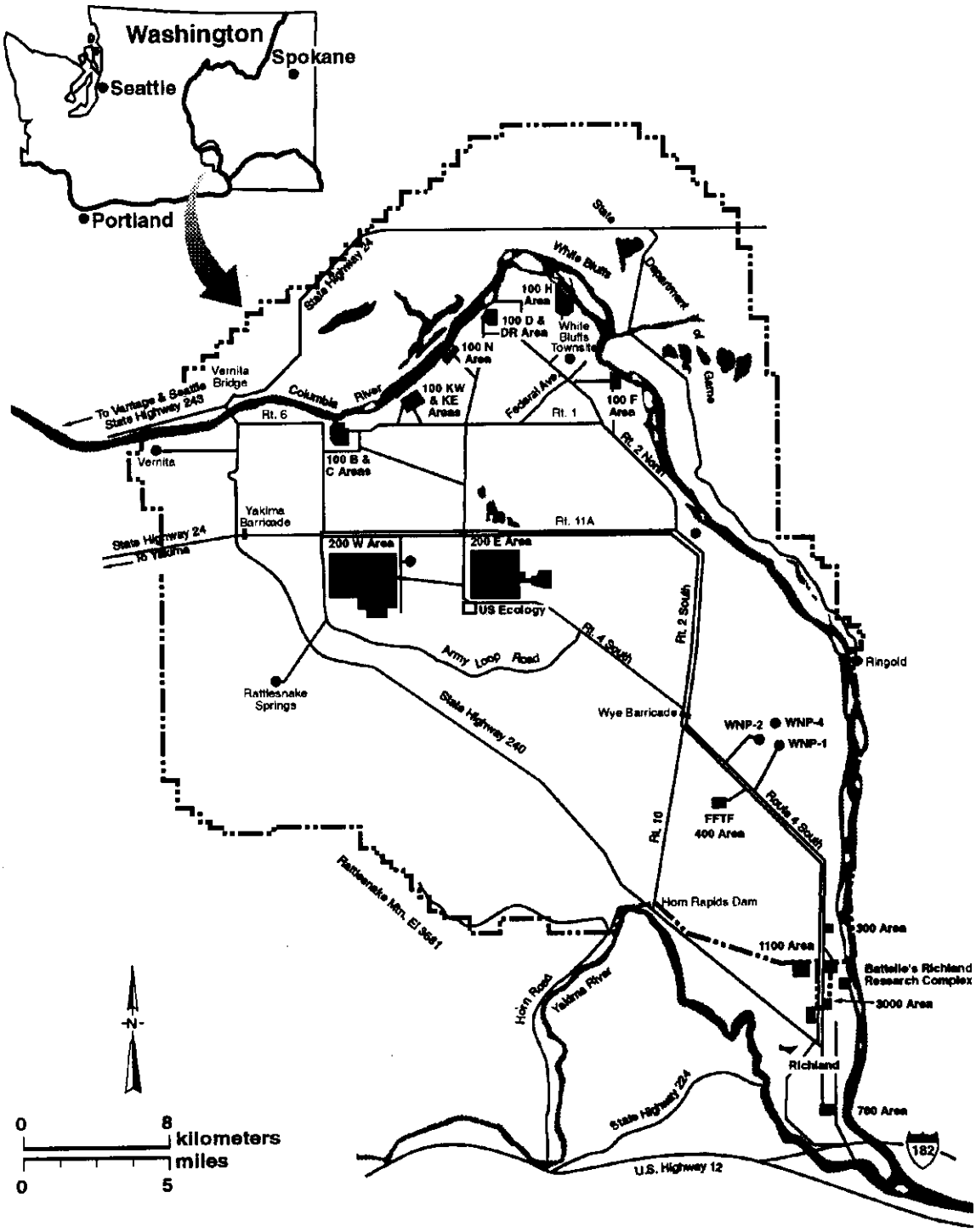
Figure ES-1. Hanford Site Map.



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NOTE: The 600 Area includes all of the Hanford Site that is not part of the 100, 200, 300, or 400 Areas.

Figure ES-2. The Tank Waste Remediation System at Hanford Consists of 177 Waste Storage Tanks and Various Related Facilities.

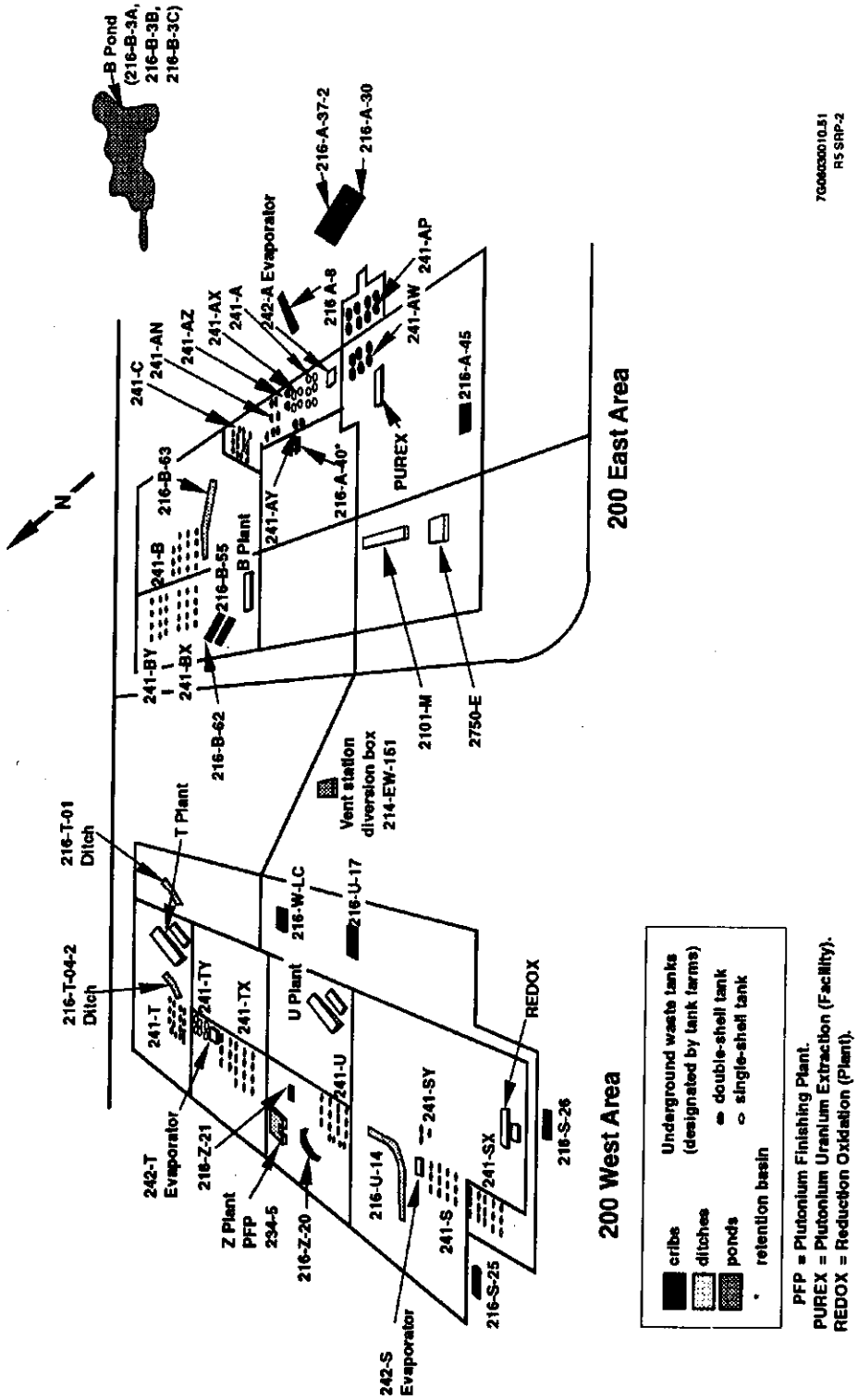

Figure ES-3. Aerial View of a Typical Tank Farm. There are eight large tanks beneath the white covers.

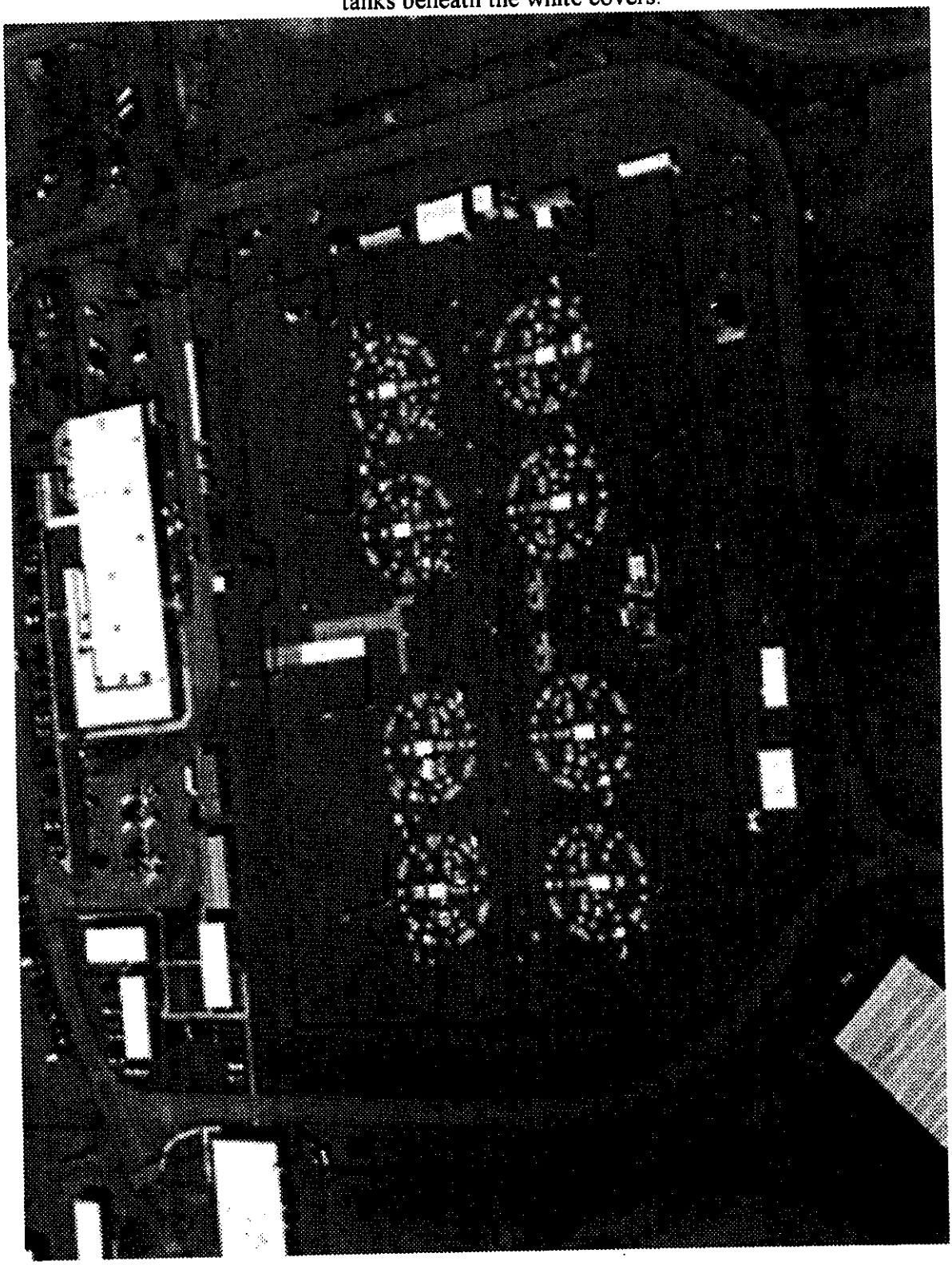

Figure ES-4. The TWRS FSAR Contributes to a Long-Term Vision for TWRS Safety Management.

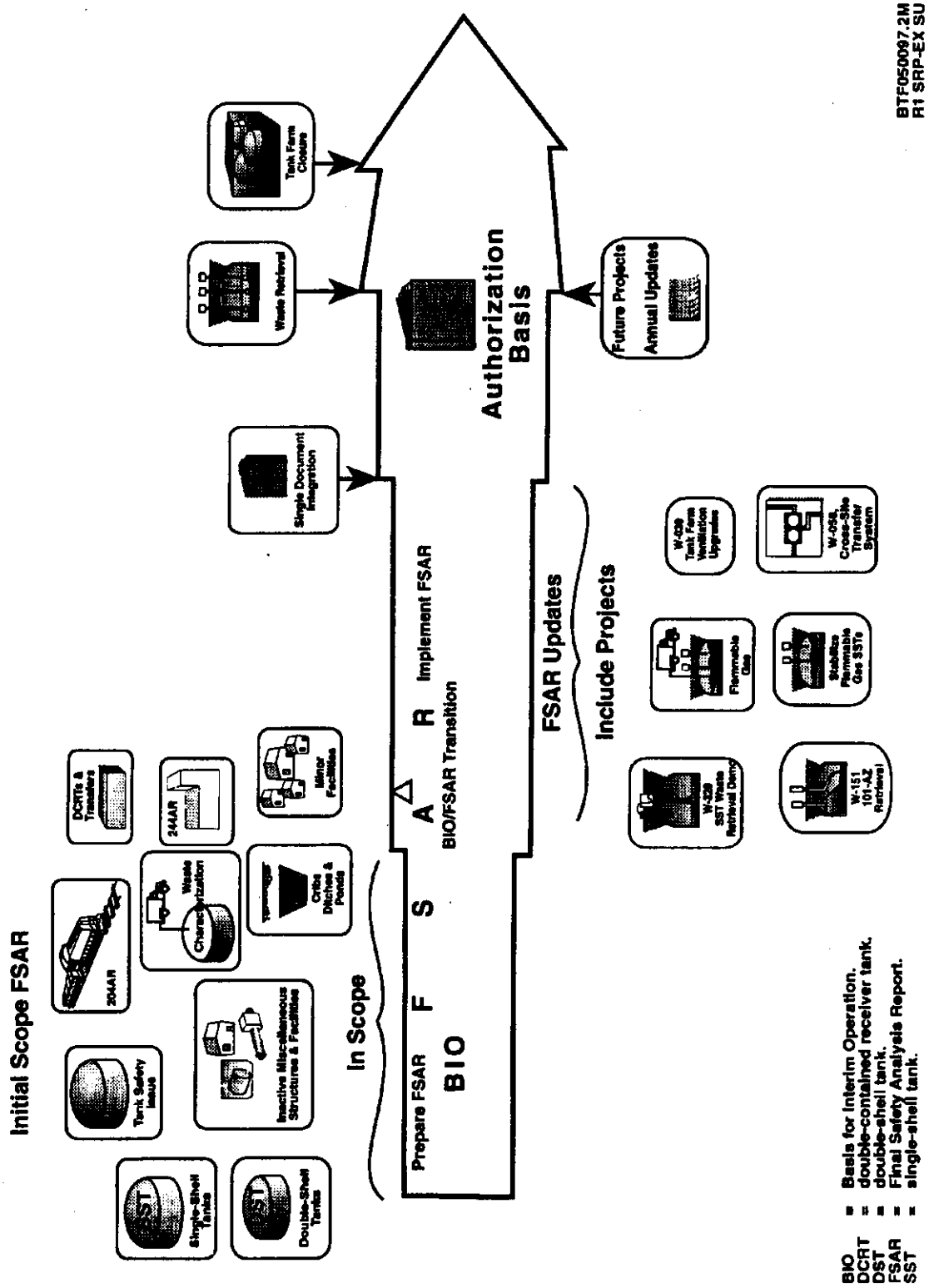

Figure ES-5. Single-Shell Tanks.

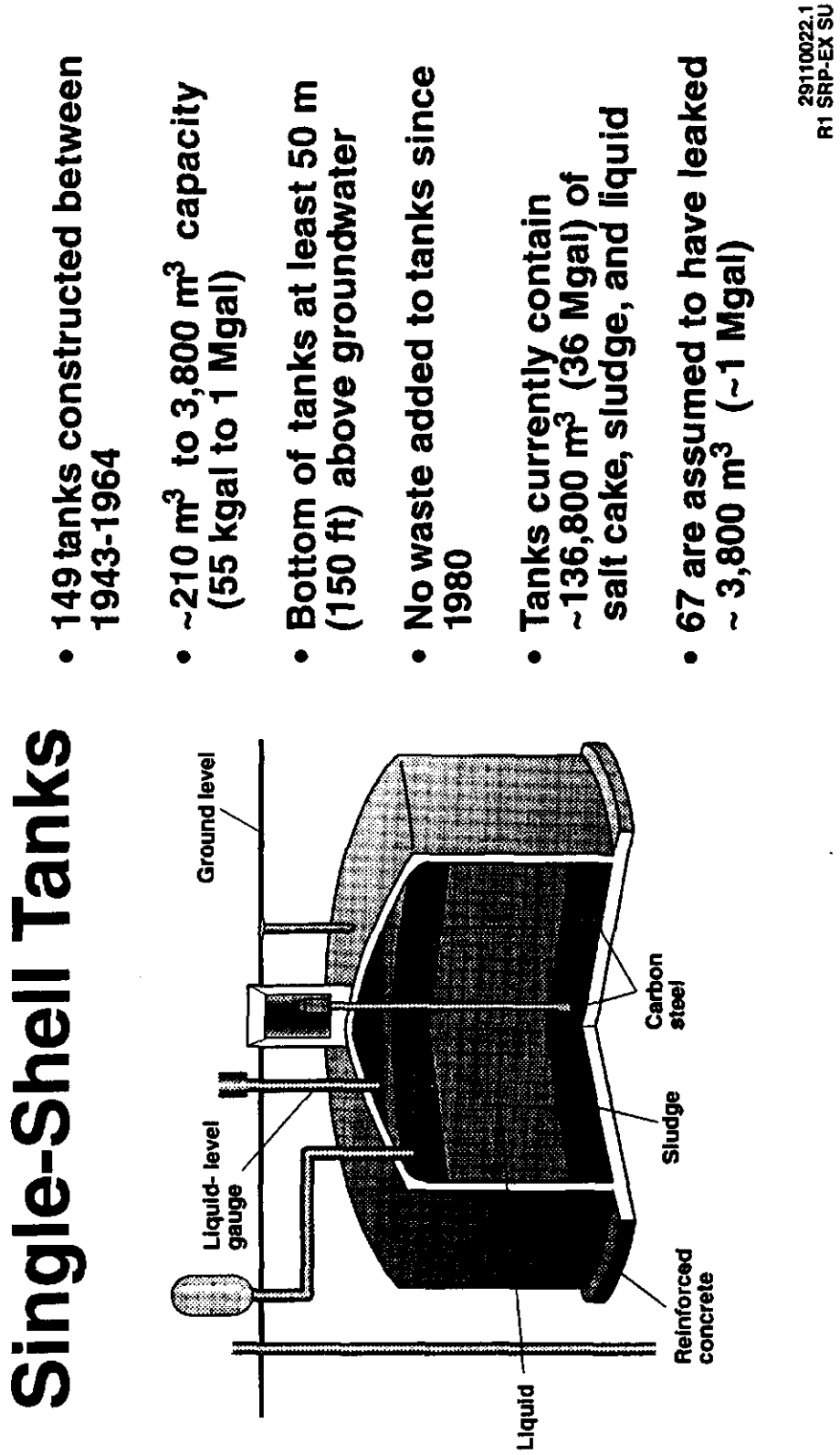

Figure ES-6. Double-Shell Tanks.

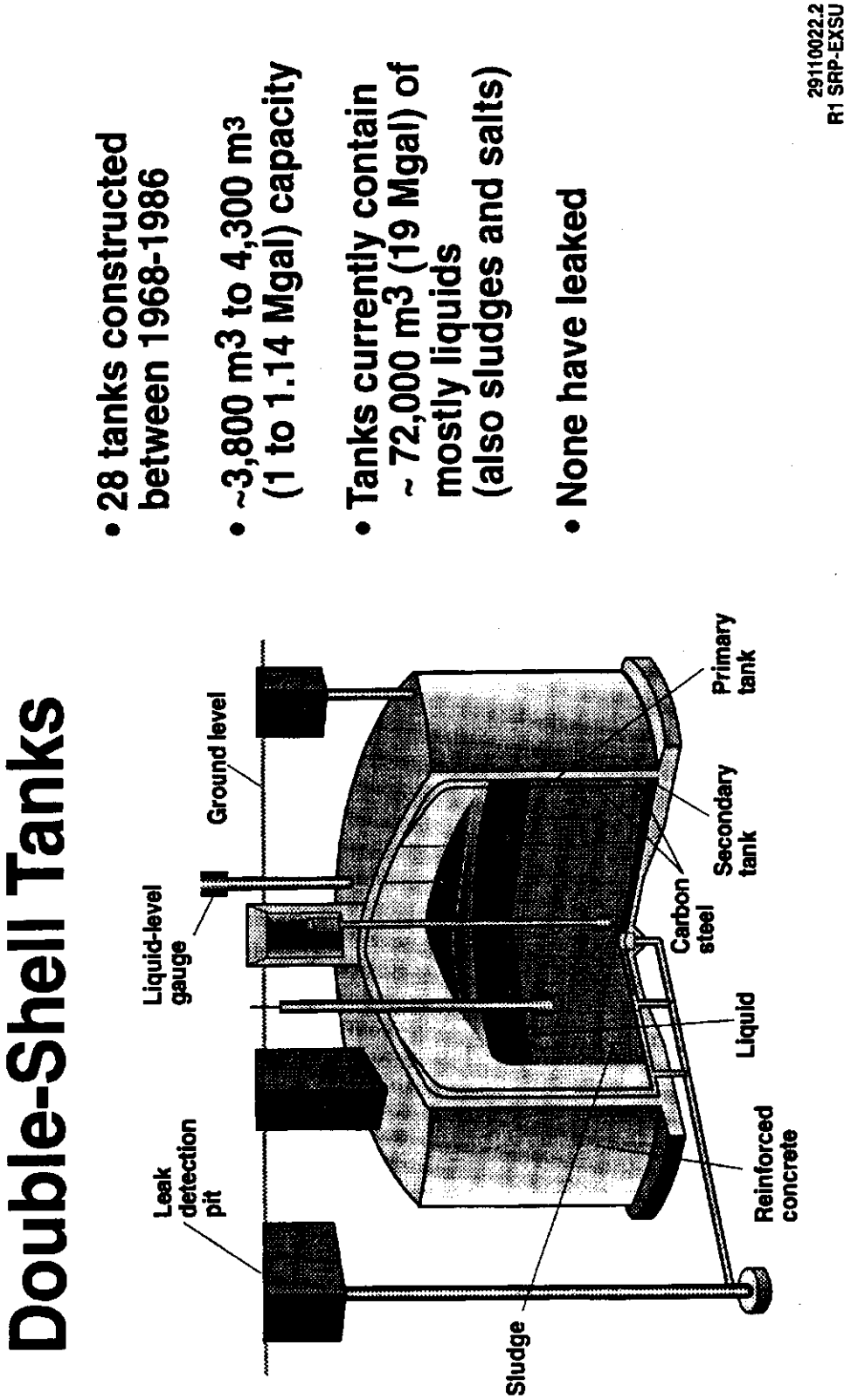

Figure ES-7. Tank Waste Remediation System Organization.

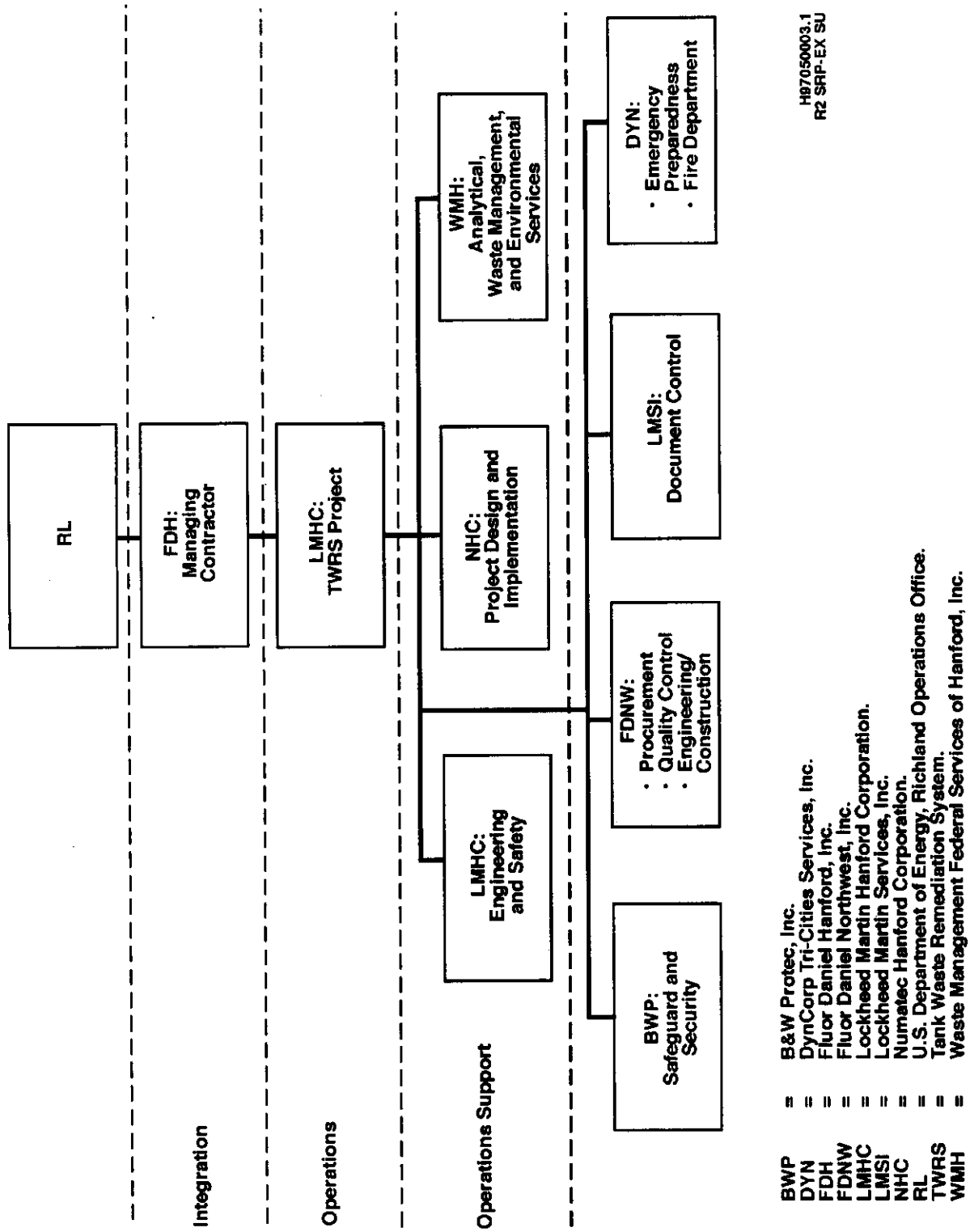

Table ES-1. Accident Analyses Performed.

Nuclear Criticality
HEPA Filter Failure-Exposure to High Temperature or Pressure (includes unfiltered releases)
Fire in Contaminated Area
Evaporator Dump
Steam Intrusion from Interfacing Systems
Leak from Railcar/Tank Trailer
Subsurface Leak Remaining Subsurface
Unplanned Excavation/Drilling in Crib/Ditch/Pond
Caustic Spray Leak
Sodium Fire
Mixing of Incompatible Material - Toxic Vapor Generation
Mixing of Incompatible Material - Tank Pressurization
Tank Failure Due to Excessive Loads (includes tank failure due to vacuum and degradation)
Flammable Gas Deflagrations
Organic Solvent Fire
In-Tank Fuel Fire/Deflagration
Organic Salt-Nitrate Reaction
Surface Leak Resulting in Pool
Subsurface Leak Resulting in Pool
Spray Leak in Structure or From Waste Transfer Lines
Spray Leak from Underground Waste Transfer Lines
Tank Bump
Natural Phenomena (high wind, lightning, and seismic) (includes aboveground structure failures)

Table ES-2. Correlation of TWRS FSAR Chapters to DOE 5480.23 Topics.

Topic	TWRS FSAR Chapter	DOE 5480.23 Topic 8.b.(3)
Executive Summary	unnumbered	(a)
Site Characteristics	1	(c)
Facility Description	2	(d)
Hazard and Accident Analyses	3	(e), (k)
Safety Structures, Systems, and Components	4	(d)
Derivation of Technical Safety Requirements	5	(p)
Prevention of Inadvertent Criticality	6	(h)
Radiation Protection	7	(i), (k)
Hazardous Material Protection	8	(j), (k)
Radioactive and Hazardous Waste Management	9	(g), (k)
Initial Testing, In-Service Surveillance, and Maintenance	10	(o)
Operational Safety	11	(q)
Procedures and Training	12	(m)
Human Factors	13	(n)
Quality Assurance	14	(r)
Emergency Preparedness Program	15	(s)
Provisions for Decontamination and Decommissioning	16	(t)
Management, Organization, and Institutional Safety Provisions	17	(l)

NOTES: Topics (b), (f), and (u) are incorporated into all applicable chapters.

DOE 5480.23, 1994, *Nuclear Safety Analysis Reports*, Change 1, U.S. Department of Energy, Washington, D.C.

FSAR = Final Safety Analysis Report.

TWRS = Tank Waste Remediation System.

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LIST OF TERMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRBG	Columbia River Basalt Group
DOE	U.S. Department of Energy
E	Young's modulus of elasticity
El.	elevation
ETF	Effluent Treatment Facility
FFTF	Fast Flux Test Facility
G	shear modulus
GTF	Grout Treatment Facility
HMS	Hanford Meteorological Station
K_d	distribution coefficient
Koc	soil/organic matter partition coefficient
LERF	Liquid Effluent Retention Facility
MB	body-wave magnitude
ML	Local (Richter) magnitude
MSL	mean sea level
NA	not applicable
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
OMC	nominal percentage of organic matter present in the soil or sediment
OWL	Olympic-Wallowa lineament
PC	Performance Category
PFP	Plutonium Finishing Plant
PMP	probable maximum precipitation
PUREX	Plutonium Uranium Extraction (Facility)
PZ	partially-saturated zone
RAW	Rattlesnake-Wallula alignment
REDOX	Reduction Oxidation (Facility)
RI/FS	Remedial Investigation and Feasibility Study
Supply System	Washington Public Power Supply System
SZ	saturated zone
TWRS	Tank Waste Remediation System
UBC	Uniform Building Code
v	vertical
V_a	shear wave velocity
V_p	compressional wave velocity
WNP	Washington Nuclear Plant
WRAP	Waste Receiving and Processing (Facility)
YFB	Yakima Fold Belt

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1.0 SITE CHARACTERISTICS

1.1 INTRODUCTION

The objective of this chapter is to describe characteristics of the Hanford Site that are applicable to the hazard and accident analyses of specified Tank Waste Remediation System (TWRS) facilities. Applicable TWRS facilities are the single-shell tank farms, the double-shell tank farms, and associated support systems and transfer equipment. See Chapter 2.0, "Facility Description," for details of the facilities addressed in this report.

Much of the Site characteristics information used in this chapter is based on PNL-6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, and DOE/EIS-0189, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington*. Site characteristics are factored into the analyses described in Chapter 3.0, "Hazard and Accident Analyses."

The figures provided in this chapter have been included to aid the reader in visualizing information that is presented in the text. These sketches should not be considered design drawings and they must not be used to make engineering modifications to any systems, structures, or components depicted. Facility modifications are approved in accordance with detailed design information found in established procedures, configuration-controlled drawings, and vendor information.

1.2 REQUIREMENTS

The following are current standards, regulations, and U.S. Department of Energy (DOE) orders that establish the requirements for Hanford Site characterization in support of safety analysis and design. Additional requirements may be imposed on new facilities and facility modifications to meet DOE safety requirements:

- DOE 5480.28, *Natural Phenomena Hazards Mitigation*, Change 0 (1993)[1]
- DOE 6430.1A, *General Design Criteria*, Change 0 (1989)[1]
- DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, Change 1 (1994)
- DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, Change 1 (1993)

[1]Although DOE 5480.28 and DOE 6430.1A have been rescinded recently, the contractor is obligated by the existing contract to meet the requirements in these orders.

- DOE-STD-1022-94, *Natural Phenomena Hazards Characterization Criteria*, Change 1 (1994)

- DOE-STD-1023-95, *Natural Phenomena Hazards Assessment Criteria*, Change 1 (1995)

- DOE-STD-1024-92, *Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites*, Change 1 (1992)

- UCRL-15910, *Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards* (1990).

1.3 SITE DESCRIPTION

The following sections address the geography and demography of the area encompassed by, and surrounding, the Hanford Site. Regional land and water use outside the Hanford Site boundary is discussed.

1.3.1 Geography

1.3.1.1 Hanford Site Vicinity. The Hanford Site is a 1,450-km^2 (560-mi^2) area located in the state of Washington, as depicted in Figure 1-1. The Columbia River enters the Hanford Site boundary at the northwest corner and crosses over to form the eastern boundary as it flows southward. The section of the river that forms the eastern boundary is a free-flowing stretch commonly referred to as the Hanford Reach. The Yakima River flows from west to east, south of the Hanford Site, and empties into the Columbia River at the conjoined cities of Kennewick, Pasco, and Richland as shown in Figure 1-1.

The Hanford Site is bordered on the north by the Saddle Mountains and on the west by the Rattlesnake Hills. Dominant natural features of the Hanford Site include the Columbia River, anticlinal ridges of basalt in and around the Site boundary, and sand dunes near the Columbia River. The surrounding basaltic ridges rise to 1,100 m (3,600 ft). See Figures 1-1 and 1-2 for maps showing some of the prominent natural features in and around the Hanford Site.

The location of the Hanford Site with respect to local counties and regional highways is shown in Figure 1-3. The Site extends into Benton, Franklin, Grant, and Adams counties. State Highway 240 passes through the Site and within 1.6 km (1.0 mi) of the 200 West Area facilities and within 4.24 km (2.65 mi) of the nearest TWRS facility.

1.3.1.2 Hanford Site. The majority of the land within the Hanford Site boundary is a limited-access area under DOE control for use in environmental restoration and remediation efforts. The DOE nuclear and nonnuclear industrial activities within an 8-km (5-mi) radius of the TWRS facilities are described in detail in Section 1.7. DOE nuclear facilities are located in what are called operational areas. Site operational areas are identified by area numbers and letters. These

areas are shown in Figure 1-4. Several other areas at the Hanford Site are managed under a multipurpose concept and serve to isolate the areas of DOE nuclear activities (Figure 1-4). All industrial activities on Hanford Site leased land must be compatible with DOE activities and must be approved by DOE.

With the exception of subsurface contamination caused by releases (inadvertent or planned) and the relatively isolated location of the Hanford Site (away from major population centers), there are no other unique or special features associated with the Site. Subsurface contamination (as it relates to accident analyses) is briefly discussed in Section 1.4.2. Existing subsurface and surface contamination areas and radiological and toxicological constituents are identified and described in DOE/EIS-0189; DOE-RL-92-19, *200 East Groundwater Aggregate Area Management Study Report*; and DOE-RL-92-16, *200 West Groundwater Aggregate Area Management Study Report*.

Public access to the Hanford Site is controlled for DOE at the Wye and Yakima Barricades (Figure 1-5). Traffic counts in 1996 indicate that an average of 61 vehicles per hour traverse State Highway 240. Approximately 10% of these are driven by members of the public. Hanford Patrol, the Site security organization, is responsible for control at the barricades. A recently constructed additional access point to the 200 East and 200 West Areas from State Highway 240, with limited hours of operation, is located near the southeast corner of the 200 West Area. Public access through the Hanford Site on State Highways 24, 240, and 243 is not DOE-controlled under normal circumstances. Traffic on the Columbia River, in the airspace over the Hanford Site, and on onsite access routes to areas used by non-DOE organizations (e.g., U.S. Ecology, Incorporated; Washington Public Power Supply System [Supply System]) is also not subject to DOE controls under normal circumstances. Under emergency plan conditions, all access to the Site (with the exception of the Columbia River) will be DOE-controlled and all Site routes to traffic not associated with official and approved activities may be closed.

1.3.1.2.1 Hanford Site Areas. In 1943, the U.S. Army Corps of Engineers selected the Hanford Site for the construction of nuclear reactors and chemical processing facilities in support of the war effort. The current mission is the management, storage, and disposal of radioactive and hazardous wastes. Approximately 6% of the total available Hanford Site land area is occupied with DOE operational areas (Figure 1-4). The remaining 94% of the Site land area is unoccupied and managed by DOE. Site operating areas are identified by area numbers and are briefly outlined below.

100 Areas. The six 100 Areas (100-B and -C, 100-D and -DR, 100-F, 100-H, 100-KW and -KE, 100-N) border directly on the Columbia River in the northernmost portion of the Site. The nine graphite-moderated plutonium production reactors (awaiting decontamination and decommissioning) are located in these areas. The 100 Areas cover about 10.4 km^2 (4 mi^2).

200 Areas. The 200 East and 200 West Areas are located near the center of the Hanford Site on a relatively flat terrace known as the 200 Areas Plateau (Figure 1-6). Waste management and storage facilities in the 200 Areas include 149 large single-shell tanks and 28 large double-shell tanks used to store radioactive and hazardous waste (Figures 1-7 and 1-8). In addition to the

177 underground storage tanks, there are approximately 40 inactive and 20 active miscellaneous underground storage tanks in the 200 Areas that contain small quantities of radioactive, hazardous and mixed waste. The 200 Areas are the location of several fuel processing facilities that are inactive or scheduled for deactivation (i.e., Reduction Oxidation Facility, Plutonium Uranium Extraction [PUREX] Facility, T Plant, B Plant, U Plant, and Plutonium Finishing Plant [PFP], buried solid waste, and irradiated fuel storage). See Section 1.7 for additional discussion of other 200 Area facilities. The TWRS facilities addressed in this report are located in the 200 East and 200 West Areas (Figures 1-7 and 1-8), which cover approximately 15.5 km^2 (6 mi^2) and contain no permanent residences.

300 Area. The 300 Area, located north of Richland, is the site of nuclear research and development. The 300 Area covers 1.5 km^2 (0.6 mi^2).

400 Area. The 400 Area is located northwest of Richland and is the site of the Fast Flux Test Facility. The 400 Area covers 1.5 km^2 (0.6 mi^2).

600 Area. The 600 Area includes all of the Hanford Site that is not part of the 100, 200 East, 200 West, 300, or 400 Areas. A cross-site transfer line, operated by TWRS, traverses the 600 Area and is used to transfer liquid wastes between underground storage tanks located in the 200 East and 200 West Areas. See Figure 1-4 for a map showing the location of these areas.

- **Fitzner-Eberhardt Arid Lands Ecology Reserve**—The Fitzner-Eberhardt Arid Lands Ecology Reserve occupies the southwest segment of the Hanford Site. This area is a limited-access area managed by Pacific Northwest National Laboratory and has been set aside for ecological studies. This area covers 310 km^2 (120 mi^2). The Big Bend Alberta Company owns mineral rights to several parcels of land in the reserve and holds the right to perform exploratory drilling.

- **State of Washington**—A segment covering 4 km^2 (1.5 mi^2) is leased by Washington State. A part of this segment between the 200 East and 200 West Areas is used for commercial low-level radioactive waste disposal. U.S. Ecology, Incorporated, is a private company responsible for managing disposal of the solid, low-level radioactive waste from commercial (not Hanford Site) sources in this area. Another segment of this area measuring 2.6 km^2 (1 mi^2) has been transferred to Washington State as a potential site for disposal of nonradioactive hazardous wastes.

- **Washington Public Power Supply System**—An area measuring 4 km^2 (1.6 mi^2) is used by the Supply System for commercial nuclear power plants. This area is located approximately 17 km (10.5 mi) southeast of the 200 East Area and approximately 5 km (3 mi) west of the Columbia River. Washington Nuclear Plant (WNP) Number 2, a boiling-water reactor, is in operation at this location.

- **Saddle Mountains National Wildlife Refuge**—About 130 km^2 (50 mi^2) of land north of the Columbia River is managed under a revocable use permit by the U.S. Fish and Wildlife Service. This area is designated as the U.S. Fish and Wildlife Service Saddle Mountains

National Wildlife Refuge. The U.S. Fish and Wildlife Service also manages seven islands in the Hanford Reach section of the Columbia River as part of the McNary National Wildlife Refuge.

- **McNary National Wildlife Refuge**—The area located near the confluence of the Columbia and Snake Rivers includes three divisions: Burbank Slough, Strawberry Island, and Hanford Islands. Only the Hanford Islands Division is within the boundaries of the Hanford Site. The Hanford Islands Division contains six islands in the Columbia River and is located upstream from the city of Richland. The Hanford Islands extend a distance of 14.5 river kilometers (9 river miles) and contain 140 ha (350 acres). The islands are closed to the public during waterfowl nesting season to protect breeding waterfowl, particularly Aleutian Canada Geese, a Federal and State endangered species.

- **Wahluke Wildlife Recreational Area**—An area measuring 225 km^2 (87 mi^2) is under a revocable use permit to the Washington State Department of Wildlife for recreational game management. This area is also located north of the Columbia River and is designated as the Wahluke Wildlife Recreational Area. Public outdoor recreational use is permitted in this area.

- **Bonneville Power Administration**—Support facilities for the controlled access areas and an electrical transmission substation at Midway, Washington, near the northwest corner of the Hanford Site, are maintained by the Bonneville Power Administration. Site transmission lines are also maintained by the Bonneville Power Administration.

The facilities in each area are accessible via existing Hanford Site streets and railroad lines, and most have utilities (i.e., steam, raw water, electricity, communications) and radioactive waste pipelines. The roads and rail lines in the 200 East and 200 West Areas and Route 3 in the 600 Area are shown in Figures 1-7 and 1-8. Electrical distribution systems (i.e., transmission lines and substations) are discussed in Section 2.8.4.

1.3.1.2.2 Hanford Site Boundaries. The Hanford Site boundary that has been established for calculating impacts of potential Site facility accidents is shown in Figure 1-4. TWRS activities in the 200 East, 200 West, and 600 Areas are within this zone. The 200 Areas and the 600 Area are surrounded by a security fence that limits general access. DOE has the authority to regulate all activities in this zone including exclusion or removal of personnel and property. There are no permanent residences in this zone or elsewhere on the Hanford Site. The minimum distance to the Site boundary, as shown in Table 3.4.1-3, was determined by measuring from a rectangular "box" around the 200 East and 200 West Areas to the nearest point on the Hanford Site boundary (WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*). It is assumed in the analysis that this is the location of the maximum offsite individual.

1.3.2 Demography

The population density on the Hanford Site is very low as a result of the federal ownership of the land, and the population distribution in the area surrounding the Hanford Site is not uniform. Most of the adjacent area east, north, and west of the Site is used for farm or range land and is populated with scattered farming communities.

Benton and Franklin counties, which are adjacent to the Hanford Site, make up the Kennewick-Pasco-Richland metropolitan statistical area. Other major cities within Benton County include Benton City, Prosser, and West Richland. The second largest city in Franklin County is Connell. Other counties in the vicinity of the Hanford Site include Yakima, Walla Walla, Adams, and Grant counties in Washington State, and Umatilla and Morrow counties in Oregon (Figure 1-9). Table 1-1 lists the Kennewick-Pasco-Richland metropolitan statistical area population for 1980 through 1995.

DOE/RL-0223, *Emergency Management Procedures*, includes implementing procedures that address evacuating and sheltering Hanford Site areas (including the areas where TWRS facilities are located) and protective actions for the offsite public.

Regional population (residential and transient) distribution data is used by the DOE Richland Operations Office for emergency response planning. Accident consequences are calculated to a maximum offsite individual located nearest to the 200 East or 200 West Areas (Section 1.3.1.2.2). The consequence data can be used in emergency response planning to determine offsite evacuation routes and mitigative features (i.e., shielding or shelters) required to protect the public. The emergency response activities are described in Chapter 15.0.

Note that the metropolitan statistical area population figures presented in Table 1-1 do not identify transient populations (e.g., onsite public recreational users and migrant workers). In addition to recreational users and migrant workers not in the employ of the contractor, transient onsite public includes individuals using public roadways that traverse the Hanford Site. Evacuation time studies performed in support of Supply System emergency planning indicate that to the east of the Supply System operating reactor, migrant worker populations are roughly two times the recreational user populations (Mogle 1987, *WNP-1, 2 Ten Mile EPZ Evacuation Time Assessment Study*). To the northwest of the reactor (i.e., in the direction of the 200 East and 200 West Areas) the transient population predominantly comprises recreational user populations (e.g., boaters). No hospitals, nursing homes, schools, or penal institutions operate within 20 km (12 mi) of TWRS facilities.

Individuals on the Columbia River or on State Highways 24, 240, and 243 are considered transient. Access to the highways or the Columbia River is not controlled, except during emergency conditions (Chapter 15.0).

Individuals from tribal organizations, universities, or other federal, state, or local government agencies, who have received approval from DOE Richland Operations Office to access areas within the Hanford Site (e.g., Fitzner-Eberhardt Arid Lands Ecology Reserve) are also considered

transient. The DOE Richland Operations Office, in accordance with DOE-RLID 1210.1, *Hanford Visitor Policies and Procedures*, may permit uncontrolled access to the Hanford Site; however, all individuals, permitted either controlled or uncontrolled access are required to receive emergency preparedness training (Chapter 15.0).

Approximately 15,000 persons were employed on the Hanford Site in late 1995. This includes contractor employees and the onsite public. The onsite public is defined as employees who are not in the direct employ of the contractor but are supporting the onsite contractor. Figures 1-10 and 1-11 are maps that identify estimated onsite employee distributions by zones as of March 1996. Some Hanford Site work assignments include shift and weekend coverage; therefore, the total number of persons on the Site at any one time varies with the time of day, the staffing requirements for active projects, and daily fluctuations in employee work attendance patterns.

1.3.3 Regional Land and Water Use

This section characterizes regional land and water use outside the Hanford Site boundaries based on information contained in DOE/EIS-0113, *Final Environmental Impact Statement: Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes, Hanford Site, Richland, Washington*, and in PNL-6415.

Land use in the six-county region surrounding the Hanford Site (i.e., Adams, Franklin, Walla Walla, Benton, Yakima, and Grant) is predominantly agricultural. The main industries in the conjoined cities of Kennewick, Pasco, and Richland are either agriculture and energy production or are related to these industries. More than 75% of the land area in the six-county region is used for agricultural purposes, compared to less than 40% agricultural land use statewide. The percentage of agricultural land that is irrigated in this region varies from a low of 33% in Yakima County to a high of 73% in Grant County. Areas of Yakima County near the Hanford Site are irrigated extensively.

The land used for agricultural purposes lies primarily north and east of the Columbia River and south of the Yakima River. The principal agricultural crops associated with irrigated and dryland farming include hay, wheat, potatoes, corn, apples, soft fruit, and vegetables. Land in the area just outside the Hanford Site to the south and west is available for farming, but the area is currently used mainly for grazing cattle and sheep. In the early 1800s the dominant regional plant was big sagebrush, but today cheatgrass is the dominant plant because of livestock grazing, crop raising, and wildfires.

Major regional water uses, in decreasing order, are agricultural, industrial, and municipal.

A U.S. Army training facility, the Yakima Firing Center, is located northwest of the western Hanford Site boundary (Figure 1-12). The nearest boundary of the firing center is more than

24 km (15 mi) west of the 200 West Area. The facility is primarily used as a training area for large-scale maneuvers, particularly those involving tracked vehicles and large long-range weapons (DOE-RW-0070, *Environmental Assessment, Reference Repository Location, Richland, Washington*).

1.4 ENVIRONMENTAL DESCRIPTION

The following sections briefly define the meteorology, hydrology, and geology of the Hanford Site. This information has been used in calculating impacts of postulated TWRS facility accidents to receptors (i.e., onsite, offsite, environmental) and in evaluating facility needs for adequate response to natural phenomena threats. See Chapter 3.0 for results of these calculations and evaluations.

1.4.1 Meteorology

This section summarizes Site-specific meteorology data. This information is used in hazards and accident analyses (e.g., wind, tornado, precipitation) in accordance with DOE-STD-1023-95 and to verify the applicability of existing natural phenomena hazard codes and standards. The Site average wind speeds are used to develop postulated accident consequences and to perform consequence determinations in Chapter 3.0. Criteria from DOE-STD-1020-94 are identified in the applicable subsections of this chapter.

An extensive meteorological monitoring program is conducted at the Hanford Site. Various meteorological data are measured, observed, and stored as part of this program. Program data are used in the preparation of safety documentation and in the preparation of emergency response planning. A wide range of meteorological variables is measured or observed at the Hanford Meteorological Station (HMS), including temperature, relative humidity, precipitation, atmospheric pressure, solar radiation, cloud cover, visibility, and subsurface temperature. Wind data is measured at various levels on a 125-m (410-ft) tower located 492 m (1,614 ft) east of the HMS. Wind and temperature measurements are recorded at various levels at three 60-m (200-ft) towers in the 300, 400, and 100-N Areas and at 23 active 9.1-m (30-ft) towers distributed on the Hanford Site and in the nearby vicinity (Figure 1-13). Data from all towers is telemetered to the HMS. The towers and the HMS make up the Hanford Site meteorological monitoring network. The Site monitoring network is described in detail in PNL-6684, *The Data Collection Component of the Hanford Meteorological Monitoring Program*.

Meteorological data collected at the HMS since 1945 is available. Data from the HMS is representative of the general meteorological conditions for the Site, and specifically for the 200 Areas Plateau. Local variation in the topography of the Hanford Site may cause some aspect of the climate at portions of the Site to differ significantly from those at the HMS. For example, winds near the Columbia River are different from those at the HMS, and, similarly, precipitation along the slopes of the Rattlesnake Hills differs from that at the HMS. Information contained in this section and the associated subsections is taken primarily from PNNL-11107, *Climatological*

Data Summary 1995, with Historical Data, and PNL-4622, *Climatological Summary for the Hanford Area*.

1.4.1.1 Regional Climate. The climate of the Hanford Site region can be classified as midlatitude semiarid, midlatitude desert, or semiarid shrub-steppe depending on the climatological classification scheme used (Critchfield 1974, *General Climatology*). Summers are warm and dry with abundant sunshine. Large diurnal temperature variation results from intense solar heating during the day and radiational cooling at night. Daytime high temperatures in June, July, and August periodically exceed 38 °C (100 °F). Winters are cool with occasional precipitation. Cold air associated with modified arctic air masses can reach the area and cause temperatures to drop below -18 °C (0 °F). Overcast skies and fog periodically occur during the winter season (PNL-4622).

Topographic features have a significant impact on the Hanford Site climate. All air masses that reach the region undergo some modification as a result of passage over the complex Pacific Northwest terrain. The climate of the region is strongly influenced by the Pacific Ocean and the Cascade Range. The relatively low annual average rainfall of 168 mm (6.6 in.) is caused largely by the rain shadow created by the Cascade Range. This mountain range limits much of the maritime influence of the Pacific Ocean that would exist if the mountains were not present. Maritime influences are experienced in the region during the passage of frontal systems that pass through gaps (e.g., Columbia River Gorge) in the Cascade Range.

The Rocky Mountains to the east and north of the Site also impact the regional climate by protecting the region from the severe winter storms and the extremely low temperatures associated with modified arctic air masses that move southward through Canada. Yakima Ridge, Rattlesnake Hills, Horse Heaven Hills, Saddle Mountains, and the Columbia River are other topographic features that impact the local climate (Figure 1-14).

The position of the jet stream directs storm systems into Washington State during the cooler months. These storm systems cause the majority of the precipitation at the Site. The cold, or occluded, fronts associated with these storm systems originate in maritime polar, continental polar, or arctic air masses. Warm fronts occur as warmer maritime air flows over colder continental air. An average of 10 identifiable warm fronts and 52 cold fronts pass through the region each year, the majority of which occur during the colder months (PNL-4622). The passage of fronts leads to increased frequency and intensity of precipitation. Persistent high-pressure ridges in the upper troposphere also periodically occur in the cool season. The high-pressure ridges can trap cold air near the surface and cause extended periods of wintertime air stagnation.

The position of the jet stream directs most storm systems north of Washington State during the warm months, which results in fewer and weaker frontal passages than in the cool months. High pressure with stable, subsiding air is the dominant meteorological condition during the warmer period. Warm weather precipitation tends to be associated with convective activity and the advection of moist, maritime air into the region (PNL-4622).

1.4.1.1.1 Temperature. Average and extreme temperatures recorded at the HMS are listed in Table 1-2. The annual average temperature is 12 °C (53 °F). July is typically the warmest month with an average maximum temperature of 33 °C (91 °F), an average minimum temperature of 16 °C (61 °F), and a monthly average temperature of 25 °C (76 °F). January tends to be the coolest month with an average maximum temperature of 4 °C (38 °F), an average minimum temperature of -4 °C (24 °F), and a monthly average temperature of 0 °C (32 °F). Observed temperature extremes for the Hanford Site since 1944 range from 45 °C (113 °F) to -31 °C (-23 °F). The highest temperature ever recorded on the Hanford Site was 46 °C (115 °F) on July 27, 1939. The lowest temperature ever recorded on the Hanford Site was -33 °C (-27 °F) on December 12, 1919. The high and low temperatures recorded before the HMS was operational are not included in Table 1-2.

Table 1-3 shows the average number of days that maximum and minimum temperatures at the HMS were above or below specified limits. Maximum temperatures greater than or equal to 38 °C (100 °F) occur an average of 12 days/yr with a range of 1 to 28 days. Maximum temperatures greater than or equal to 32 °C (90 °F) occur an average of 51 days/yr with a range of 29 to 79 days. Maximum temperatures less than or equal to 0 °C (32 °F) occur an average of 24 days/yr with a range of 2 to 58 days. Minimum temperatures less than or equal to 0 °C (32 °F) occur an average of 106 days/yr with a range of 70 to 143 days. Minimum temperatures less than or equal to -18 °C (0 °F) occur an average of 3 days/yr with a range of 0 to 18 days. An average of 183 days/yr are free of freezing temperatures with the recorded range being 142 to 216 days.

Severe and abrupt temperature changes occur in the Hanford Site vicinity. During winter, rapid temperature increases, accompanied by surface winds varying from calm to greater than 32 km/h (20 mi/h), frequently occur. This phenomenon, known as a Chinook wind, may produce dramatic temperature variations. For example, on February 10, 1971, a 9 °C (16.2 °F) rise in 12 min was observed at the HMS (PNL-4622).

1.4.1.1.2 Precipitation. The annual average precipitation at the Hanford Site is 168 mm (6.6 in.), with 312 mm (12.3 in.) in the wettest year (1995) and 76 mm (3 in.) in the driest year (1976). Monthly averaged and annual extreme precipitation amounts recorded at the Hanford Site are listed in Table 1-4. On average, 54% of normal annual precipitation falls during November through February. December is the wettest month with 25 mm (1 in.), and July is the driest month with 5.1 mm (0.2 in.). The wettest month on record is June 1950 with 74 mm (2.9 in.). September 1991, August 1988, and August 1955 are the driest months on record with no precipitation. A trace (i.e., less than 0.1 mm [0.005 in.]) or more of precipitation falls an average of 125 days/yr. The average number of days per month in which a trace or more of precipitation falls ranges from 16 days in January to 5 days in July. Precipitation totaling 2.5 mm (0.1 in.) or more in a day occurs 24 days/yr. During a 51-yr period of record (1945 through 1995), precipitation totaling 25 mm (1 in.) or more in a day has occurred 63 times. The greatest recorded 1-day precipitation was 41 mm (1.6 in.) on October 1, 1957 (PNNL-11107).

Hansen et al. 1994, *Probable Maximum Precipitation—Pacific Northwest States*, documents a recent cooperative study by the National Oceanic and Atmospheric Administration, the Bureau

of Reclamation, and the U.S. Army Corps of Engineers, which updates the probable maximum precipitation estimates for the Pacific Northwest. This study supersedes earlier work done by the three organizations. The probable maximum precipitation values, shown in Table 1-5, are estimates of the maximum precipitation physically possible for both general storms (i.e., large air mass interactions) and local storms (i.e., unstable air, thunderstorms). Hansen et al. (1994) shows that at the Hanford Site the probable maximum precipitation for a 6-h local storm produces more precipitation than that produced in the probable maximum for a 24-h general storm. The probable maximum precipitation for a 6-h local storm is related to the area of the storm, the smaller area yielding the most intense storm and highest precipitation. Data is presented for the 2.6-km^2 (1.0-mi^2) and the 26-km^2 (10-mi^2) storm. No annual probability of exceedance is given in Hansen et al. (1994) for the probable maximum precipitation for either storm. The probable maximum precipitation is conservatively assumed to have a less than 1×10^{-6} annual probability of exceedance based on ASCE-7, *Minimum Design Loads for Buildings and Other Structures*.

The probable 6-h maximum precipitation for more frequent storms is based on the analysis of extreme values from 22 yrs of Hanford Site meteorological data (Table 1-5). The precipitation estimates for 100- and 1,000-yr return periods are based on HMS data. Although the estimated values cannot be compared directly with the 2.6-km^2 (1-mi^2) local storm or the 26-km^2 (10-mi^2) general storm, the values do provide a data-based estimate for extreme precipitation on the 200 Areas Plateau. The 6-h precipitation hazard curve has been estimated using the 100- and 1,000-yr average return period values (1×10^{-2} and 1×10^{-3} annual probability exceedance, respectively) from BNWL-1605, *Climatography of the Hanford Area*, and using the 6-h probable maximum precipitation at an assumed frequency of 1×10^{-6} (Figure 1-15).

Total annual snowfall (i.e., all frozen precipitation) varies from 7.6 mm (0.3 in.) to 1,422 mm (56 in.). The average snowfall is 381 mm (15 in.) a year. Table 1-6 presents the monthly average and seasonal maximum snowfalls. The maximum snow depth recorded at HMS (396 mm [15.6 in.]) occurred in December 1985, but the maximum recorded snow depth for the Hanford Site (610 mm [24 in.]) occurred in February 1916. The record number of days with snow depth greater than or equal to 152 mm (6 in.) was 43 days in the winter of 1992-1993. The probability that the depth of snow on the ground will exceed 152 mm (6 in.) is 30% during the winter season. The scatter plot in Figure 1-16 shows Hanford Site snow depth probabilities based on the maximum depths of snow on the ground at the Site that were recorded from the winter of 1946-1947 to the winter of 1980-1981.

Model building codes and standards specify the design criteria for snow loads (DOE-STD-1020-94). The building standards for snow loads are found in ASCE-7. The design ground snow load for the Hanford Site is 73.2 kg/m^2 (15 lb/ft^2).

Glaze ice is a coating of ice formed when rain or drizzle freezes on contact with any surface having a temperature that is below freezing. The annual average number of days with glaze ice is six. Glaze ice generally occurs between November and March. The highest number of days with glaze ice in any winter season is 18. The lowest number of days with glaze ice in any winter season is one. The highest number of days with glaze ice in any given month was nine in January 1970. Rime ice (i.e., supercooled droplets that freeze on contact with solid objects) is another

type of icing phenomenon that is generally associated with supercooled fog in the nearby hills or along the banks of the Columbia River.

1.4.1.1.3 Thunderstorms. A thunderstorm day is a calendar day in which thunder is heard at the HMS observing station one or more times. Table 1-7 shows the average number of thunderstorm days recorded at the HMS per month and per year. The average number of thunderstorm days per year is 10, with the total of days varying from a low of 3 to a high of 23. The largest number of thunderstorm days in a single month was 8. Thunderstorm season is essentially from April through September, but thunderstorms can occur during any month of the year although none have been observed in November or January.

Thunderstorms are classified as "severe" by the National Weather Service when wind gusts exceed 93 km/h (58 mi/h) or when hail diameter equals or exceeds 25 mm (1 in.). Of all thunderstorm events observed at the HMS, 1.9% have been "severe" (PNL-6415). Of the 1.9%, all of the "severe" storm events met the wind gust classification criteria, but hail was seldom observed. The maximum recorded number of days with hail in a year is two.

Thunderstorm speed at the Hanford Site is not quantified by a specific study because of the infrequent occurrences of these storms. In addition, travel speed is complicated by vertical wind speeds within the storm and the storm type. A typical thunderstorm in the Hanford area is a single-cell variety. Travel speeds of 9 m/s (20 mi/h) are reasonable for storms of this nature, based on multicell storm speeds in the midwest (Marwitz 1972, "The Structure and Motion of Severe Hailstorms, Part II Multi-Cell Storms").

Large differences in electrical potential between cloud and earth can occur during thunderstorms and can lead to lightning strikes. There is an average of 0.06 lightning strikes per year per square kilometer at the Hanford Site (WHC-SD-WM-ES-387, *Probability, Consequences, and Mitigation for Lightning Strikes to Hanford High Level Waste Tanks*). The probability of lightning directly striking one of 161 tanks (i.e., the 16 smaller single-shell tanks excluded) was calculated as 3×10^{-5} every year. Considering all 177 tanks, the probability of a lightning strike in some tank farm area is about 1×10^{-2} strike a year. Lightning strikes in the tank farms have not been documented.

1.4.1.1.4 Extreme Winds and Tornadoes. The maximum peak gusts recorded at the HMS are shown in Table 1-8. The highest peak gust, measured at 15 m (50 ft) above ground level, was 129 km/h (80 mi/h) in January 1972. Peak wind gusts at the other 23 meteorological towers located throughout the Site have been observed to be as high as 147 km/h (91 mi/h). On the basis of peak gusts observed from 1945 through 1980, an extreme peak gust at 15 m (50 ft), 100-yr return period, is estimated in PNL-4622 to be 137 km/h (86 mi/h), and an extreme peak gust at 15 m (50 ft), 10-yr return period, is estimated to be 113 km/h (70 mi/h).

Two probabilistic wind hazard assessments have been completed for the Hanford Site. The first assessment, UCRL-53526, *Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites*, is based on more than 30 yr of pre-1979 Hanford Site wind data. The results of the assessment addressed in UCRL-53526 are

shown in Figure 1-17 and are the basis for the recommended Hanford Site wind speeds for calculating hazard assessments listed in DOE-STD-1020-94.

NUREG/CR-4492, *Methodology for Estimating Extreme Winds for Probabilistic Risk Assessments*, is the other probabilistic wind hazard assessment that describes a procedure for estimating extreme wind probabilities. The application of this methodology to Hanford Site data, including post-1979 data, resulted in the hazard curves shown in Figure 1-17.

The wind hazard annual probability of exceedance for Performance Categories 1 and 2 is 2×10^{-2} (DOE-STD-1020-94). In Figure 1-17, this is about 89 km/h (55 mi/h) on the UCRL-53526 curve and about 93 km/h (58 mi/h) on the NUREG/CR-4492 curve. A minimum-design wind speed of 113 km/h (70 mi/h) is required in ASCE-7 and recommended in DOE-STD-1020-94. The Hanford Site design-basis wind speed for Performance Categories 1 and 2 is 113 km/h (70 mi/h). All wind speeds are fastest mile speeds at 9 m (30 ft) off the ground. No criteria exist for windblown missiles for Performance Category 1 and 2 facilities.

The straight wind hazard exceedance probability for Performance Category 3 is 1×10^{-3}. In Figure 1-17, this is approximately 108 km/h (67 mi/h) on the UCRL-53526 curve and 116 km/h (72 mi/h) on the NUREG/CR-4492 curve. The minimum straight wind speed for a Performance Category 3 design basis in DOE-STD-1020-94 is 129 km/h (80 mi/h), which is higher than either of the wind hazard studies and is, therefore, the design basis for the Site. No criteria exist for windblown missiles for existing Performance Category 3 facilities; however, for new facilities a missile is defined as a 2 by 4 plank 9 m (30 ft) aboveground.

The minimum Performance Category 4 wind speed is 145 km/h (90 mi/h). This exceeds values for both of the straight wind curves and is, therefore, the design wind speed for Performance Category 4. Existing criteria for Performance Category 4 facilities do not apply to any TWRS facility.

The point at which the straight-wind and tornado hazard curves intersect determines whether tornadoes should be included in the design and evaluation criteria for the TWRS facilities (UCRL-53526). If the exceedance probability at the intersection is less than 2×10^{-5}, straight winds control the design criteria. In Figure 1-17, the intersection is at 3×10^{-6} on the UCRL-53526 curve and 8×10^{-6} on the NUREG/CR-4492 curve. Therefore, following DOE guidance the Hanford Site does not have a DOE design-basis tornado (UCRL-53526).

1.4.1.1.5 Dust and Blowing Dust. Dust and blowing dust conditions occur with some frequency at the Hanford Site. Dust and blowing dust conditions are recorded at the HMS when horizontal visibility is reduced to 9.6 km (6 mi) or less. Dust conditions occur when dust is carried into the area from distant sources. Dust conditions may or may not occur during strong winds and have been observed with wind speeds ranging from 6 km/h (4 mi/h) to 48 km/h (30 mi/h). Blowing dust conditions occur when dust is being picked up locally and occurs with strong winds. Wind speeds during blowing dust conditions range from 31 km/h (19 mi/h) to 129 km/h (80 mi/h). Dust and blowing dust conditions occur at the HMS, but blowing dust is most common. Table 1-9 shows the average number of days of dust or blowing dust conditions

recorded at the HMS. The average number of days per year with dust or blowing dust conditions is five. The greatest number of such days in any year has been 20, while the fewest has been zero. The greatest number of days with dust or blowing dust in any month was nine in May 1980. Dust and blowing dust conditions occur most frequently between March and May, and again in September, and occur least frequently during November and December. There is no specific design basis criteria associated with dust and blowing dust. Past evaluation of dust and blowing dust has been similar to volcanic ash for design and evaluation purposes.

1.4.1.1.6 Fog and Cloud Cover. Fog conditions are recorded at the HMS any time horizontal visibility is reduced to 9.6 km (6 mi) or less because of suspension of water droplets in the surface layer of the atmosphere. Table 1-10 shows the average monthly and annual number of days with fog and dense fog at the Hanford Site. Dense fog conditions are recorded when horizontal visibility is reduced to 0.40 km (0.25 mi) or less. Most of the fog recorded at the HMS is a common type of fog that forms on nights with light wind, clear sky, and moist air in the lower levels of the atmosphere. Nearly 90% of fog and dense fog conditions occur during the late autumn and winter months. The longest recorded duration of fog was 114 h in December 1985, and the longest duration of dense fog was 47 h in December 1957 (PNNL-11107).

Cloud cover is a term used to express the condition when a portion of the celestial dome is (1) covered but not necessarily hidden by clouds or obscuring phenomena aloft; (2) hidden by an obscuring phenomenon on the ground (e.g., fog, smoke); or (3) a combination of (1) and (2). Cloud cover at the HMS is measured hourly by scanning the sky and estimating the number of tenths that are covered. Cloud cover designation on a given day is based on the cloud cover average from sunrise to sunset. Cloud cover designations are as follows:

- Clear (zero to three tenths)
- Partly cloudy (four to seven tenths)
- Cloudy (eight to 10 tenths).

Table 1-11 shows the average monthly sky cover, sunrise to sunset, from 1946 through 1994; and Table 1-12 shows the average number of clear, partly cloudy, and cloudy days from 1954 to 1995. During the period of record (1954 through 1995), an average of 199 sunny days (sum of clear and partly cloudy days) was recorded per year at the HMS.

1.4.1.1.7 Relative Humidity. The annual mean relative humidity recorded at the HMS is 55%, with the highest average monthly relative humidity (80%) occurring in December and the lowest average monthly relative humidity (33%) occurring in July. Daily relative humidity can change 20% to 30% between early morning and late afternoon. Changes in relative humidity are less pronounced during the winter months (PNL-4622). Higher relative humidity can be expected at locations near the Columbia River and at some locations on the Site periphery where there is increased airborne water vapor from the Columbia River and from irrigated land.

1.4.1.1.8 Dispersion Climatology. Atmospheric dispersion, the transport and diffusion of gases and particles within the atmosphere, is a function of wind speed, duration and direction of wind, the intensity of atmospheric turbulence (i.e., wind motion at very small time scales that acts

to disperse gas and particles rather than transport them downwind), and mixing layer. Atmospheric turbulence often cannot be measured directly and is estimated by the atmospheric stability. Atmospheric stability is the thermal stratification or vertical temperature structure of the atmosphere. The more unstable the atmosphere, the more atmospheric turbulence.

Conditions are favorable for dispersion when (1) the atmosphere is considered to be unstable or neutral, (2) the winds are moderate to strong, and (3) the mixing layer is deep. These three conditions are most common in the summer when neutral and unstable stratification exists about 56% of the time (PNL-4622). Less favorable dispersion conditions may occur when the wind speed is light and the mixing layer is shallow. Less favorable conditions are most common during the winter when moderately to extremely stable stratification exists about 66% of the time (PNL-4622). Less favorable conditions also occur periodically for surface and low-level releases in all seasons from around sunset to around an hour after sunrise as a result of ground-based temperature inversions and shallow mixing layers. There are occasional extended periods of poor dispersion conditions associated with stagnant air in stationary high-pressure systems, primarily during the winter months (PNL-4622). Table 1-13 provides a summary of the mixing-layer thicknesses by season and time of day.

Estimates of the probability of extended periods of poor dispersion conditions are documented in BNWL-1605. The probability of an inversion, once established, persisting more than 12 h varies from a low of about 10% in May and June to a high of about 64% in September and October. These probabilities decrease rapidly for durations of more than 12 h. Table 1-14 contains the probabilities (percent) associated with extended periods of surface-based inversions.

To estimate atmospheric diffusion factors, the dispersion models used in the TWRS facility accident analyses required a joint frequency distribution of wind speed, wind direction, and atmospheric stability. Tables 1-15 and 1-16 present the joint frequency distribution of hourly averaged wind data collected from January 1983 to December 1991 at the 200 East and 200 West Areas, respectively. Before March 1983, atmospheric stability was determined at the HMS on the basis of sky cover or wind speed (Pasquill 1961, "The Estimation of the Dispersion of Windborne Material"). Since March 1983, atmospheric stabilities have been determined by using the U.S. Nuclear Regulatory Commission temperature gradient method (NUREG 1.23, *Onsite Meteorological Programs*).

The frequency of each stability class that occurred at the 200 East and 200 West Areas during the years 1983 to 1991 is listed in Table 1-17. Stability Class D, relatively neutral diffusion conditions, occurred 28% of the time. Conditions favorable for turbulent dispersion, represented by the unstable classes A, B, and C, occurred about 23% of the time. Classes E, F, and G, indicative of conditions unfavorable for turbulent dispersion, occurred about 49% of the time.

Graphical representations of the wind direction and wind speed distribution at the 200 East and 200 West Areas are shown in Figures 1-18 and 1-19. For the 200 East Area (Figure 1-18), winds from the west-northwest occur most frequently (about 20% of the time). Winds out of the northwest and west also occur with a relatively high frequency (12% and 11%, respectively). For the 200 West Area (Figure 1-19), winds out of the west-northwest (15% of the time), northwest

(15% of the time), and west (12% of the time) occur most frequently. For the hours of unstable conditions (stability classes A, B, and C), winds from the northwest occur most frequently in the 200 East and 200 West Areas, and for the hours of stable conditions (classes E, F, and G), winds from the west-northwest occur most frequently.

1.4.2 Hydrology

This section presents the hydrogeology (water and soil characteristics) of the Hanford Site, focusing on the characteristics of the unsaturated zone or vadose zone and the saturated zone or groundwater. Summary discussions of actual or estimated liquid plume travel times through the zones are included. These discussions are based on observed data for known release locations and release mechanisms. See Section 1.4.3 for a detailed discussion of Hanford Site geology.

This hydrostratigraphy data has been used in the TWRS facilities hazards and accident analyses to evaluate releases to the soil column. The data has been used to model and calculate the consequences of associated surface pools (i.e., infiltration), near-surface plumes (i.e., adsorption), or deep underground plumes (i.e., travel times through the unsaturated and saturated zones).

The Columbia River and its tributary, the Yakima River, are the primary Hanford Site surface water features (Figure 1-20). Located on the Fitzner-Eberhardt Arid Lands Ecology Reserve are two small spring-fed streams. West Lake, about 0.04 km^2 (0.02 mi^2) and less than 1 m (3 ft) deep, is the only natural lake to the south of the Columbia River on the Hanford Site. To the north of the Columbia River and on the Hanford Site are natural and seepage lakes. Artificial surface water bodies include ponds and ditches created and used for wastewater disposal.

The vadose zone (i.e., zone of unsaturated sediments between the water table and the ground surface) at the Hanford Site mainly comprises unconsolidated gravels and sands. The thickness of the vadose zone ranges from 0 m (0 ft) at the Columbia River bank and West Lake to more than 100 m (328 ft) at the 200 East and 200 West Areas.

Sand- and gravel-dominated stratigraphic units form aquifers, and fine-grained deposits form aquitards in the unconfined aquifer system. The shallowest suprabasalt aquifer is the unconfined system beneath most of the Hanford Site. Saturated sediments make up a series of aquifers (i.e., permeable bodies of rock) and aquitards (i.e., beds of low permeability adjacent to an aquifer). Confined aquifers are present in sedimentary interbeds and interflow zones between dense basalt flows. The main water-bearing portions (aquifers) of the interflow zones are networks of interconnecting vesicles and fractures of the flow tops and flow bottoms.

1.4.2.1 Surface Water. An overview of flood potential from natural and artificial surface water bodies in and around the 200 East and 200 West Areas is presented in the following subsections.

1.4.2.1.1 Columbia River. The Columbia River originates in the mountains of eastern British Columbia, Canada, and drains an area of approximately 70,800 km^2 (27,300 mi^2) enroute

to the Pacific Ocean (Figure 1-21). Columbia River flow at the United States Geological Survey gauging station, located just west of the Hanford Site boundary (located downstream of Priest Rapids Dam), has been measured since 1917. These data show an average discharge of 3,400 m^3/s (120,000 ft^3/s). The historical maximum discharge recorded at this location was 23,000 m^3/s (812,000 ft^3/s), the historical minimum discharge 1,100 m^3/s (39,500 ft^3/s). The river elevation is approximately 120 m (396 ft) near the 100-B and -C Area and approximately 104 m (343 ft) at the 300 Area (see Figure 1-4 for area locations).

PNL-7500, *1988 Hanford Riverbank Springs Characterization Report*, contains a comparison of Columbia River water quality upstream and downstream of the Hanford Site. Most radioactive constituents were not detected or were detected in similar concentrations at both sampling locations. Only tritium and technetium-99 concentrations were higher downstream. Tritium was measured at 580 ± 180 pCi/L at the downstream location, compared with 180 ± 170 pCi/L upstream. The minimum (0.6 ± 1.2 pCi/L) and maximum (1.8 ± 1.2 pCi/L) levels of technetium overlapped; therefore, no environmental impact due to technetium is apparent.

Flow on the Columbia River is regulated by three upstream dams in Canada and by seven upstream dams in the United States (Figure 1-21). The Hanford Reach, approximately 80 km (50 mi) long, extends from Priest Rapids Dam to just north of the 300 Area. Flow through the Hanford Reach fluctuates significantly and is controlled at Priest Rapids Dam. The three dams with the largest reservoirs upstream from the Hanford Site are the Mica and Hugh Keenleyside dams in Canada and the Grand Coulee Dam in the United States. The controlled flow of the Columbia River caused by these dams results in a lower flood hazard for high-probability floods (e.g., 100-yr floods); however, dam-failure scenarios are significant contributors that result in high flood flows.

The U.S. Army Corps of Engineers evaluated a number of scenarios on the effects of failures of Grand Coulee Dam, assuming flow conditions on the order of 11,000 m^3/s (400,000 ft^3/s). The discharge resulting from a 50% breach at the outfall of Grand Coulee Dam was determined to be 600,000 m^3/s (21 million ft^3/s). No determinations were made for breaches greater than 50% of Grand Coulee, for failures of dams upstream, or for associated failures downstream of Grand Coulee. Based on a 1951 U.S. Army Corps of Engineers study (COE 1951, *Artificial Flood Possibilities on the Columbia River*), the 50% scenario was believed to represent the largest realistically conceivable flow resulting from either a natural or human-induced breach (DOE-RW-0070). The original 1951 study was not reviewed for the purposes of this safety analysis report.

A flood scenario of a 50% breach of Grand Coulee Dam results in a flood level of about 143 m (470 ft) above mean sea level at Columbia River mile 365; this low point is the closest flood route to the 200 Areas Plateau (Figure 1-22). River mile 365 is about 46 m (150 ft) below the ground surface of the lowest elevation tank farm. The 50% breach of the Grand Coulee Dam would not impact the 200 East and 200 West Areas or the land within the 600 Area (i.e., between the 200 East and 200 West Areas) occupied by TWRS. Therefore, this scenario bounds all other

Columbia River flood scenarios. UCRL-21069, *Probabilistic Flood Hazard Assessment for the N Reactor, Hanford, Washington*, provides a detailed hazard assessment of other flood scenarios.

1.4.2.1.2 Yakima River. The Yakima River is approximately 20 km (12 mi) south of and greater than 60 m (200 ft) in elevation below the 200 East and 200 West Areas. The Yakima River is not a flood hazard for the TWRS facilities.

1.4.2.1.3 Cold Creek. Cold Creek and its tributary, Dry Creek, are ephemeral, discontinuous streams in the Yakima River drainage basin (Figure 1-23). The Cold Creek watershed, located in the southwestern portion of the Hanford Site, extends about 16 km (10 mi) up the Cold Creek and Dry Creek valleys. A flood risk analysis of Cold Creek, documented in RHO-BWI-C-120, *Flood Risk Analysis of Cold Creek Near the Hanford Site*, was conducted in 1980 to determine the probable maximum precipitation flood for the Cold Creek system. A map of the extent of the probable maximum flood determined in the risk analysis is presented in Figure 1-23. A recurrence interval is not estimated for this flood, but any occurrence would be a flash flood of short duration. The postulated probable maximum precipitation flood reaches an elevation of about 195 m (640 ft) above mean sea level on the southwestern portion of the 200 West Area. Because the surface elevation of the lowest elevation tank farms (i.e., 241-S, 241-SY, 241-SX, 241-U) is 201 to 204 m (660 to 670 ft) above mean sea level, surface flooding is not anticipated; however, the bottoms of the tanks are below the flood level. Because of the expected short duration of a flash flood, a significant rise in the water table in these areas is not anticipated; therefore, some contaminants from previous waste leak discharges may be mobilized, but the tanks would not be impacted.

1.4.2.1.4 Artificial Water Bodies. In the past, numerous artificial surface water bodies (e.g., cribs, ditches, ponds) existed in the 200 East and 200 West Areas. Effluent disposal wastewater infiltrated the ground and, in many instances, affected groundwater flow and chemistry. Today, only B Pond and the Treated Effluent Disposal Facility located east of the 200 East Area and the state-approved land disposal site located in the 200 West Area receive significant volumes of effluent.

1.4.2.2 Vadose Zone. The vadose zone extends from the ground surface to the top of the saturated sediments of the unconfined aquifer (Figure 1-24). The rate, extent, and direction of liquid flow downward from the surface is based on the characteristics of the vadose zone. This zone variably includes the Hanford formation and locally includes the Ringold Formation Unit E Gravel. In the 200 West Area, the vadose zone is approximately 72 m (240 ft) thick (DOE-RL-92-16). In the 200 East Area, the vadose zone is over 90 m (300 ft) thick, based on the 1991 depth to water level of the unconfined aquifer (DOE-RL-92-19).

The following sections have been taken from DOE/EIS-0189 and provide a description of the vadose zone characteristics (infiltration, perched water, and soil moisture) and vadose zone contamination.

1.4.2.2.1 Infiltration. The thick vadose zone, combined with the general aridity of the climate in the area, result in natural infiltration ranging from near zero (below detection) to

approximately 11 cm/yr (4.3 in./yr) (Gee et al. 1992, *Variations in Recharge at the Hanford Site*). Some episodic recharge of groundwater may occur following periods of high precipitation, especially if combined with topographic depressions, highly permeable surface deposits such as gravel, and where the land is denuded of vegetation. Also, present conditions (bare ground and coarse sand and gravel surfaces) within the tank farms are conducive to higher infiltration than would be expected on undisturbed ground within the 200 Areas. For such conditions, infiltration near the upper range of 10 cm/yr (4.0 in./yr) would not be unreasonable.

The total natural recharge in the 200 West Area is estimated to be approximately 1.3×10^8 L/yr (3.4×10^7 gal/yr) (DOE-RL-92-16). This is based on an average recharge rate of 0.1 cm/yr (0.04 in./yr) through fine-textured soil with deep-rooted vegetation. This value is approximately 10 times lower than recharge volumes from artificial sources.

The current principal sources of artificial recharge in the 200 West Area are four cribs and one ditch associated with the U Plant area located in the eastern portion of the 200 West Area (DOE-RL-92-16). There are also four septic tanks and drain fields that actively discharge water to the soil. The combined volume discharge from these drain fields is estimated to be 12,000 L/day (3,200 gal/day). The total wastewater discharged from these facilities from 1944 to 1992, including the U Plant cribs and ditches, is estimated to have been 1.7×10^{11} L (4.5×10^{10} gal). T Plant and S Plant operations also resulted in large volumes of wastewater discharged to the soil. Liquid is no longer discharged to the soil column from U, T, or S Plants.

Natural recharge in the 200 East Area is estimated to be approximately 2×10^7 L (5×10^6 gal) (DOE-RL-92-19). This is based on a similar average natural recharge rate through fine-textured soil with deep-rooted vegetation, as noted previously for the 200 West Area. Artificial recharge in the 200 East Area is associated with approximately 140 ponds, trenches, cribs, and drains that were used to dispose of approximately 1×10^{12} L (3×10^{11} gal) of wastewater. The wastewater, except for limited discharges to the B Pond, is not directly discharged to the ground. The wastewater is treated to meet the State groundwater standards and piped to a common discharge location in the 200 Areas for discharge to the soil column. The remaining discharges to the ground at B Pond were rerouted to the common discharge location in 1997. Currently, there are 11 active waste management units and 20 active drain fields. These waste management units are associated with B Plant and the PUREX Facility and are located east and northeast of the TWRS site (DOE-RL-92-19). The primary recipients of the wastewater from three waste management units were the ponds and trenches associated with B Plant and PUREX Facility; the 216-A-25 and B-3 Ponds received approximately 7.0×10^{11} L (1.8×10^{11} gal). Liquid is no longer discharged to the soil column from B Plant or the PUREX Facility.

Wastewater, such as the condensate removed from tank waste by the 242-A Evaporator, which is located in the eastern portion of the 200 East Area, is transferred by pipeline to the Effluent Treatment Facility, also located in the 200 East Area. The treated effluent from the Effluent Treatment Facility is then transferred by pipeline and discharged to the ground at the State-approved land disposal site located north of the 200 West Area. The treated wastewater meets all State groundwater discharge requirements except for tritium. The water is disposed of

at this location further to the west so that the tritium contamination will decay to below drinking water standards in the groundwater before it reaches the Columbia River.

1.4.2.2.2 Perched Water. Perched water may occur within the vadose zone in the 200 West Area upon the caliche layer, approximately 55 m (180 ft) beneath the ground surface (DOE-RL-92-16). Measured hydraulic conductivities of this unit range from 0.0009 to 0.09 m/day (0.003 to 0.3 ft/day). Caliche layers have not been encountered in the 200 East Area, and perched groundwater is not as likely to occur except in localized areas (WHC-SD-EN-TI-037, *Summary of the Geology of the 200-BP-1 Operable Unit*). Perched water has been reported in the vicinity of B Pond within the lower part of the Hanford formation.

1.4.2.2.3 Soil Moisture. In areas where artificial recharge is occurring from ponds and trenches, soil is expected to be close to saturation and would not likely be capable of holding substantial amounts of additional liquid. In addition, groundwater mounds have developed beneath these recharge areas. Where there is no artificial recharge, soil in the 200 Areas has a large moisture-holding capacity (DOE-RL-92-19). The potential effect of recharge from Site wastewater disposal activities is discussed in DOE/EIS-0189, Appendix K.

1.4.2.2.4 Vadose Zone Contamination. Contaminants in the vadose zone in the 200 Areas are believed to be associated primarily with waste disposal practices that use engineered structures such as cribs, drains, septic tanks and associated drain fields, and reverse wells (wells that do not penetrate to the groundwater); percolation from ponds, ditches, and trenches such as B Pond and U Pond; and unplanned releases such as leaks from single-shell tanks. The vadose zone is expected to be impacted by these past (and in some cases ongoing) waste management practices in the area immediately beneath the discharging facility and in an undetermined adjacent area (due to spreading as liquid percolates downward). Emerging data regarding vadose zone contamination from past single-shell tank leaks is provided in DOE/EIS-0189, Appendixes F and K.

Most Hanford Site environmental investigations have focused on the potential impacts of contaminants to the groundwater, not the vadose zone. Vadose zone investigations have often relied on geophysical gamma logs that are semiquantitative. The types of contaminants potentially present in the vadose zone near planned and unplanned release sites can be inferred by contaminants detected in the underlying groundwater, contaminants that are reported in waste disposal inventories, or from the Track Radioactive Component inventory system used for single-shell tanks that may be leaking. Table 1-18 (excerpted verbatim from DOE/EIS-0189) lists these contaminants, which include both radioactive materials (transuranic isotopes, uranium, and fission products) and nonradioactive materials (metals, volatile organics, semivolatile organics, and inorganics).

1.4.2.3 Aquifers. Two major aquifer systems, the suprabasalt aquifer system and the confined interbeds in the basalt aquifer system, lie beneath the 200 East and 200 West Areas (Figure 1-24). The stratigraphy of the 200 East and 200 West Areas is discussed in greater detail in Section 1.4.3.

1.4.2.3.1 Suprabasalt and Interbed Aquifer System. The suprabasalt aquifer system at the 200 East and 200 West Areas occurs primarily in the Ringold Formation and lower part of the Hanford formation stratigraphic segments. The sediment in these segments contains interlayered coarse- and fine-grained units, forming a series of aquifers and aquitards. The suprabasalt aquifer system is called the unconfined aquifer because typically there is no upper confining boundary. The depth to the water table below ground surface ranges from less than 37 m (122 ft) near B Pond in the 200 East Area to approximately 104 m (341 ft) south of 200 East Area.

The uppermost part of the aquifer is in a sand and gravel unit and is more than 75 m (246 ft) thick (WHC-SD-ER-TI-003, *Geology and Hydrology of Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*). The lower part of the unconfined aquifer is semi-confined and occurs in the fine-grained sediments of the Lower Mud unit stratigraphic segment. The thickness of this semi-confined zone ranges from less than 6 m (20 ft) beneath the northern portion of the 200 West Area to greater than 15 m (49 ft) in the southern portion of that area (PNL-6820, *Hydrogeology of the 200 Areas Low Level Burial Grounds*). The entire suprabasalt aquifer system is unconfined in the northern portion of the 200 West Area.

The suprabasalt aquifer system at the 200 East Area occurs in the Ringold Formation and parts of the Hanford formation. The suprabasalt aquifer system ranges in thickness from zero where basalt is present above the water table to 60 m (197 ft) in the south and west portions of the 200 East Area.

Horizontal hydraulic conductivity of units within the suprabasalt aquifer system varies considerably (Table 1-19). WHC-SD-EN-TI-019, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, compiles and maps hydraulic conductivity data for the upper portion of the uppermost aquifer in the 200 East and 200 West Areas. The highest conductivity occurs in a channel stretching northwest to southeast across the 200 East Area.

Groundwater flow beneath the 200 East Area is complex because of the convergence of flow from the natural groundwater flow system from the groundwater mound that remains from the now deactivated U Pond in the west and the artificial recharge from B Pond from the east which has also resulted in a large groundwater mound. The high transmissivity beneath most of the 200 East Area causes hydraulic gradients to be very small. Groundwater in the suprabasalt aquifer generally flows from west to east beneath the 200 West Area. Figure 1-25 shows groundwater contours and steady streamlines from the 200 East and 200 West Areas waste sites to the Columbia River. Contaminant plume maps of the 200 East and 200 West Areas are indicative of the effects of waste water disposal on the Site since the mid-1940s and indicate a north-to-northwest direction of flow in the extreme north-central portion of the 200 East Area and a south-to-southeast direction of flow in the southeast portion of the 200 East Area (BNWL-2000, "An Investigation of Regional Flow Patterns Over an Area of Complex Terrain").

Groundwater in the suprabasalt aquifer system at the 200 East and 200 West Areas is contaminated with various hazardous and radioactive constituents. The most significant contaminants include nitrate, carbon tetrachloride, tritium, and technetium (BNWL-2000).

PNL-6328, *Estimation of Ground-Water Travel Time at the Hanford Site: Description, Past Work, and Future Needs*, compiles various estimates of groundwater travel times from the 200 East and 200 West Areas to the Columbia River.

Travel time through the aquifer is much easier to determine than travel time through the vadose zone. Groundwater flow through the saturated zone is easier to model and, at the Hanford Site, the historical movement of plumes in the groundwater provides direct information on travel times and a set of data that can be used to calibrate flow and transport models. Groundwater velocity (average pore velocity) through the aquifer from the 200 East Area is 3.3 m/day (11 ft/day) based on the movement of the tritium plume from the PUREX Facility cribs to well 699-24-33. This results in a travel time of approximately 16 yr from the 200 East Area to the Columbia River (PNL-10550, *Environmental Settings for Selected U.S. Department of Energy Installations - Support Information for the Programmatic Environmental Impact Statement and the Baseline Environmental Management Report*). Travel time from the 200 West Area is greater because of the lower permeability of sediments in the saturated zone. The average pore velocity near 200 West Area is calculated at 0.2 m/day (0.7 ft/day) based on movement of the nitrate plume in this area. The travel time from 200 West Area tank farms to the more permeable sediments near 200 East Area is calculated at 55 yr (PNL-10550), and the total travel time to the Columbia River is calculated at 71 yr (i.e., 16 yr through groundwater and 55 yr through the vadose zone). These estimates are comparable to those of USGS (1987a), *Subsurface Transport of Radionuclides in Shallow Deposits of the Hanford Nuclear Reservation - Review of Selected Previous Work and Suggestions for Further Study*, and PNL-6328 which estimate 10 to 20 yr and 21 to 23 yr, respectively, from the 200 East Area to the Columbia River. ARH-ST-149, *Hanford Pathline Calculational Program - Theory, Error Analysis and Applications*, estimates a minimum of 27 yr from 200 East Area and 84 yr from 200 West Area on the basis of modeling. Assuming vadose travel times of 25 to 30 yr, the estimated travel times from the 200 East and 200 West Areas to the Columbia River are roughly 45 and 100 yr, respectively.

1.4.2.3.2 Sedimentary and Interbed and Aquifer System. The basalt flows and associated sedimentary interbeds form a series of aquifers and aquitards. The dense basalt flows generally form aquitards and the sedimentary interbeds and the vesicular flows on top of the basalt form aquifers. The uppermost extensive confined aquifer beneath the 200 East and 200 West Areas comprises a single interbed and adjacent permeable basalt. The interbed, called the Rattlesnake Ridge interbed, is 15 to 25 m (49 to 82 ft) thick beneath the 200 East and 200 West Areas and generally thickens toward the west (RHO-ST-42, *Hydrology of the Separations Area*; RHO-RE-ST-12P, *An Assessment of Aquifer Intercommunication with B Pond-Gable Mountain Pond Area of the Hanford Site*). Recharge to the Rattlesnake Ridge interbed aquifer occurs in the higher elevations to the west, north, and northeast of the 200 East and 200 West Areas. Groundwater generally flows toward the west to west-northwest beneath the 200 West Area and toward the northeast beneath the 200 East Area (WHC-SD-ER-TI-003).

The Rattlesnake Ridge aquifer is generally separated from the suprabasalt aquifer system by a basalt flow known as the Elephant Mountain Member that is up to 35 m (115 ft) thick. The Elephant Mountain Member north of the 200 East Area has been locally removed by erosion.

Erosion of this member has allowed for hydraulic communication between the Rattlesnake Ridge aquifer and the suprabasalt aquifer system. Contamination found in the Rattlesnake Ridge interbed aquifer results from intercommunication through erosional windows in the Elephant Mountain Member between the interbed and the overlying unconfined aquifer (RHO-RE-ST-12P). Transmissivity rates of the Rattlesnake Ridge interbed and the Elephant Mountain Member interflow zone are included in Table 1-19.

1.4.3 Geology

This section provides a summary of the geologic processes that have occurred and continue to occur in and around the Hanford Site. Included are discussions summarizing historical and recent geologic events that have defined the Site stratigraphy as it relates to the geohydrological and seismic characteristics. These events include volcanism, flooding, and tectonic deformation (seismic). The Site stratigraphy, developed from borehole data, provides the bases for the conclusions and observations of the liquid plume travel times through the saturated and unsaturated zones discussed in Section 1.4.2. The structural and seismic data is used to identify and develop a seismic hazard evaluation in accordance with the guidance provided in DOE-STD-1023-95. The volcanic activity discussion provides data for the volcanic hazard evaluation to be used in accident analyses (i.e., roof loading and loss of high-efficiency particulate air filters).

The Hanford Site lies in the Pasco Basin, one of the largest sub-basins of the Columbia Plateau, in Washington State. The Columbia Plateau is a broad plain situated between the Cascade Range to the west and the Rocky Mountains to the east (Figure 1-26). There are no nearby mountains to the north or south. The Columbia Plateau is often called the Columbia Basin. In the central and western sections of the Columbia Basin, the Miocene Epoch Columbia River Basalt Group (CRBG) is underlain predominantly by continental sedimentary rocks from the Tertiary Period and overlain by fluvial and glaciofluvial deposits from the Tertiary and Quaternary Periods.

1.4.3.1 Physiography. The physiography of the Hanford Site is dominated by the low-relief plains of the Central Plains physiographic region and the anticlinal ridges of the Yakima Folds physiographic region (Figure 1-27). The physiography of the Columbia Basin is the result of late Cenozoic faulting and folding of the CRBG and overlying sediments of the Ringold Formation. The surface topography of the Site has been modified in the past several million years by geomorphic processes related to (1) Pleistocene Epoch cataclysmic floods, (2) Holocene Epoch eolian activity, (3) continuous landslides, and (4) Columbia River erosion.

1.4.3.2 Stratigraphy. The stratigraphy of the Pacific Northwest comprises a collection of accreted terrane rocks added onto the North American craton between the Precambrian and early Cenozoic Eras that are now mostly covered by Cenozoic Era volcanic rocks. Sedimentary rocks derived from eroding uplands areas are intercalated with the volcanic rocks in structural basins that developed along the evolving continental margin.

The generalized stratigraphy of the CRBG is shown in Figure 1-28. The principal bedrock of the Hanford Site is basalt and intercalated and overlying sedimentary rocks. Rocks older than the CRBG are exposed primarily along the margin of the Columbia Basin and vary widely in age, lithology, and structure. The complex stratigraphy and structure that underlie the CRBG at the Columbia Basin are the probable sources for seismic hazards under the basalt. Because of the thick basalt cover, the stratigraphy and types of structure under the Hanford Site are poorly constrained. The sedimentary rocks that overlie the CRBG are principally the fluvial deposits of the Ringold Formation and the Pleistocene Epoch cataclysmic flood deposits of the Hanford Site formation.

1.4.3.2.1 Columbia River Basalt Group. The CRBG is a series of tholeiitic flood basalt flows that were erupted between 17 and 6 million years ago (Figure 1-28). The CRBG covers approximately 164,000 km^2 (63,304 mi^2) and consists of 280,000 km^3 (67,164 mi^3) of basalt (Tolan, et al. 1989, "Revisions to the Estimates of the Areal Extent and Volume of the Columbia River Basalt Group"). The CRBG flows were erupted from north-northwest-trending fissures or linear vent systems in north-central and northeastern Oregon, eastern Washington, and western Idaho (USGS 1979, *Revisions in Stratigraphic Nomenclature of the Columbia River Basalt Group*).

1.4.3.2.2 Stratigraphy of Intercalated and Overlying Sediments. The Hanford Site is situated on a sequence of sedimentary units that overlie the CRBG. These sediments are confined largely to the synclinal valleys and basins of the western Columbia Basin. Although the sedimentary record is incomplete, it is a direct reflection of the structural development of the area (Fecht et al. 1987, "Paleodrainage of the Columbia River System on the Columbia Plateau of Washington State—A Summary"). The upper Miocene Epoch to middle Pliocene Epoch record of the Columbia River system in the Columbia Basin is represented by the upper Ellensburg Formation, Ringold Formation, and Snipes Mountain conglomerate. Except for local deposits (e.g., the Plio-Pleistocene unit and the Early Palouse soils unit) there is a hiatus (caused by erosion or lack of sedimentation) in the stratigraphic record between the end of the Ringold (3.4 million years ago) and the Pleistocene Epoch cataclysmic flood deposits (1.6 million years ago) (DOE-RW-0164, *Site Characterization Plan Reference Repository Location, Hanford Site, Washington*).

Pleistocene Epoch to Recent Epoch sediments overlying the CRBG at the Hanford Site include cataclysmic flood gravels and slackwater sediments of the Hanford formation; terrace gravels of the Columbia River and adjacent rivers (i.e., Snake and Yakima); and eolian deposits.

Late Neogene Sediments. Two main late Neogene Period sedimentary units, the Ellensburg Formation and the Ringold Formation, occur in the Hanford Site region (Figure 1-28). The Ellensburg Formation includes epiclastic and volcaniclastic sedimentary rocks that are intercalated with and overlie the CRBG (Waters 1961, "Stratigraphic and Lithologic Variations in the Columbia River Basalt," USGS 1979). At the Hanford Site, the Ellensburg Formation is mixed with sediments deposited by the ancestral Clearwater and Columbia Rivers. The stratigraphy of the Ellensburg Formation at the Hanford Site is discussed in RHO-BWI-ST-14, *Subsurface Geology of the Cold Creek Syncline*, and Fecht et al. (1987).

Fluvial sediments of the Ringold Formation were those that continued to be deposited in most synclinal valleys of the central Columbia Basin long after the eruptions of the CRBG. Although exposures of the Ringold Formation are limited to the White Bluffs on the east side of the Hanford Site and isolated exposures on the west side, extensive data on the Ringold Formation is available from boreholes at the Hanford Site.

The Ringold Formation consists of semi-indurated clay, silt, pedogenically altered sediment, fine- to coarse-grained sand, and granule-to-cobble gravel layers. Strata of the Ringold Formation are typically below the water table. The textural variations of the strata influence groundwater flow.

The upper part of the Ringold Formation consists of a sequence of fluvial sands, overbank deposits, and lacustrine sediments. The fluvial sand facies is the principal facies of the upper Ringold Formation under the tank farms. The fluvial sand facies consists of quartzo-feldspathic, cross-bedded, and cross-laminated sands that are intercalated with lenticular silty sands, clays, and thin gravels. These sands usually contain less than 15% basalt lithic fragments, and fining upwards sequences are common. Strata were deposited in wide, shallow channels.

1.4.3.2.3 Quaternary Period Stratigraphy. Sediment layers of the Quaternary Period, as thick as 100 m (328 ft) in the Pasco Basin, overlie the Ringold Formation and are the main layers beneath the tank farms. In the Hanford formation, the most extensive Quaternary Period layer is the Pleistocene-aged cataclysmic flood deposits (Figure 1-29). The Hanford formation and underlying Ringold Formation are separated locally by several laterally discontinuous and informally defined units.

Fluvial deposits from major rivers (i.e., Yakima, Snake, Columbia) are represented in the Pasco Basin, dating since at least the late Tertiary Period (Baker et al. 1991, "Quaternary Geology of the Columbia Plateau"). Two main alluvial units, the Plio-Pleistocene unit and the Pre-Missoula gravels unit, are recognized at the Hanford Site. In the central Pasco Basin, mainstream alluvium lies stratigraphically between the Ringold Formation and the Hanford formation. The Pre-Missoula gravels unit, a thick sheet of well-rounded and well-sorted gravel, disconformably overlies the Ringold Formation in much of the central Pasco Basin. This unit is interpreted to be of the early Pleistocene Epoch on the basis of magnetic polarity and stratigraphic position. The mainstream alluvium of probable early Pleistocene Epoch is exposed along Cold Creek and the Yakima Bluffs.

Overlying the tilted and truncated Ringold Formation in an unconformable relationship, in the western Cold Creek syncline (near the 200 West Area) is the laterally discontinuous Plio-Pleistocene unit (DOE-RW-0164). The Plio-Pleistocene unit appears to be correlative to other sidestream alluvial and pedogenic deposits found near the base of the ridges bounding the Pasco Basin on the north, west, and south. These sidestream alluvial and pedogenic deposits are inferred to be of the late Pliocene to early Pleistocene Epoch on the basis of stratigraphic position and magnetic polarity of interfingering loess units.

Eolian Deposits. Loess deposits at the Hanford Site contain a detailed Quaternary record. Five units of the Quaternary record are represented in the Pasco Basin (WHC-MR-0391, *Field Trip Guide to the Hanford Site*). These units are informally referred to as L1 through L5 and are differentiated on the basis of position relative to other stratigraphic units, color, soil development, and paleomagnetic polarity.

The main eolian unit in the subsurface at the Hanford Site is the Early Palouse soils. The Early Palouse soils unit consists of up to 20 m (66 ft) of massive, brown-yellow, compact loess-like silt and minor fine-grained sand (RHO-ST-23, *Geology of the Separations Areas, Hanford Site, South-Central Washington*; RHO-BWI-ST-14; DOE-RW-0164). Granule-sized grains, consisting primarily of basalt, are common in this unit. These deposits overlie the Plio-Pleistocene unit in the western Cold Creek syncline around the 200 West Area. See Figure 1-29 for a graphic representation of this stratigraphy. The main eolian unit is differentiated from overlying graded rhythmites by greater calcium carbonate content, massive structure in core, and high natural gamma response in geophysical logs (DOE-RW-0164). The upper contact of the eolian unit is poorly defined, and the unit may grade up-section into silty strata commonly found in the lower part of the Hanford formation. The unit is inferred to be of the early Pleistocene Epoch on the basis of a predominantly reversed polarity.

The Plio-Pleistocene Epoch deposits and Early Palouse soils form a fine-grained unit in the vadose zone that results in increased lateral spreading of downward moving moisture.

Hanford Formation. Hanford formation is the informal name given to all cataclysmic flood deposits from the Pleistocene Epoch. The Hanford formation is the main stratigraphic unit at the surface of the tank farms. The formation consists of pebble to boulder gravel, fine- to coarse-grained sand, and silt. These deposits are divided into the (1) gravel-dominated, (2) sand-dominated, and (3) silty facies. These facies are referred to as coarse-grained deposits, plane-laminated sand facies, and rhythmite facies, respectively (RHO-BW-SA-563A, *Quaternary Geology of the Pasco Basin, Washington*). The rhythmite facies are also referred to as the "Touchet beds." The Hanford formation is thickest in the vicinity of the 200 East and 200 West Areas (up to 65 m [213 ft] thick). Hanford formation deposits are absent on ridges above approximately 385 m (1,263 ft) above sea level, the highest level of cataclysmic flooding in the Pasco Basin (RHO-BW-SA-563A).

Volcanic Ash Deposits. Volcanism in the Cascade Range was active throughout the Pleistocene Epoch and has continued through the Holocene Epoch (10,000 yr before present to present). The eruption history of the current Holocene Epoch best characterizes the most likely types of activity in the next 100 yr. Many of the Cascade Range volcanoes have been active in the last 10,000 yr, including Mount Mazama (Crater Lake) and Mount Hood in Oregon; and Mount St. Helens, Mount Adams, and Mount Rainier in Washington. These eruptions are recorded in the Quaternary sediments in the form of ash deposits that are interlayered with the sediments. Maps in Figures 1-30 and 1-31 depict the annual probability of volcanic ash accumulation on the Hanford Site.

1.4.3.3 History of Cataclysmic Flooding in the Pasco Basin. Cataclysmic floods inundated the Pasco Basin several times during the Pleistocene Epoch when ice dams failed in northern Washington. Net erosion caused by these floods was minimal and is assumed to have been associated with only the earliest floods. Later floods partially incised older flood deposits before backfilling. Deciphering the history of cataclysmic flooding in the Pasco Basin is complicated due to the probable occurrence of numerous smaller individual floods. Evidence for cataclysmic flooding in the Pasco Basin, besides the sediments, includes high-water marks and faint strandlines along the basin margins. Floods from multiple sources and the paths of Missoula floodwaters migrated and changed course with the advance and retreat of the Cordilleran ice sheet. The best preserved cataclysmic flood record is that of the last Missoula flood.

1.4.3.4 Geologic Structures of the Columbia Basin. The geologic structure of the Pacific Northwest is controlled by a basement rock assemblage of accreted terranes fused onto the structurally complex North American craton from the early Mesozoic to early Cenozoic Eras. The accreted terranes form the backbone of the Cascade Range, Okanogan Highlands, and the Blue Mountains. The terranes are now extensively covered by Cenozoic Era rocks that were folded and faulted in a north-south-oriented compressive regime. North-south compression is continuing in the Pacific Northwest east of the Cascades. This pattern of Cenozoic Era deformation is expected to continue into the future.

The Columbia Basin is a structurally and topographically low area surrounded by mountains ranging in age from the late Mesozoic Era to Recent Epoch. The Columbia Basin has two major structural subdivisions or subprovinces: the Yakima Fold Belt (YFB) and the Palouse Slope (Figure 1-27). The YFB is a series of anticlinal ridges and synclinal valleys in the western and central Columbia Basin. The Hanford Site is in the east part of the YFB. The Palouse Slope forms the eastern part of the Columbia Basin and is mainly a westward-tilting paleoslope. The west boundary of the Palouse Slope is at the east boundary of the Hanford Site.

1.4.3.4.1 Major Structural Features of the Columbia Basin. Three major structural features cross-cut the Columbia Basin and influence the geology of the Hanford Site. These are the Olympic-Wallowa lineament, the Hog Ranch-Naneum Ridge anticline, and the YFB. The Olympic-Wallowa lineament passes along the southern boundary of the Hanford Site and the Hog Ranch-Naneum Ridge anticline forms the western structural boundary of the Pasco Basin. A map of these major structural features of the YFB is shown in Figure 1-32.

Olympic-Wallowa Lineament. The Olympic-Wallowa lineament (Figure 1-32) is a major topographic feature in Washington and Oregon that crosscuts the Columbia Basin and forms the southern boundary of the Hanford Site. The alignment of the topographic features of this lineament parallels prebasalt structural trends along the northwest margin of the Columbia Basin, but it has not been linked to any individual structure (Campbell 1989, *Structural and Stratigraphic Interpretation of Rocks Under the Yakima Fold Belt, Columbia Basin, Based on Recent Surface Mapping and Well Detail*; Reidel and Campbell 1989, "Structure of the Yakima Fold Belt, Central Washington").

The portion of the Olympic-Wallowa lineament that crosses the Columbia Basin is called the Cle Elum-Wallula lineament (Keinle et al. 1978, "Geologic Reconnaissance in the Cle Elum-Wallula Lineament and Related Structures"). It is a 10-km (6-mi) wide, moderately diffuse zone of anticlines that has a N 50° W orientation. As defined in Keinle et al. (1978), the Cle Elum-Wallula lineament consists of three structural parts: (1) a broad zone of deflected or anomalous fold and fault trends extending south from the city of Cle Elum to Rattlesnake Mountain; (2) a narrow belt of topographically aligned domes and doubly plunging anticlines extending from Rattlesnake Mountain to Wallula Gap; and (3) the Wallula fault zone extending from Wallula Gap to the Blue Mountains.

The structural significance of the Olympic-Wallowa lineament has been called into question by two recent geophysical studies. Neither a seismic profiling survey nor a gravity survey revealed any obvious geophysical signatures of this lineament below the CRBG (Jarchow 1991, *Investigations of Magmatic Underplating Beneath the Northwestern Basin and Range Province, Nevada, Seismic Data Acquisition and Tectonic Problems of the Columbia Plateau, Washington and the Nature of the Mohorovicic Discontinuity Worldwide*).

Hog Ranch-Naneum Ridge Anticline. The western structural boundary of the Pasco Basin is the Hog Ranch-Naneum Ridge anticline (Figure 1-32). This anticline is a broad south-trending anticline in the CRBG that crosses the YFB in a north-south direction. This south plunging structure passes through five YFB folds and the Olympic-Wallowa lineament. The Hog Ranch-Naneum Ridge anticline was active in the late to middle Miocene Epoch as demonstrated by thinning of basalt flows across it (Reidel et al. 1989, "The Geologic Evolution of the Central Columbia Plateau"). The east-trending YFB folds show no apparent offset by the cross-structure (Campbell 1989; Keinle et al. 1978; Reidel et al. 1989), nor is the Hog Ranch-Naneum Ridge anticline offset where the Olympic-Wallowa lineament and Cle Elum-Wallula lineament cross it. Growth of the Hog Ranch-Naneum Ridge anticline continued from the Miocene Epoch to Recent Epoch and is now marked by the highest structural points along the ridges that cross it.

Yakima Fold Belt. The YFB subprovince covers about 14,000 km^2 (5,404 mi^2) of the western Columbia Basin (Figure 1-32). The YFB formed as basalt flows and intercalated sediments were folded and faulted under north-south directed compression. The Pasco Basin is near the eastern border of the YFB. The YFB gives the Hanford Site its principal physiographic features and has been the primary structure influencing Hanford Site geohydrologic conditions.

1.4.3.4.2 Structure of the Hanford Site. The Cold Creek syncline, shown in Figure 1-32, lies between the Umtanum Ridge-Gable Mountain uplift and the Yakima Ridge uplift and is an asymmetric and relatively flat-bottomed structure. The 200 East and 200 West Areas lie on the northern flank of the Cold Creek syncline where the bedrock dips approximately 5° to the south. The 300 Area lies at the east end of the Cold Creek syncline where it merges with the Pasco Basin syncline.

The Wahluke syncline is the principal structural unit that underlies the 100 Areas (Figure 1-33). The Wahluke syncline is an asymmetric and relatively flat-bottomed structure similar to the Cold Creek syncline. The northern limb dips approximately 5° to the south. The

steepest limb of the Wahluke syncline is adjacent to the Umtanum Ridge-Gable Mountain structure.

The Umtanum Ridge-Gable Mountain structural trend is a segmented anticlinal ridge extending for a length of 110 km (68 mi) in an east-west direction and passes north of the 200 East, 200 West, and 300 Areas and south of the 100 Areas. The Umtanum Ridge plunges from west to east and joins the Gable Mountain-Gable Butte segment just east of the west boundary of the Hanford Site. The easternmost segment of the Umtanum Ridge, the Southeast anticline, trends southeast off the east boundary of the Gable Mountain-Gable Butte segment.

The 200 East, 200 West, and 300 Areas are situated on the south flank of the Umtanum Ridge-Gable Mountain anticline where the Miocene-aged basalt bedrock dips to the southwest into the Cold Creek syncline. The 100 Areas lie north of the Umtanum Ridge-Gable Mountain anticline in the Wahluke syncline. The deepest parts of the Cold Creek syncline, the Wye Barricade depression and the Cold Creek depression, are approximately 12 km (8 mi) southeast of the 200 East and 200 West Areas. The Cold Creek syncline and Cold Creek depression are under the 200 West Area.

Geologic Structure of the 200 East Area. The general geology and geologic stratigraphy of the 200 East Area are depicted in Figures 1-34, 1-35, and 1-36. Suprabasalt sediments under this area consist of the Ringold Formation and Hanford formation. The Ringold Formation conforms to the basalt bedrock surface and tilts southeast toward the axis of the Cold Creek syncline. The Ringold Formation is dominated by gravel units E and A (i.e., the main unconfined aquifers) that are separated by the Lower Mud unit. The Ringold Formation thins from 50 m (164 ft) at the south end to nearly pinching out at the north end of the area. The units have been truncated and are unconformably overlain by the Hanford formation. The Hanford formation is between 75 and 100 m (246 and 328 ft) thick at the 200 East Area.

Geologic Structure of the 200 West Area. The geology and geologic stratigraphy of the 200 West Area are depicted in Figures 1-34, 1-36, and 1-37. The Elephant Mountain Member of the CRBG forms the bedrock under the 200 West Area. Tank Farms located in the 200 West Area overlie sediments that rest on the CRBG.

The suprabasalt sediments at the 200 West Area consist of the Ringold Formation, Plio-Pleistocene/Early Palouse soils, and Hanford formation. The sediments conform to the basalt bedrock surface and tilt south toward the axis of the Cold Creek syncline. The Ringold Formation thins slightly from north to south and is dominated by gravel units E and A, which are separated by the Lower Mud unit. The Ringold Formation varies from 110 to 130 m (361 to 427 ft) thick, and gravel units A and E are the main unconfined aquifers. The upper Ringold unit is present only in the northern part of the 200 West Area and mainly comprises sands. The Plio-Pleistocene/Early Palouse soils overlie the Ringold Formation and are present throughout the 200 West Area. The Hanford formation overlies the Plio-Pleistocene and Early Palouse soils units and thickens from north to south. The Hanford formation varies from about 10 to 40 m (33 to 131 ft) in thickness.

1.4.3.5 Tectonic Development of the Hanford Site. The geologic history of the Hanford Site from the Precambrian Period to the present significantly impacts hazards analyses (WHC-SD-W236A-TI-002, *Probabilistic Seismic Hazard Analysis, DOE Hanford Site, Washington*). This section summarizes the principal geologic events in the development of the Site geology.

The present structure of the Columbia Basin is the product of north-south compression that began in the early Tertiary Period before the eruption of the CRBG and continues today. The Columbia Basin comprises two fundamental subprovinces: the Palouse Slope and the YFB.

The pattern of deformation in the Columbia Basin has been dominated by north-south compression and subsidence. The YFB is the principal product of the compression and subsidence. This deformation has controlled the location of the Columbia River system since the late Miocene Epoch and has also controlled the depositional pattern of the post-basalt sediments.

The rates of deformation, both regional subsidence and rate of local uplift, in the Columbia Basin have declined since the early Tertiary Period. The present rate of subsidence in the basin is estimated at 3.0×10^{-3} mm/yr (1.0×10^{-4} in./yr), and the rate of ridge growth is estimated at 5.0×10^{-2} mm/yr (2.0×10^{-3} in./yr).

Microseismicity (i.e., high in situ stress conditions) and the geometry of Quaternary-Holocene Epoch faulting indicate that the Columbia Basin is still experiencing north-south compression. Although known late Cenozoic faults are found exclusively on the anticlinal ridges, earthquake focal mechanisms and strain measurements suggest that most stress release is occurring in the synclinal areas. The high in situ stress in the Cold Creek syncline explains the microseismicity in that region, but the absence of microseismicity associated with the anticlinal ridges may result from weakened fault zones lubricated with groundwater, or the fault zones may be locked up.

1.4.3.6 Contemporary Stress and Strain from Seismicity. Seismic monitoring at the Hanford Site began in 1969 when the U.S. Geological Survey installed a small array of seismograph stations around the Site. A closely spaced seismic network was installed at the Site in 1982 to characterize Site microseismicity for a possible high-level waste repository. The complete network operated until 1988 when the number of stations in the network was reduced to its present size of 21 sites. Earthquakes of Richter magnitude 2.5 and larger do occur through most of eastern Washington State.

Earthquakes at the Hanford Site can be related to three crustal layers and five general sources (Tables 1-20 and 1-21). All layers and sources are monitored at the Hanford Site except the Cascadia Subduction Zone source, which is monitored at the University of Washington.

1.4.3.6.1 Vertical Patterns. There are three horizontal layers of stratigraphy related to seismicity at the Hanford Site and vicinity: the CRBG, the prebasalt sediments, and the crystalline basement (Table 1-20). About 75% of Site earthquake events originate in the CRBG layer. The prebasalt sedimentary layer has been the origin of 8% of the events, and the crystalline basement has been the origin of 17% of these events.

Shallow Earthquakes in the Basalt. The majority of the seismicity at the Hanford Site and the surrounding area originates from the basalt layer that extends from the surface to approximately 5 km (3 mi) belowground.

Earthquakes in Sedimentary Rock Below the Basalt. The seismicity in the pre-CRBG sedimentary rock under the Hanford Site is relatively low when compared with the basalt layer but may be related to localized detachment zones that have resulted from the growth of anticlinal structures.

Earthquakes in the Crystalline Basement. Deep earthquakes below 10 km (6 mi) appear to be concentrated in the west and southwest portion of the Hanford Site. The deepest earthquakes located below the Site are shallower than 30 km (19 mi) (WHC-SD-W236A-TI-002).

1.4.3.6.2 Spacial Patterns. There are five different tectonic environments (i.e., earthquake sources) where earthquakes can occur at the Hanford Site (Table 1-21). The five environments are as follows:

- Reverse and thrust faults in the CRBG associated with major anticlinal ridges (e.g., Rattlesnake Mountain, Yakima Ridge, and Umtanum Ridge)
- Secondary faults occurring on the major anticlinal ridges
- Small geographic areas of unknown geologic structure that produce clusters of events, called swarms, usually in the CRBG in synclinal valleys
- Basement source structures
- The Cascadia Subduction Zone.

Very little is known about geologic structures in the crystalline basement beneath the Hanford Site; therefore, earthquakes cannot be directly tied to a mapped fault or other basement structure. The Cascadia Subduction Zone has recently been postulated to be capable of producing a Richter magnitude 5.6 earthquake (WHC-SD-W236A-TI-002).

Floating Earthquakes. Because of a special tectonic environment covering the entire Columbia Basin, the basin is considered a "floating" earthquake region. A floating earthquake is one that, for seismic design purposes, can occur anywhere in a tectonic province, is not associated with any known geologic structure, and can therefore "float" anywhere in the province.

Earthquake Swarm Areas. The major source of earthquakes at the Hanford Site is swarm activity. The location and activity of shallow, intermediate, and deep swarms are described in Supply System 1997, *Final Safety Analysis Report WPPSS Nuclear Project No. 2*. Swarm activity originates in synclinal areas in the YFB. Earthquake swarm events provide evidence for the stress regime in the Pasco Basin. Swarm events do not pose a significant hazard to the Site because these are of relatively small magnitude. There are four general areas of significant swarm

activity that can impact the Hanford Site: the Wooded Island Swarm Area, Coyote Rapids Swarm Area, Cold Creek, and the West Saddle Mountains Swarm Area (see Figure 1-38).

The Wooded Island Swarm Area, located near the 300 Area, occurs at the eastern edge of the YFB where it abuts with the Palouse Slope. This boundary marks the suture zone between the old accreted terranes to the west and the stable Precambrian-Paleozoic craton to the east (Reidel et al. 1994, "Late Cenozoic Structure and Stratigraphy of South-Central Washington"). This zone is also marked by an abrupt increase in thickness of basalt and sub-basalt sediment over the accreted terranes and abrupt thinning of basalt and sediment over the craton.

The Coyote Rapids swarm area is located at the horn of the Columbia River between the 100-K and 100-N Areas. The swarm area occurs over no known geologic structure, but does lie at the intersection of two paleoslopes that make a northeast-southwest trough extending from the city of Spokane, through the Hanford Site, to the Columbia River Gorge. This intersection zone may be a basement weakness zone, but no reason is known for swarms to occur in the present position of the intersection zone.

The Saddle Mountains swarm area is located along the north side of the Saddle Mountains. The swarm area is located north of the Saddle Mountains fault zone in an area that has no mapped geologic structures. Although evidence of recent faulting exists (past 13,000 yr) on the Saddle Mountains fault, no evidence exists of faults at the Saddle Mountains swarm area. The cause of the earthquake swarm is not known.

Magnitude of Earthquakes. Since July 1982, approximately 650 earthquakes between Richter magnitudes 0.0 and 3.8 have been recorded on and around the Hanford Site. The pattern of earthquake activity in the Hanford Site area between 1990 and 1995 is shown in Figure 1-39. The greatest seismic activity is in the low-Richter magnitude range, with only five events exceeding a magnitude of 3.0. The largest regional earthquake recorded was Richter magnitude 5.7 on July 16, 1936, 100 km (62 mi) southeast of the Hanford Site. The 1936 earthquake was estimated to have a peak acceleration of 0.03 *g*.

The largest earthquake recorded on the Hanford Site was Richter magnitude 3.8 near the Coyote Rapids on the Columbia River, near the N Reactor and 15 km (9 mi) from the nearest TWRS facilities. The largest recently felt earthquake was Richter magnitude 3.3 on June 12, 1995, in the Wooded Island Swarm Area. Very shallow earthquakes of 3.8 Richter magnitude in soils similar to the Hanford Site would be expected to produce a ground motion of 0.01 to 0.05 *g* at a distance of 5 km (3 mi). There is very high uncertainty with ground motions of small earthquakes because of the limited data. As shown in Table 1-22, 15 earthquakes with a Richter magnitude of 3.0 or greater have been recorded on the Hanford Site between 1969 and 1995. None of the recorded earthquakes was centered in the areas occupied by TWRS. The records do not include any specific data on resulting actual ground motion at TWRS facilities.

Contemporary Stress in the Cold Creek Syncline. Contemporary stress in the Cold Creek syncline is expressed principally as horizontal shortening and subsidence. Geodetic surveys were

performed across the Pasco Basin to determine rates of shortening (Prescott and Savage 1984, *Crustal Deformation Near Hanford, Washington*). The data suggests north-south shortening, but the rate of shortening is not statistically significant at the 95% confidence level.

Contemporary stress measurements were performed at the Hanford Site as part of the Basalt Waste Isolation Project. Hydraulic fracturing tests were conducted in boreholes drilled in the Cold Creek syncline at about 1 km (0.6 mi) depth (DOE-RW-0164). The results indicated high in-situ stress. The maximum horizontal stress was shown to range from 52.6 to 67.4 Mpa (7,630 to 9,780 lbf/in.^{2}) and the minimum horizontal stress ranges from 30.3 to 35.7 MPa (4,400 to 5,180 lbf/in.^{2}) with a mean horizontal-to-vertical ratio of 1.77 ± 0.20. The mean orientation of induced fractures, and the direction of the maximum horizontal stress are consistent with north-south compression.

Subsidence has been occurring in the Pasco Basin since at least the Eocene Epoch. Estimates of subsidence since the middle Miocene Epoch (17 million years ago) indicate the rates of subsidence have declined to the present. From 17 to about 15.6 million years ago, the rate of subsidence was about 1.0 to 0.7 cm/yr (0.4 to 0.3 in./yr). This subsidence rate decreased to about 0.03 cm/yr (0.01 in./yr) 15.6 to 14.5 million years ago. The present rate of ridge growth is estimated at 0.44 mm/yr (0.02 in./yr), and the rate of subsidence in the basin is estimated at 0.003 mm/yr (0.0001 in./yr).

The patterns of subsidence in the Cold Creek syncline are shown in Figure 1-40. The two broad areas of subsidence in the Cold Creek syncline include the Wye Barricade depression and the Cold Creek depression. Both areas have had a long, slow history of subsidence (RHO-BWI-ST-19, *Preliminary Interpretation of Tectonic Stability of the Reference Repository Location - Cold Creek Syncline, Hanford Site*), but neither is located near the 200 East or 200 West Areas.

1.4.3.7 Geologic Hazards. The geologic hazards that affect the performance of TWRS facility activities have been assessed on the basis of the geologic data addressed in previous sections. These hazards are discussed below and, where appropriate, are quantified for use in the structural evaluations and safety analyses for the TWRS facilities addressed in this report.

1.4.3.7.1 Seismic Hazard Assessment. A seismic hazard analysis was recently completed for the DOE-controlled areas on the Hanford Site (WHC-SD-W236A-TI-002). Power et al. (1981), "Seismic Exposure for the WNP-2 and WNP-1/4 Site," documents a previous Site seismic hazard analysis performed for the Supply System. Application of the analysis findings (Power et al. 1981) to the DOE-controlled areas on the Hanford Site is documented in WHC-MR-0023, *Evaluation of Seismic Hazard for Nonreactor Facilities, Hanford Reservation, Hanford, Washington.*

WHC-SD-W236A-TI-002 incorporates seismo-tectonic data and interpretations that postdate the Power et al. (1981) assessment. Potential seismic crustal sources determined to be major contributors to the seismic hazard in and around the Hanford Site are as follows:

- Fault sources related to the YFB
- Shallow basalt sources that account for the observed seismicity in the CRBG and not associated with the anticlines
- Crystalline basement source region.

The mean seismic hazard curves for the 200 East and 200 West Areas are shown in Figure 1-41. Proximity to the YFB fault sources is the chief reason for seismic hazard differences across the Hanford Site. The difference between 200 East and 200 West Area hazard curves is chiefly related to the distance from the Yakima Ridge buried extension. Figure 1-42 illustrates contributions of individual YFB folds to the mean seismic hazard at the 200 East and 200 West Areas.

The seismic hazard exceedance probabilities for each Performance Category are derived in DOE-STD-1020-94 and presented in Table 1-23. The peak horizontal surface ground accelerations for the 200 East and 200 West Areas are also shown in Table 1-23.

Horizontal equal-hazard response spectra were developed for the 200 East and 200 West Areas. The 200 West Area Performance Category 3 response spectra at 5% damping are shown in Figure 1-43. The response spectra are anchored to the peak surface ground acceleration. Additional response spectra damping values are presented in WHC-SD-W236A-TI-002 and Tables 1-24, 1-25, 1-26, and 1-27.

The Site response characteristics of the soils underlying the 200 East and 200 West Areas are similar to those represented in the California empirical strong motion database (WHC-SD-W236A-TI-002). This similarity was determined by comparing the relative response of characteristic Hanford Site soil profiles and dynamic soil properties with those of California deep soil strong-motion recording stations. Time histories representative of the events contributing to the Hanford Site hazard were used for ground motion input (WHC-SD-W236A-TI-002).

The TWRS waste tanks were analyzed and designed to the seismic response spectra criteria in place at the time of their analysis or design. Figure 1-43 also illustrates two previously used response spectra for comparative purposes. The horizontal design response spectrum used from October 1, 1973, to September 5, 1989, was developed for the Fast Flux Test Facility reactor. The response spectrum criterion from September 6, 1989, to present was developed in compliance with UCRL-15910. DOE-STD-1020-94 provides guidance for evaluating existing facilities from which the response spectrum for existing 200 East and 200 West Area facilities was developed (Figure 1-43).

1.4.3.7.2 Volcanic Hazard Assessment. Two types of volcanic hazards have affected the Hanford Site in the past 20 million years. The hazards were (1) continental flood basalt volcanism that produced the CRBG and (2) volcanism associated with the Cascade Range. Several volcanoes in the Cascade Range are currently considered to be active, but activity associated with flood basalt volcanism has ceased.

The flood basalt volcanism that produced the CRBG occurred between 17 and 6 million years ago. Most of the lava was extruded during the first 2 to 2.5 million years of the 11-million-year volcanic episode. Volcanic activity has not recurred during the last 6 million years, suggesting that the tectonic processes that created the episode have ceased. The recurrence of CRBG volcanism is not considered to be a credible volcanic hazard (DOE-RW-0164).

Volcanism in the Cascade Range was active throughout the Pleistocene Epoch and has remained active through the Holocene Epoch. The eruption history of the current Holocene Epoch best characterizes the most likely types of activity in the next 100 yr. Many of the volcanoes have been active in the last 10,000 yr, including Mount Mazama (Crater Lake) and Mount Hood in Oregon; and Mount Saint Helens, Mount Adams, and Mount Rainier in Washington (Figures 1-30 and 1-31). The Hanford Site is approximately 150 km (93 mi) from Mount Adams, 175 km (109 mi) from Mount Rainier, and 200 km (124 mi) from Mount Saint Helens, the three closest active volcanoes. At these distances, the tephra (ash) is the only hazard. Mount Saint Helens has been considerably more active throughout the Holocene Epoch than Mount Rainier or Mount Adams, which is the least active of the three.

Probabilistic volcanic hazard studies of the Cascade Range have been completed by the U.S. Geological Survey (USGS 1987b, *Volcanic Hazards with Regards to Siting Nuclear-Power Plants in the Pacific Northwest*; USGS 1995, *Volcanic Hazards in the Mount Adams Region, Washington*). Figure 1-30 illustrates the annual probability of exceeding 10 mm (0.4 in.) of volcanic ash accumulation in Washington and Oregon following the eruption of a major Cascade Range volcano, and Figure 1-31 illustrates the annual probability of exceeding 100 mm (4 in.) of volcanic ash accumulation. Figure 1-44 presents this information as a volcanic ash hazard curve for the Hanford Site.

1.4.3.7.3 Subsurface Stability. The tank farms and associated facilities are all on the 200 Areas Plateau, a large flood bar formed by cataclysmic flooding during the Pleistocene Epoch. The foundation material is predominantly the sand-dominated facies of the Hanford formation with varying amounts of gravel. The backfill used at the tank farm sites consists of native soil that has been compacted. Though the 200 Areas Plateau soils have the same genesis, variations in the depositional energy results in textural variation across the plateau. The static and dynamic properties of the plateau soils are quite similar, but the specific characteristics at each tank farm must be evaluated for certain analyses.

Soils investigations completed at a site near the west boundary of the 200 East Area and at a site in the 200 West Area for proposed new tanks provided information on static, dynamic, and general soil characteristics (ICF KH 1995a, *Geotechnical Investigation KEH W-236A, Multi-Function Waste Tank Facility, 200 East Area, Hanford Site, Richland, Washington*;

ICF KH 1995b, *Geotechnical Investigation KEH W-236A, Multi-Function Waste Tank Facility, 200 West Area, Hanford Site, Richland, Washington*). Tables 1-28 and 1-29 summarize the static soil properties near the 200 East and 200 West Areas. The dynamic soil properties for the two areas are shown in Tables 1-30 and 1-31. These property lists illustrate the general characteristics of the 200 Areas Plateau soils.

Soil properties are presented in these tables for several strata. Stratum 1 is the loose wind-blown surface material that is characterized as loose to dense silt with sand and is not considered a structural foundation material. Stratum 2, the next underlying layer, is medium dense to very dense, fine to coarse gravel. The next lower layer is Stratum 3, a dense to very dense, fine to medium sand. Materials lying below the Hanford formation sands and gravels are discussed in Section 1.4.3 and shown in Figure 1-36. Tables 1-28, 1-29, 1-30, and 1-31 refer to materials below elevation 42.7 m (140 ft) as bedrock. Backfill is excavated material from Strata 2 and 3, which has been mixed-conditioned and then placed as engineered fill.

Field and laboratory studies that have been completed at many of the tank farm sites are summarized in WHC-SD-GN-ER-30009, *Bibliography and Summary of Geotechnical Studies at the Hanford Site*. These studies reveal that there are no areas of potential surface or subsurface subsidence, uplift, or collapse at the Site, with the minor exceptions of the Cold Creek and Wye Barricade depressions discussed previously. With the exception of the loose superficial wind-deposited silt and sand in some locations, the in-place soils are competent and form good foundations.

Liquefaction is the sudden decrease of shearing resistance of a cohesionless soil, caused by the collapse of the structure by shock or strain, and is associated with a sudden but temporary increase of the pore fluid pressure. Saturated or near-saturated soil (sediments) are required for liquefaction to occur. Therefore, liquefaction of soils beneath the tank farms is not a credible hazard because the water table is greater than 65 m (213 ft) below ground surface.

1.5 NATURAL PHENOMENA THREATS

The meteorology, hydrology, geology, seismology, and geotechnical site information presented in previous sections of this chapter are summaries of the data required by DOE-STD-1022-94. This data provides the fundamental input for development of the natural phenomena hazards following guidance in DOE-STD-1023-95. Hazard curves were developed and are presented for straight wind and tornado, local precipitation, seismic ground motion, and volcanic ash.

DOE-STD-1020-94 presents a graded approach to hazard mitigation, including graded performance goals based on the Safety-Class designation and hazard of the facility, design guidance for the natural phenomena hazards, and a probability of exceedance for each hazard.

The following natural phenomena have been addressed in the preceding sections and represent initiating events that should be addressed in Chapter 3.0. The TWRS is designated a Hazard

Category 2 nuclear facility; design or evaluation criteria for Performance Category 1, 2, and 3 facilities are provided in Table 1-32. The natural phenomena threats that require evaluation in the hazards and accident analysis are addressed below and in Table 1-32:

- **Temperature**—No design or evaluation guidance is provided for evaluation of extreme temperatures. Although extreme temperatures are not considered initiating events, extreme temperature is considered during the evaluation of systems important to safety.

- **Precipitation**—No design or evaluation guidance, with the exception of that for snowfall, is provided for the evaluation of maximum precipitation. However, in addition to snow loading, as a potential initiator, the impacts associated with flash flooding of the Cold Creek are evaluated.

- **Thunderstorms**—No design or evaluation guidance is provided for the evaluation of thunderstorms; however, the phenomena associated with thunderstorms (i.e., hail and lightning) are appropriate for consideration. There have been limited observances of hail on the Hanford Site (maximum observance is 2 days in 1 yr); however, because of the potential for lightning strikes and the potential for lightning to be an initiating event, thunderstorms are evaluated.

- **Extreme Winds and Tornadoes**—Design or evaluation guidance is provided for the evaluation of extreme winds and tornadoes and wind-generated missiles. High winds are considered an initiating event and dispersion mechanism. Tornadoes are not considered credible following the methodology prescribed in UCRL-53526.

- **Dust and Blowing Dust**—No design or evaluation guidance is provided for the evaluation of dust or blowing dust. These phenomena will have similar impacts associated with blowing or falling volcanic ash and are addressed similarly.

- **Fog and Cloud Cover**—No design or evaluation guidance is provided for the evaluation of fog and cloud cover. This is not considered an initiating event; however, fog and cloud cover may impact dose consequence evaluations.

- **Relative Humidity**—No design or evaluation guidance is provided for the evaluation of relative humidity. Although these are not considered initiating events, humidity is considered during evaluation of systems important to safety.

- **Dispersion Climatology**—This data is used to determine consequences to receptors, plume travel times and distances, and contaminant concentration levels. This data is provided as joint frequency data, which is input into dose consequence models used in Chapter 3.0.

- **Hydrology**—No design or evaluation guidance is provided for the evaluation of hydrogeologic properties, including infiltration rates, liquid travel times through the vadose zone and the groundwater, and flooding. The discussion associated with liquid

travel times is presented to provide an understanding of the potential impacts of releases to the soil column for consideration in the hazards and accident analysis. Dam flooding is not considered credible because of the elevation of the 200 East, 200 West, and 600 Areas with respect to the Columbia River. As identified in the maximum precipitation discussion, the impacts associated with flash flooding of the Cold Creek are evaluated.

- **Seismic Hazards**—Seismic events are considered credible accident initiators at the Hanford Site and should be evaluated. Design or evaluation guidance, specific to the Hanford Site, is provided for the evaluation of seismic events. All events (i.e., low- and high-magnitude earthquakes) are considered in the hazards and accident analyses.

- **Volcanic Hazards**—Design or evaluation guidance is provided for the evaluation of ashfall loading as a potential initiating event. Although no criteria are provided for blowing or falling ash, ash is evaluated as an initiating event (e.g., loss of ventilation systems).

- **Subsurface Stability**—No design or evaluation guidance is provided for the subsurface stability. The discussion associated with subsurface stability is presented to provide an understanding of the potential for impacts to facilities or structures from long-term (40+ yr) settling of compacted soils.

1.6 EXTERNAL MAN-MADE THREATS

This section identifies and investigates specific man-made threats associated with the TWRS facilities that are considered to be potential accident initiators, exclusive of sabotage and terrorism. Transportation activities discussed separately include potential accidents from roadway vehicles, railcars, and aircraft.

The highways traversing the Hanford Site and the restricted-access Site roadways are transportation routes for trucks delivering gas, diesel fuel, and chemicals. Because of the distance from these highways to the TWRS facilities, the impact of a highway accident involving toxic and hazardous chemicals will be less severe than a worst-case chemical or toxic material accident occurring in the 200 East and 200 West Areas. The restricted access onsite roadways are routinely used for transporting personnel to and from TWRS facilities and for delivery and removal of parts, process chemicals, and solid or liquid waste. Many of these roadways are adjacent to (i.e., within 15 m [50 ft] of a facility or tank farm gate) and provide access to the facilities. Therefore, vehicular impacts on the onsite roadways are evaluated.

The main line of the Hanford Site railroad passes within about 250 m (820 ft) of the 241-T, 241-TX, and 241-TY Tank Farms (Figure 1-8). A toxic or hazardous chemical spill from a nearby railcar could impact the facilities; however, the potential for a railcar physically impacting a TWRS facility is credible only at the 204-AR Waste Unloading Facility (see Chapter 3.0).

No commercial refineries or major oil, ammunition, or explosive storage facilities are located within 32 km (20 mi) of the TWRS facilities. The nearest natural gas transmission pipeline is approximately 48 km (30 mi) from the facilities. The distance of the refineries, storage facilities, and the pipeline from the 200 East and 200 West Areas makes the hazard from explosions or fires at the commercial refineries and storage facilities almost nonexistent.

No private, commercial, or DOE-owned airports are located within 32 km (20 mi) to the east of the 200 East and 200 West Areas. To the south a private airfield is located 11 km (7 mi) from the 200 West Area. The four nearest airports are the Richland Airport, the Tri-Cities Airport in Pasco, Vista Field in Kennewick, and the Prosser Airport in Prosser. The small, general-utility Prosser Airport is the nearest (38 km [24 mi] to the south). Commercial air carriers use the Tri-Cities Airport, located approximately 48 km (30 mi) southeast of the 200 East and 200 West Areas. The probability that commercial aircraft at the Tri-Cities Airport or small private and commercial aircraft at Richland Airport, Vista Field, and Prosser would adversely impact the TWRS facilities is remote, given the low air traffic volume and the distance of the airports from the 200 East and 200 West Areas.

1.7 NEARBY FACILITIES

Accidents in certain nearby facilities have the potential to impact TWRS facilities and operations. Conversely, certain nearby facilities can be affected by accidents in the TWRS facilities.

1.7.1 Potential Effects from Nearby Facilities

Potential hazards to TWRS facilities from onsite or offsite hazardous operations or facilities are examined under three general classifications:

1. Nonreactor nuclear and nonnuclear industrial facilities within 8 km (5 mi) of the TWRS facility sites, including all activities conducted in and near the 200 East and 200 West Areas

2. Nuclear reactors within an 8-km (5-mi) radius of the tank farms

3. Military activities.

1.7.1.1 Hazards to Tank Waste Remediation System Facilities from Nonreactor Nuclear Facilities. Safety documentation for facilities not part of this Final Safety Analysis Report scope were reviewed for hazard potential. The facilities selected are those believed to pose significant risk to safe operations of TWRS. The selected facilities were those (1) currently operating, (2) recently operating, or (3) with potential to affect TWRS facilities in the 200 East and 200 West Areas. Safety analysis reports and accident analyses prepared for the nonreactor nuclear facilities were reviewed to determine possible hazards (e.g., radiological doses to

personnel resulting from direct radiation, release of airborne radioactivity, exposure to toxic chemicals).

Hazard potential was considered from the burial grounds, inactive cribs, ditches, and ponds, Liquid Effluent Retention Facility, Effluent Treatment Facility, T Plant, U Plant, Reduction Oxidation Facility, 222-S Laboratory, and the Critical Mass Laboratory. These facilities have insufficient radiological or toxicological inventories to cause an accident that could significantly affect TWRS operations. Facilities specifically discussed in Chapter 3.0 include the following:

- PUREX Facility (200 East)
- Grout Treatment Facility (200 East)
- B Plant (200 East)
- Waste Encapsulation and Storage Facility (200 East)
- 242-A Evaporator (200 East)
- PFP (200 West)
- Low-Level Waste Disposal Site (200 West)
- K Basins (100-KE and 100-KW Areas).

Each of the postulated facility accidents has the potential to impact TWRS operations; however, if a release occurs, the impacts and response actions (facility or Hanford Site) are identified in the facility (where the release originated), TWRS, and Hanford Site emergency response plans in DOE-RL-93-75, *Hanford Facility Contingency Plan*. When appropriate, impacts associated with interfacing facilities (i.e., facilities interfacing with TWRS that have the potential to initiate an accident at a TWRS facility) have been addressed in Chapter 3.0.

1.7.1.1.1 Plutonium Uranium Extraction Facility. The PUREX Facility is located in the 200 East Area, southwest of the 241-AW Tank Farm. This facility is the most recently constructed of the irradiated fuel separation facilities and was used for processing N Reactor fuel. The principal product was a solution of plutonium nitrate that was transferred to the PFP for further processing. Another product was uranyl nitrate solution, which was processed at the Uranium Oxide Plant. The PUREX Facility is shut down and awaiting decontamination and decommissioning. The postulated PUREX Facility accidents having the most severe radiological consequences to a maximally exposed individual are associated with a loss of active ventilation in conjunction with an external event (i.e., natural or human-made) with sufficient energy to suspend surface contamination (fixed or loose).

1.7.1.1.2 Grout Treatment Facility. The Grout Treatment Facility is located approximately 400 m (1,312 ft) due east of the 241-AP Tank Farm (Figure 1-7). At this facility tank wastes are combined with grout-forming solids to create a grout slurry. The waste feed stream constituent of this slurry comprises low-level fractions of radioactive wastes. The slurry ultimately is pumped into near-surface concrete-lined vaults for permanent disposal. Only one vault has been filled with grout (completed in 1987), even though additional vaults have been designed and constructed. The Grout Treatment Facility is currently not operational, but there is a possibility that the facility will operate again in the future.

1.7.1.1.3 B Plant Facility. The B Plant is located in the 200 East Area southwest of the 241-BX Tank Farm. B Plant was operated as a fuel separation facility until 1952. In 1968, the plant was converted to a waste fractionation plant to remove cesium-137 and strontium-90 from radioactive waste streams to reduce the heat load in the double-shell tanks. The B Plant now provides essential support to the Waste Encapsulation and Storage Facility and is undergoing preparations for a transition to shutdown status. The most credible accident at B Plant results from the simultaneous occurrence of (1) a solvent fire in which hot gases from the fire heat filters and drive off material on the filters, and (2) a blow back of solution into the pipe gallery from tank pressurization (WHC-SD-WM-TI-385, *B Plant Preliminary Accident Analysis*).

1.7.1.1.4 Waste Encapsulation and Storage Facility. The Waste Encapsulation and Storage Facility is distinct from B Plant even though it shares a common wall at the west end of B Plant. Historically, activities at the Waste Encapsulation and Storage Facility involved converting cesium and strontium into cesium chloride and strontium fluoride salts. These materials were then encapsulated in double-walled metal containers and stored in a water-filled cooling basin. Cesium chloride and strontium fluoride capsules are still being stored at the facility in the cooling basin, but no new capsules are being produced. The worst-case credible accidents postulated for B Plant involve a truck fire with a leaking gas tank that catches fire in the plant truck port and causes an extended loss of water in the pool cells.

1.7.1.1.5 242-A Evaporator. The 242-A Evaporator is located directly south of the 241-A Tank Farm and directly north of the 241-AW Tank Farm. At the 242-A Evaporator, evaporative concentration is used to reduce the volume of liquid wastes (low-heat-generating tank wastes). Once reduced, the concentrated slurry is transferred and stored in an underground waste storage tank. The process condensate is routed to the Liquid Effluent Retention Facility for storage and eventual treatment at the Effluent Treatment Facility. Following startup of the Effluent Treatment Facility, the process condensate will be routed directly to that facility.

Five 242-A Evaporator design basis accidents were analyzed that involved radiological releases (WHC-SD-WM-SAR-023, *242-A Evaporator/Crystallizer Safety Analysis Report*). The worst-case scenario involved a release from a spray leak in the pump room and a failure of the exhaust system high-efficiency particulate air filters.

1.7.1.1.6 Plutonium Finishing Plant. The PFP is located near the western boundary of the Hanford Site in the 200 West Area, southwest of the 241-TX Tank Farm. At this plant, plutonium nitrate solution is converted to plutonium metal, and plutonium handling and storage operations are performed. Contaminated liquid waste streams from the PFP are routed to the tank farms. The plant is currently in a standby mode and is not anticipated to operate again in the future. The worst-case accident scenario at this point is associated with a postulated fire having an airborne release of plutonium-239 (WHC-SD-SQA-TI-013, *Safety and Risk Assessment Technical Information to Support Plutonium Finishing Plant Restart*).

1.7.1.1.7 Low-Level Waste Disposal Site. The commercial low-level waste disposal site, operated by U.S. Ecology, Incorporated, is the only non-DOE industrial facility within 8 km (5 mi) of the nearest TWRS facilities. The disposal site is on land leased from Washington State

(see Section 1.3.1.2). The low-level waste is buried in lined containers. Groundwater, vegetation, and other activities are monitored as required by the facility U.S. Nuclear Regulatory Commission operating license and environmental impact statement.

1.7.1.1.8 K Basins. The K Basins include the fuel storage pools located in the 100-K East and 100-K West Area fuel storage facilities. The facilities were constructed as storage for spent nuclear fuel following irradiation in 100-K East and 100-K West reactors before processing. A review of WHC-SD-SNF-TI-013, *K Basin Environmental Impact Statement Technical Input*, indicates that the worst-case event at either basin is a cask dropped into a spent fuel pool. This event would result in a release of spent fuel and canister sludge.

1.7.1.2 Hazards to Tank Waste Remediation System Facilities from Nonnuclear Industrial Facilities. A number of nonnuclear industrial facilities operating in the 200 East and 200 West Areas pose the potential for accidental fires, explosions, or releases of toxic fumes. These facilities include the essential materials warehouse (Building 275-EA), oil and paint storage buildings, fabrication shops, gas cylinder storage buildings, the spare parts and electrical warehouse, B Plant storage buildings, maintenance facilities, gasoline service stations, the powerhouse complexes (284-E and 284-W), and the water treatment facilities (283-E and 283-W).

Building 275-EA is an essential materials warehouse that is considered representative of most warehouses and fabrication shops on Site. The building is located approximately 150 m (500 ft) north of the PUREX Facility and approximately 100 km (328 ft) southwest of the 204-AR Waste Unloading Facility. Building 275-EA is classified as an unprotected wood frame structure and is susceptible to collapse as a result of an external event (e.g., earthquake, wind, snow, or ash loading) or an internal event (e.g., forklift collision with a bearing wall or fire). More than 100 different types of potentially hazardous solids and liquids are currently stored in Building 275-EA. The solids and liquids include acids, bases, solvents, fluorides, pesticides, and herbicides. Radioactive materials are not stored in this building. The worst-case chemical release postulated in the safety analysis occurs following a building collapse whereupon 2,450 kg (5,445 lb) of 1,1,1-trichloromethane evaporates under adverse atmospheric conditions.

The three boilers in the 242-A Package Boiler System provide steam for evaporator operation and building heat loads. The system description and potential hazardous conditions to TWRS were discussed and evaluated in HNF-1727, *Hazard Evaluation of the 242-A Package Boiler System Impact on Tank Farms*. Based on the evaluation, the 242-A Package Boiler System does not increase the frequencies or consequences or present any new or modified accidents not already addressed by the FSAR.

Other nonnuclear industrial facilities with the potential to impact TWRS operations are those facilities that provide raw water and electricity. Raw water is supplied to the 200 East Area from the 282-E Building and in the 200 West Area from the 282-W Building. Raw water from the 282-E and 282-W reservoirs is piped to the 283-E and 283-W water treatment facilities to be chlorinated for use as sanitary water. These systems are not pressurized and thus do not represent

a significant hazard during normal operations. Only programmatic impacts (i.e., loss of facility capability) have been identified. No other nonnuclear industrial facilities or operations have been identified that may impact TWRS operations.

1.7.1.3 Hazards to Tank Waste Remediation System Facilities from Nuclear Reactors. The N Reactor and Fast Flux Test Facility are reactors that have recently been in operation, but pose no threat to TWRS facilities.

The N Reactor was a 4,000-MW, dual-purpose, pressure-tube, light-water cooled, graphite-moderated reactor. The reactor, which is located in the 100-N Area, began operating in 1964 and was used to produce plutonium for the defense program and steam for electrical power generation. The reactor was shut down in 1987 for safety improvements and then subsequently defueled and placed in cold standby in 1988. N Reactor is currently undergoing decontamination and decommissioning.

The Fast Flux Test Facility is a 400-MW, sodium-cooled, mixed-oxide-fueled, breeder reactor that is currently in "hot shutdown" and has been defueled. "Hot shutdown" does not preclude reloading and restart of the reactor. The reactor is located in the 400 Area and is approximately 7.2 km (4.5 mi) from the nearest Hanford Site boundary. As discussed in WHC-SD-WM-SAR-023, the worst-case event analyzed will not impact operations at the 242-A Evaporator, which is adjacent to 241-AW and 241-AP Tank Farms.

The only nuclear reactor on the Hanford Site operating during the lifetime of the TWRS facilities is WNP-2 (Figure 1-4). WNP-2 is an operational commercial nuclear power plant using a boiling-water reactor steam supply system. Worst-case accidents at the WNP-2 reactor do not carry any potential for adversely impacting TWRS operations or personnel.

1.7.1.4 Hazards to Tank Waste Remediation System Facilities from Military Facilities. There are two military facilities within 80 km (50 mi) of the Hanford Site: the Umatilla Army Depot and the Yakima Firing Center. Both facilities pose potential hazards to the Site; however, the Yakima Firing Center is directly adjacent to the Site and has performed military exercises near the Site. For this reason, only the Yakima Firing Center is discussed further.

The Yakima Firing Center, a subinstallation under the command of Fort Lewis (Tacoma, Washington), is the site of the only significant military activity in the vicinity of the Hanford Site (DOA 1979, *Final Environmental Impact Statement-Ft. Lewis Military Installation*). The multiple launch rocket system is the only weapon currently in use at the center that is known to present a hazard to Hanford Site facilities. With a range of approximately 26 km (16 mi), a rocket launched from the system has the potential to impact the 200 West Area (Figure 1-45); however, the rocket system is only fired with dummy warheads from the perimeter of the Yakima Firing Center, away from the Hanford Site, and into a centrally located impact zone.

A more probable hazard from the Yakima Firing Center to Hanford Site facilities is a scenario in which a fire starts in the Yakima Firing Center boundary and spreads to the Hanford Site. Exploding artillery shells and sparks from tracked vehicles or other machines may start brush fires

that, under adverse meteorological conditions, could spread rapidly beyond the firing center boundaries. Hazards associated with range fires are discussed in Chapter 3.0.

1.7.2 Potential Effects on Nearby Facilities

TWRS facility accidents with the potential to affect the maximum onsite individual (which may include persons at some of the facilities cited in Section 1.7.1) are specifically limited to those accidents discussed in Chapter 3.0.

1.8 VALIDITY OF EXISTING ENVIRONMENTAL ANALYSES

No significant discrepancies have been identified between the Site characteristic assumptions herein and those existing in DOE/EIS-0113 or DOE/EIS-0189.

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Figure 1-1. Location of the Hanford Site, Principal Cities and Towns in the Vicinity of the Site, and Prominent Natural Features in Washington State.

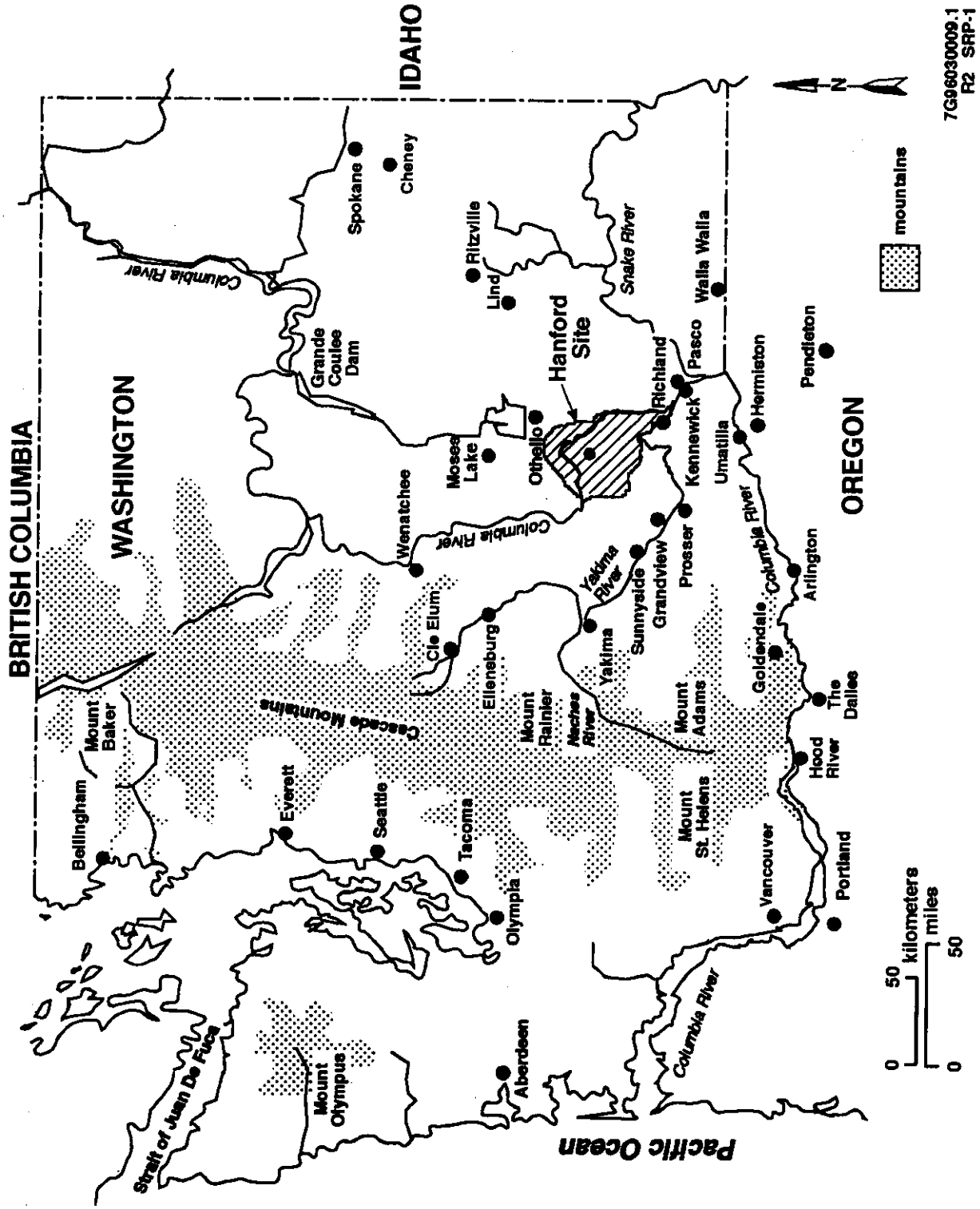


Figure 1-2. Prominent Natural Features of the Hanford Site Vicinity.

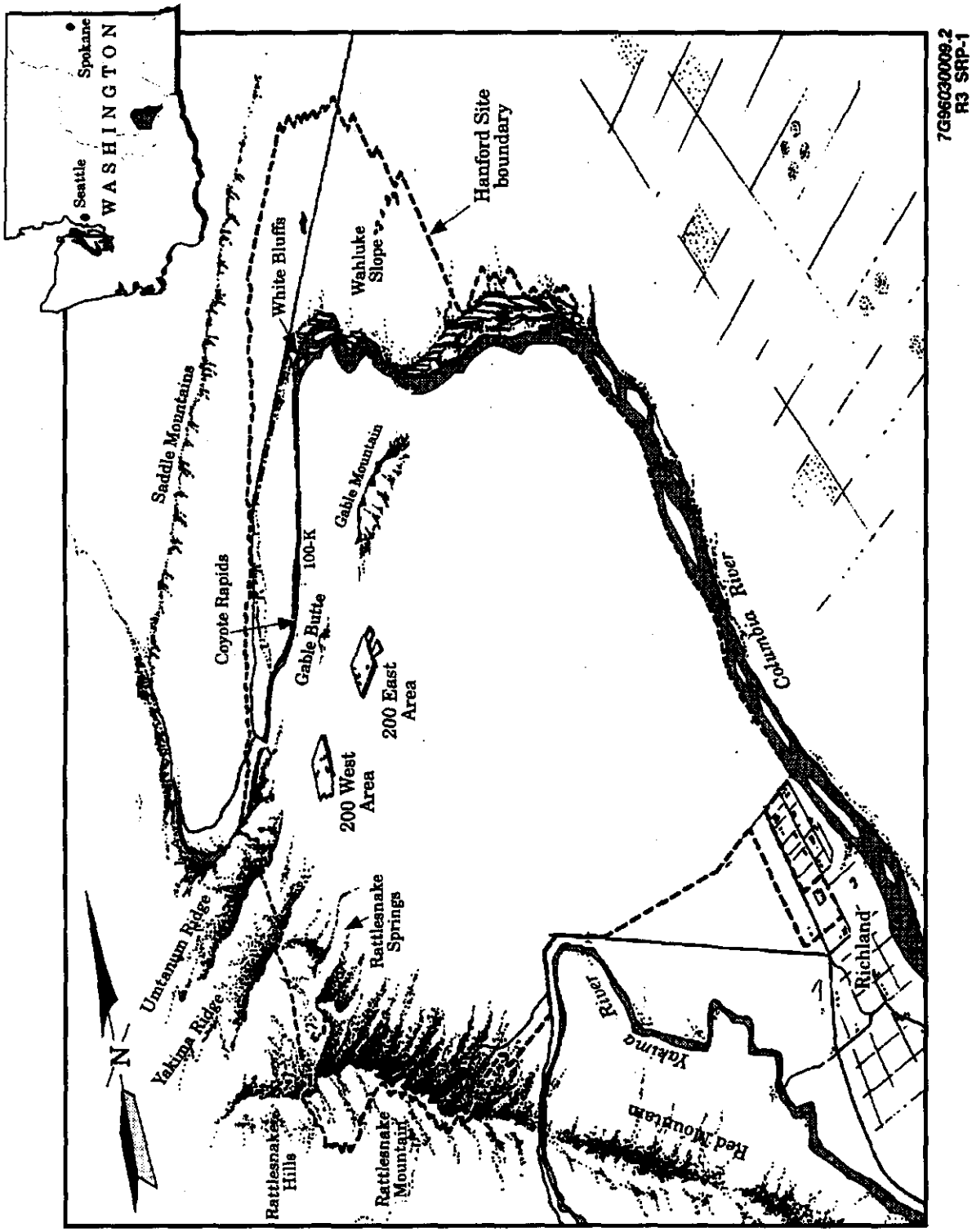


Figure 1-3. Location of the Hanford Site with Respect to Local Counties and Regional Highways.

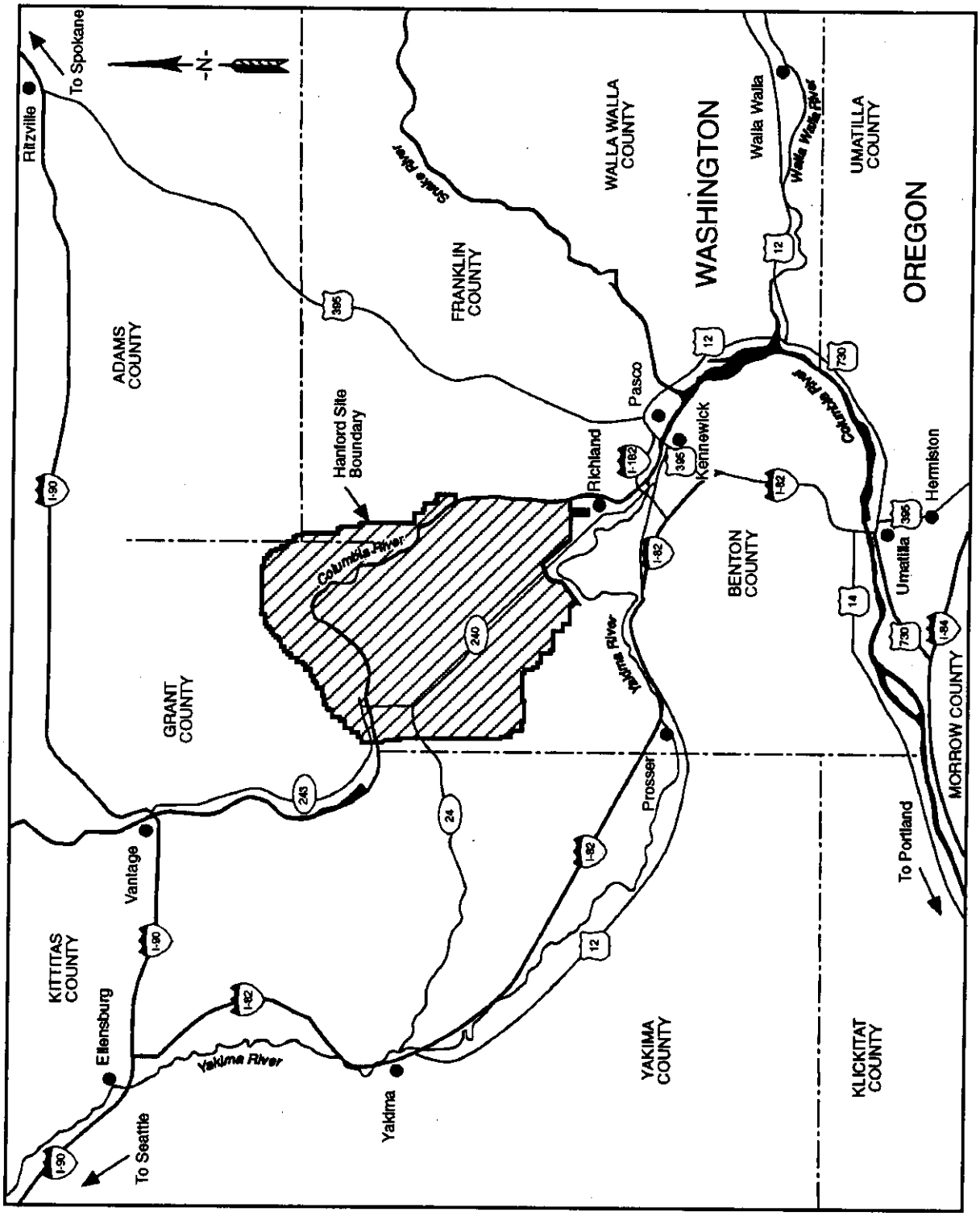
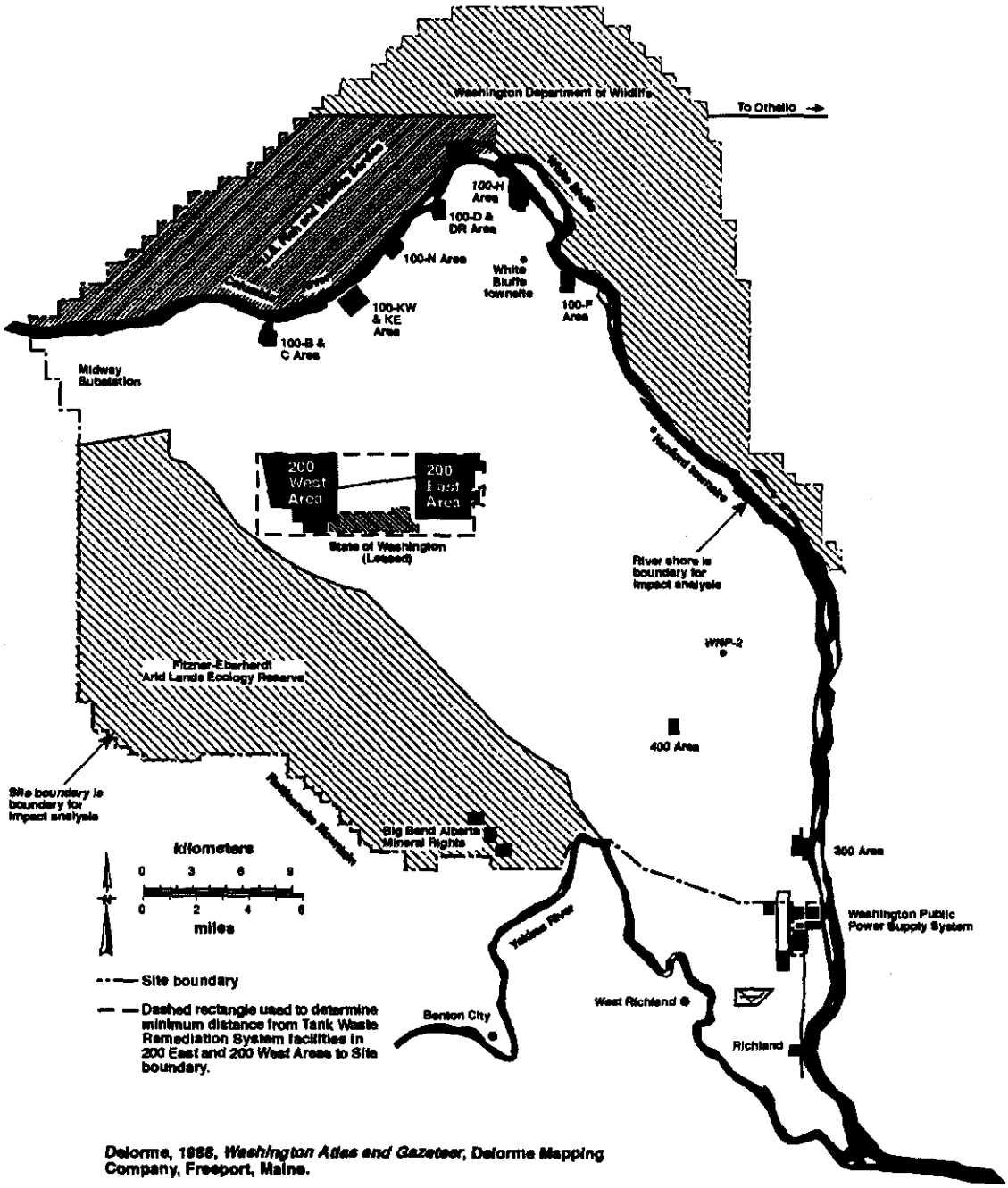


Figure 1-4. Hanford Site Map Showing Operational and Multipurpose Area Boundaries.



Delorme, 1988, *Washington Atlas and Gazeteer*, Delorme Mapping Company, Freeport, Maine.

WNP = Washington Nuclear Plant.

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Figure 1-5. Hanford Site Map Showing Surrounding Facilities and Access Routes.

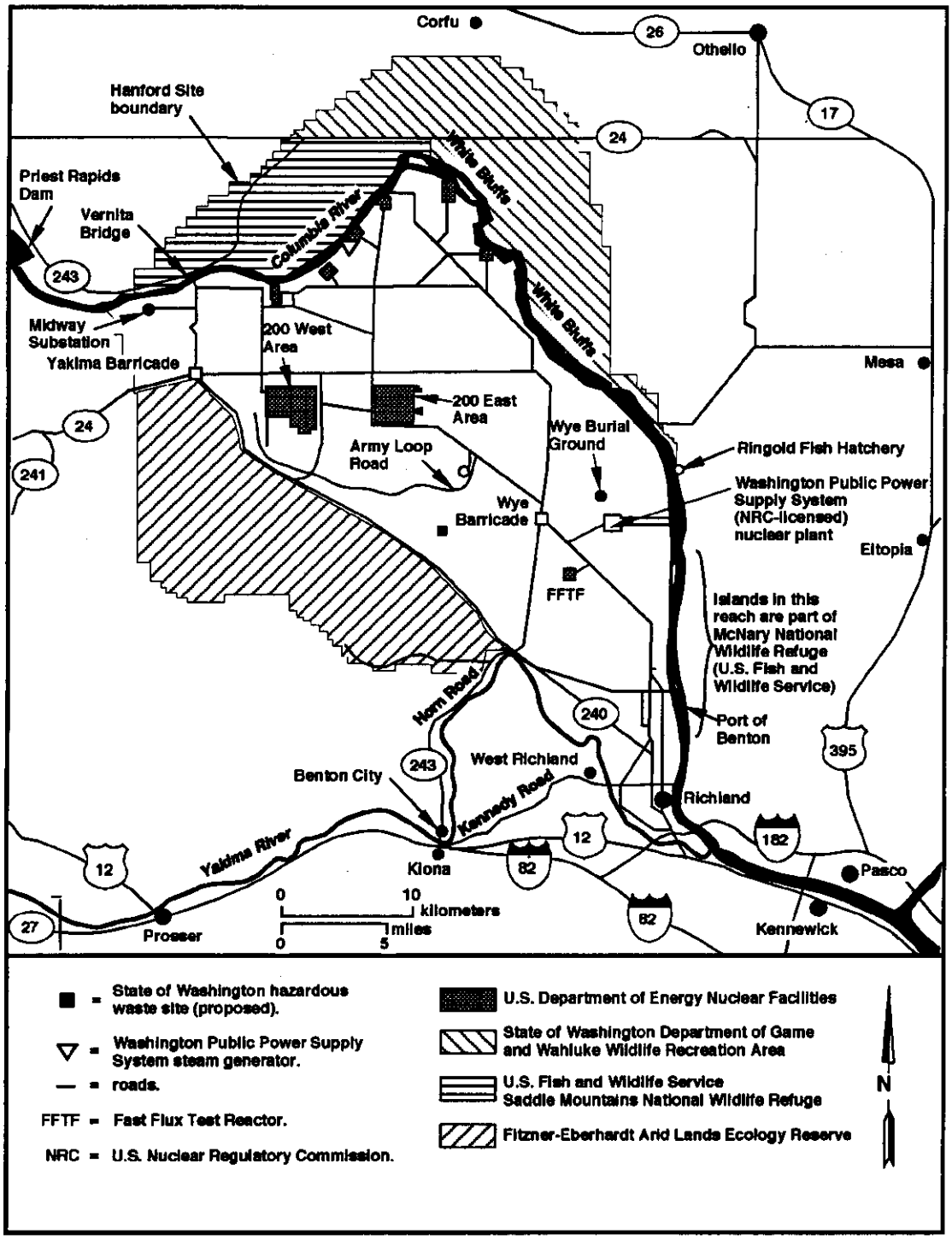

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Figure 1-6. Hanford Site Topographic Map and Cross-Section.

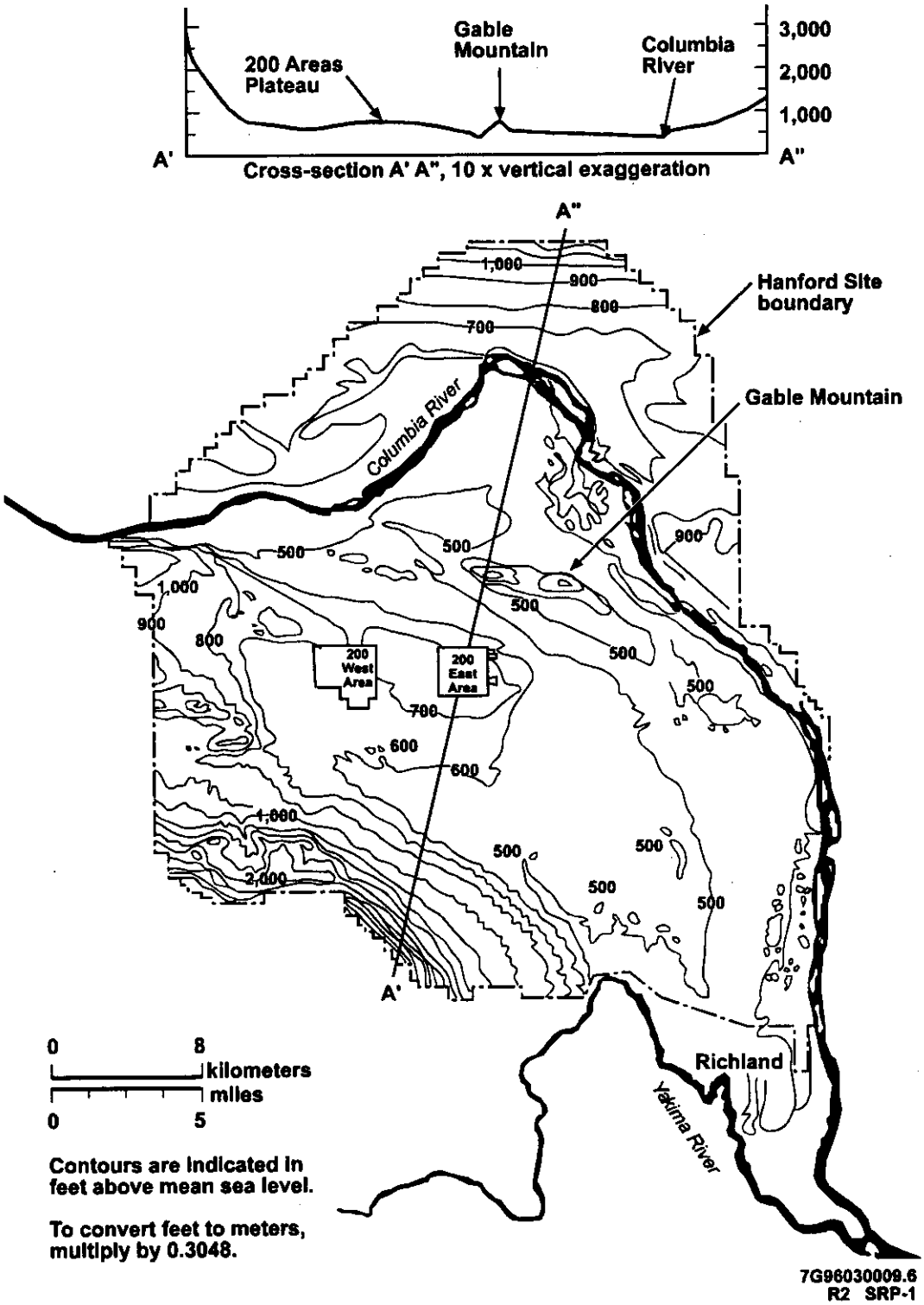


Figure 1-7. Map of the 200 East Area Facilities, Including Tank Waste Remediation System Facilities.

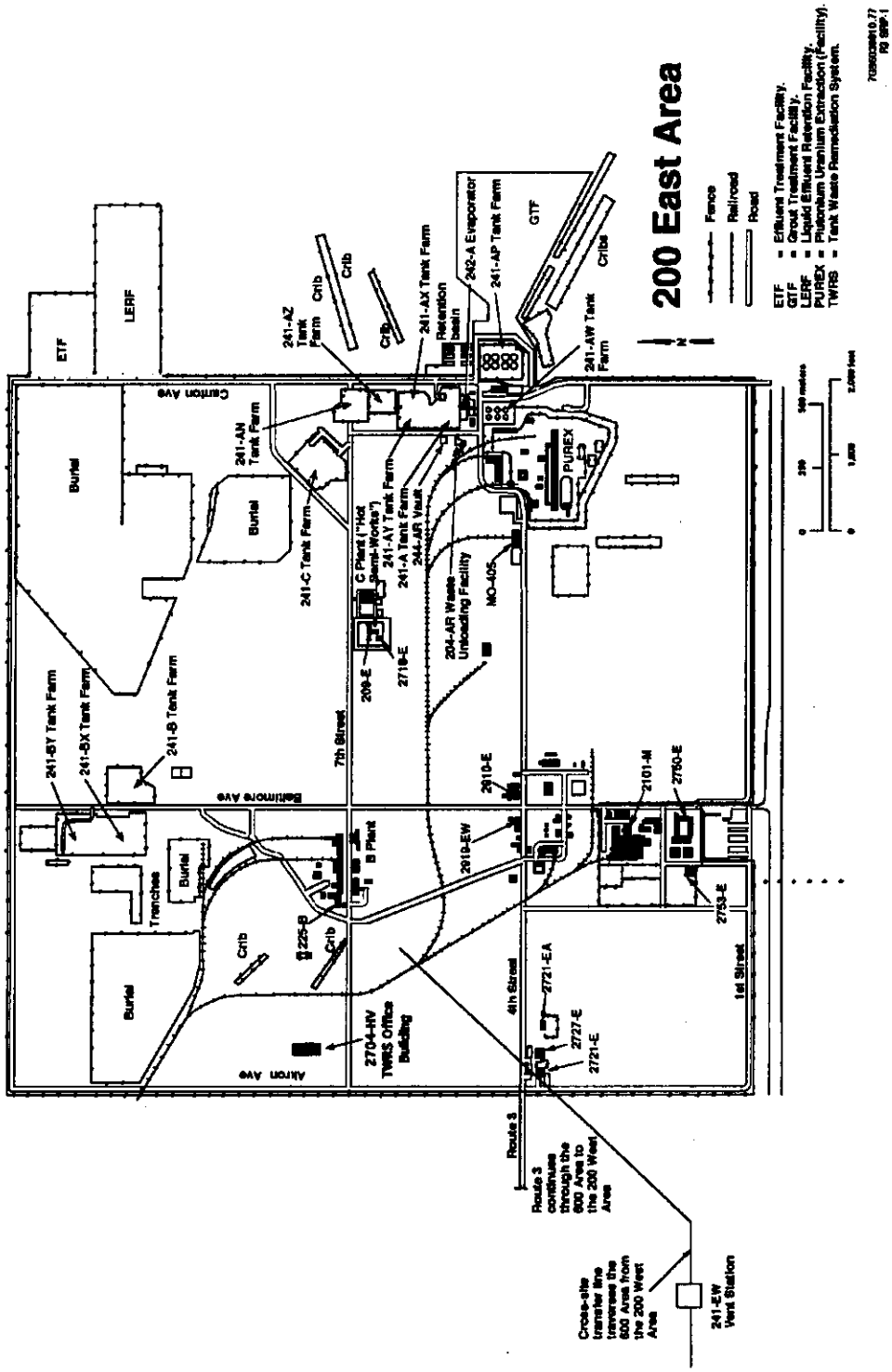


Figure 1-8. Map of the 200 West Area Facilities, Including Tank Waste Remediation System Facilities.

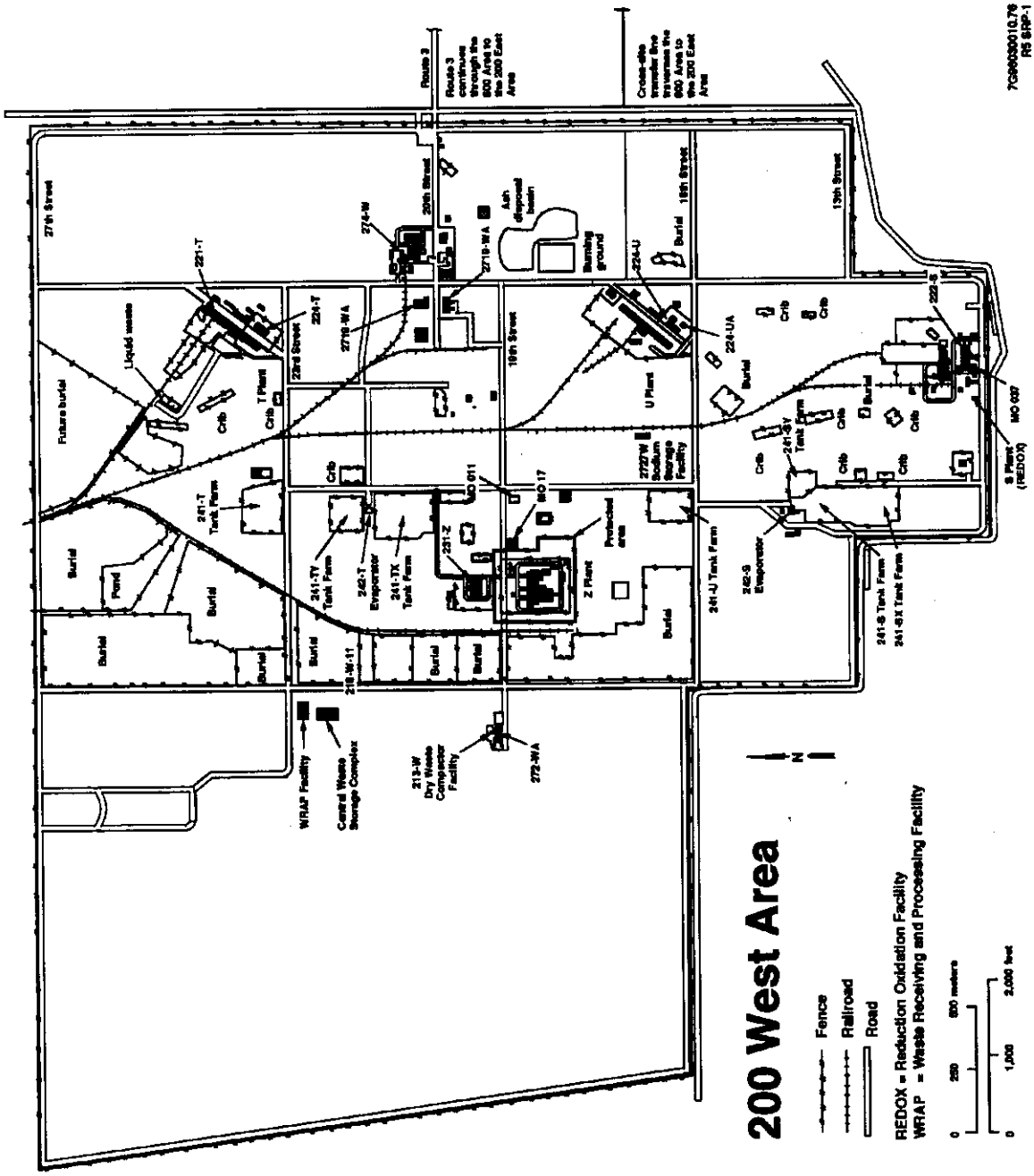
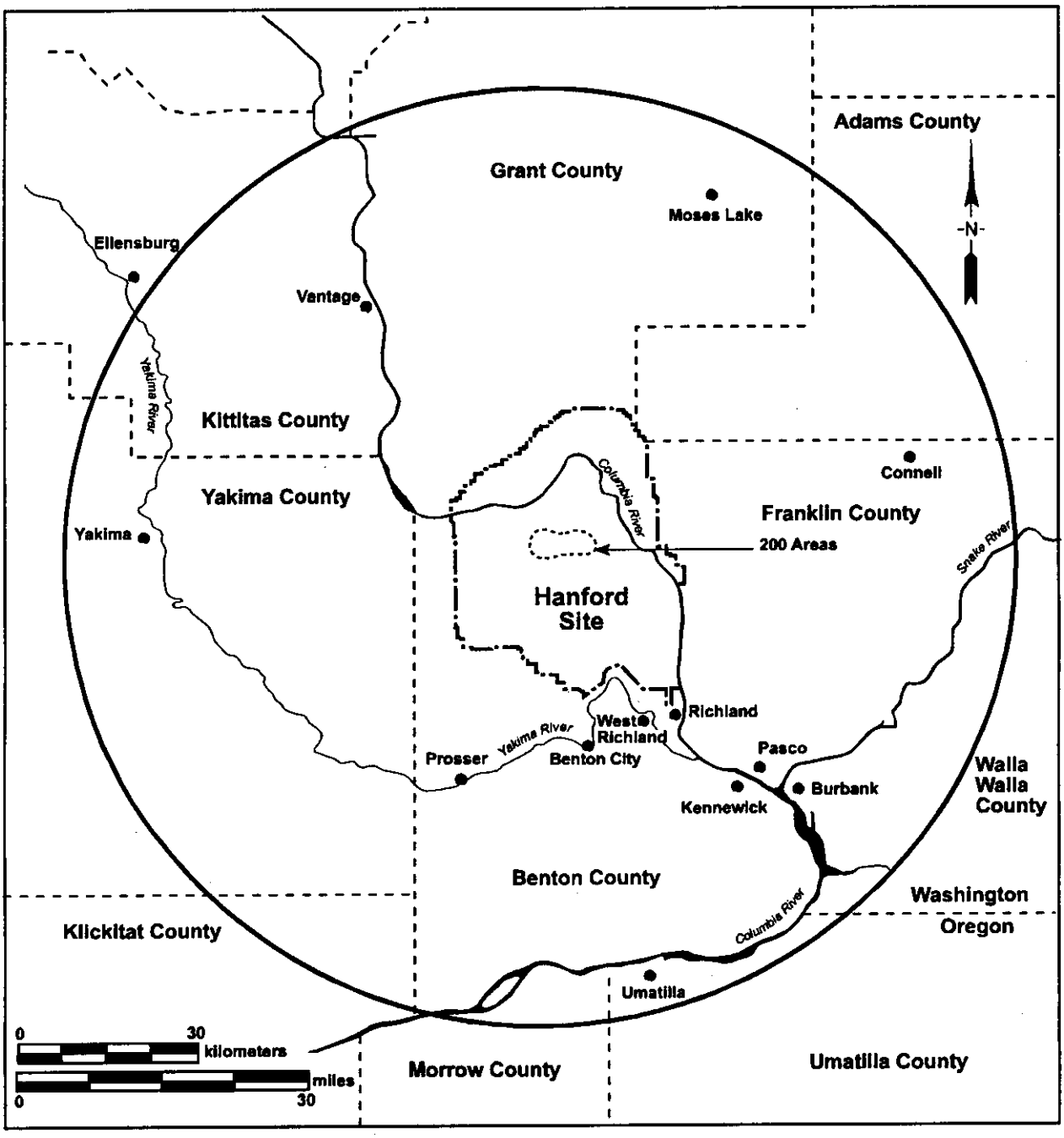


Figure 1-9. Counties and Major Cities Within 80 km (50 mi) of the Hanford Site.



County boundaries

Hanford Site boundary

80 km (50 mi) radius

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Figure 1-10. Estimated 1996 Onsite Employee Distribution in the 200 East Area by Zones.

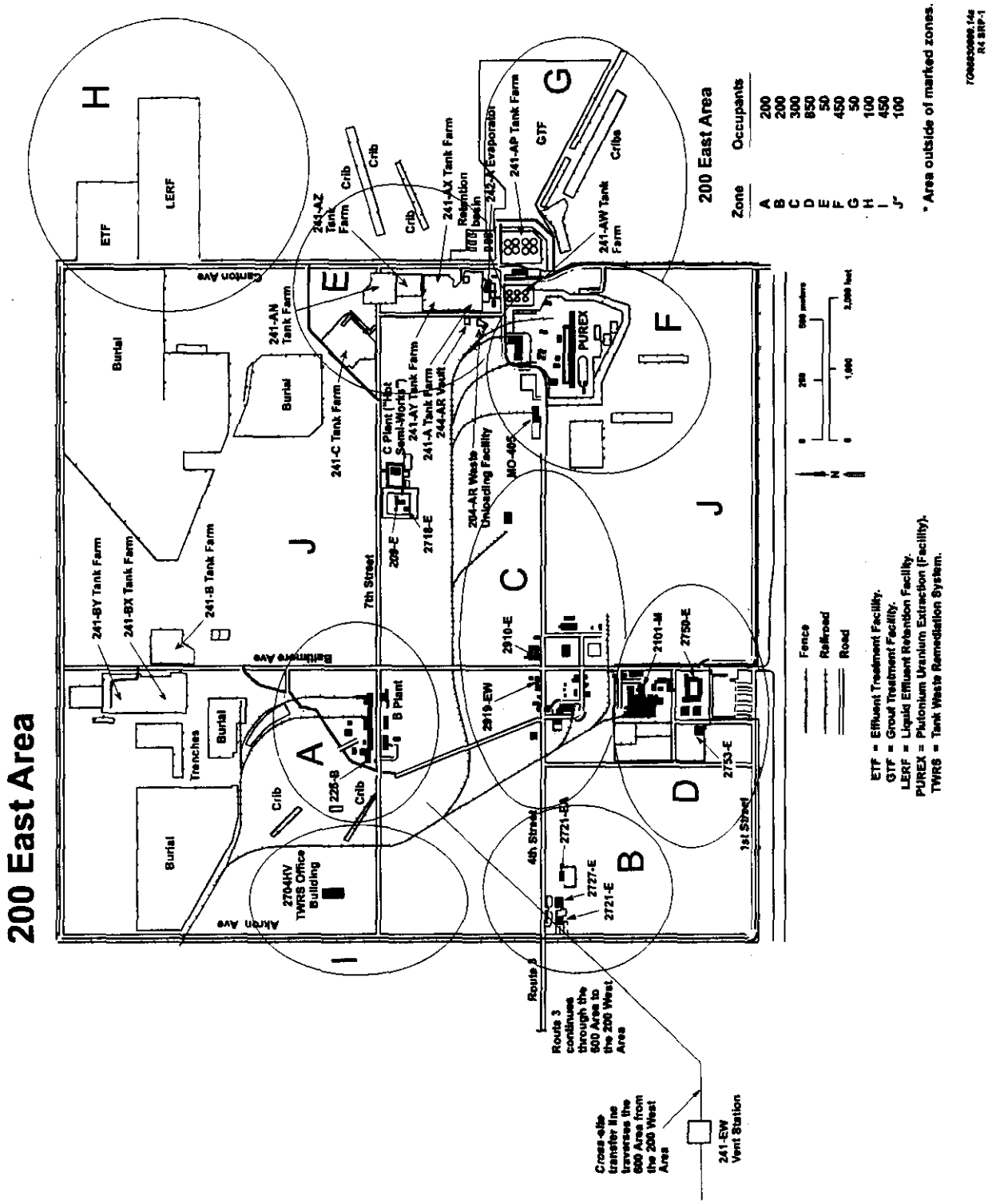


Figure 1-11. Estimated 1996 Onsite Employee Distribution in the 200 West and 600 Areas by Zones.

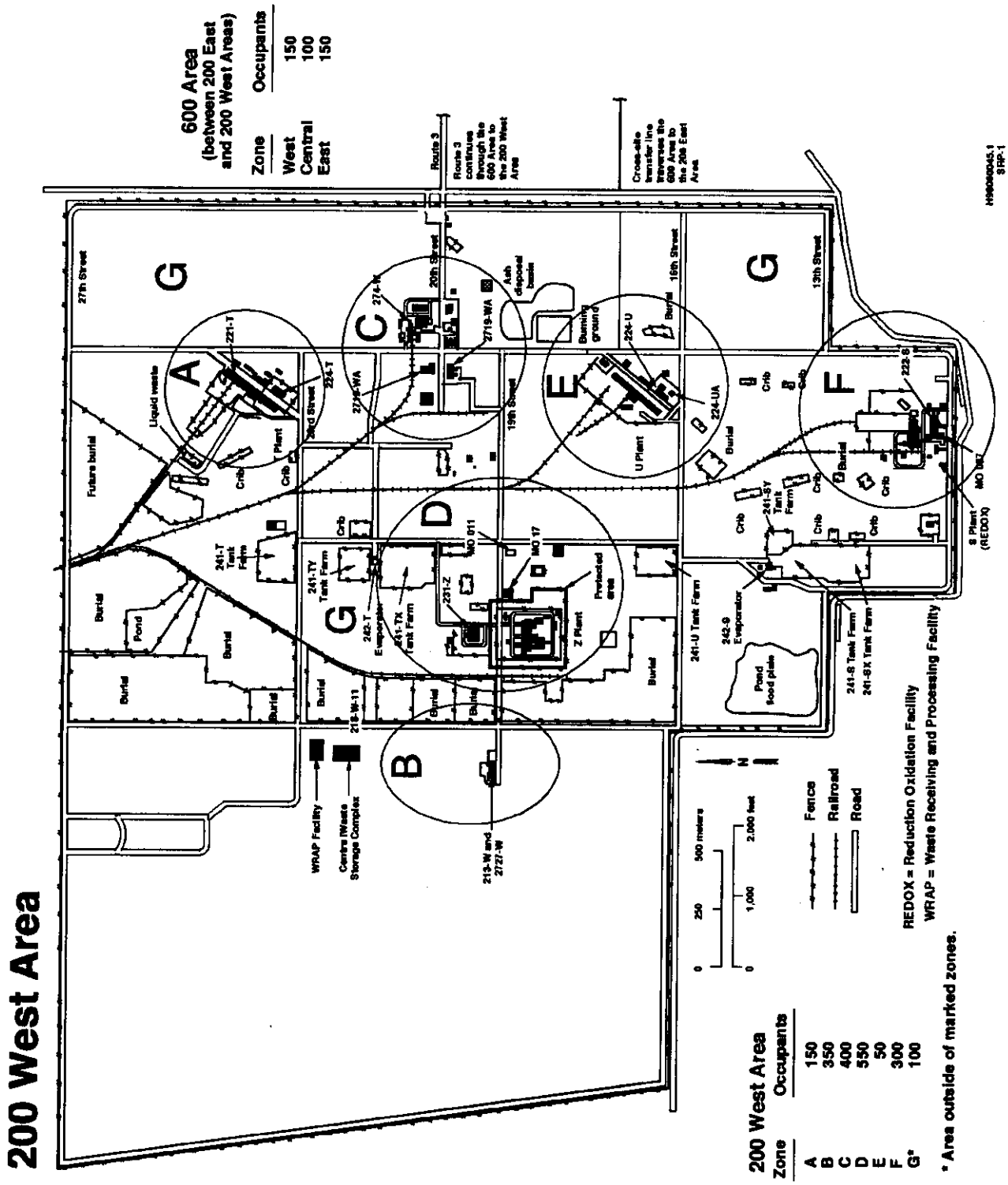


Figure 1-12. Location of the Yakima Firing Center with Respect to the Hanford Site.

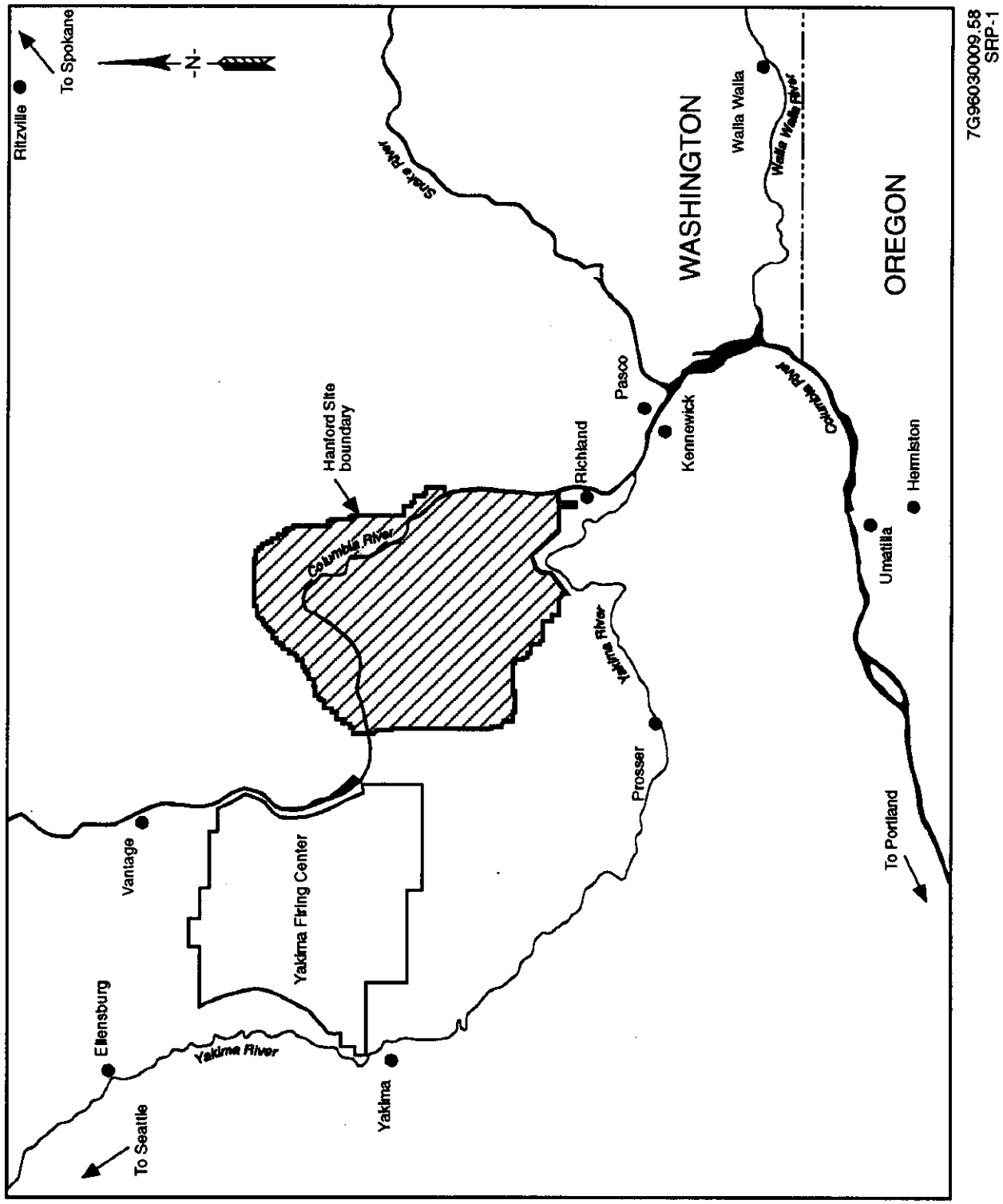
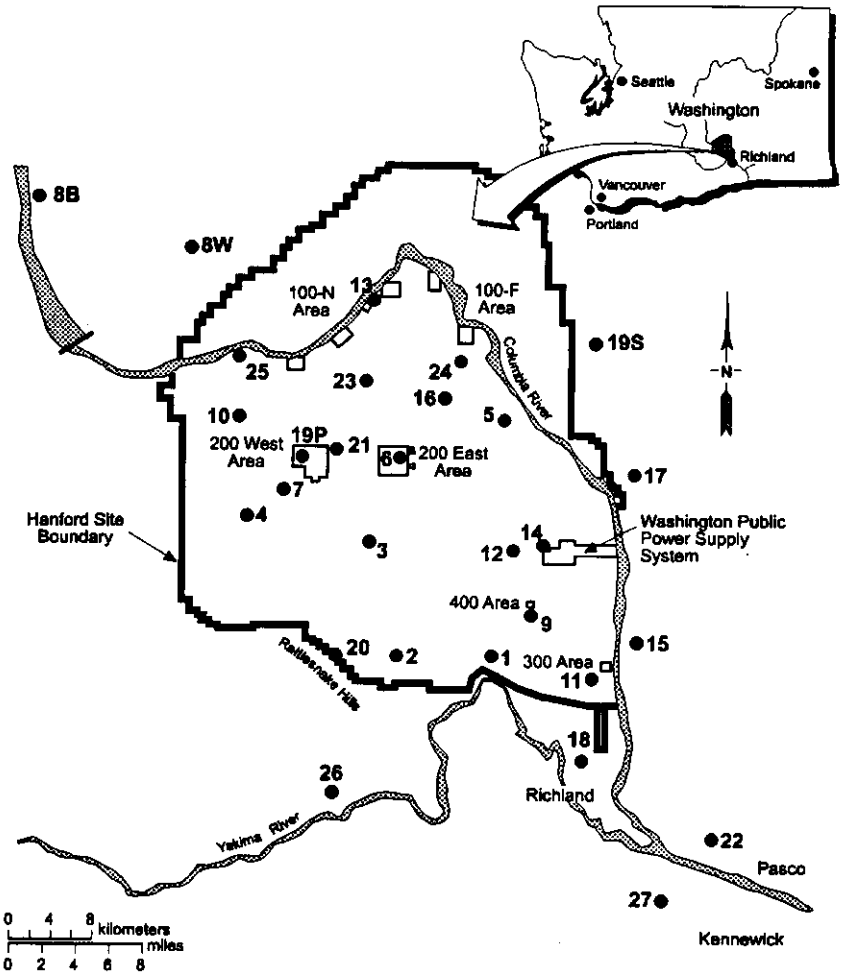


Figure 1-13. Hanford Site Meteorological Monitoring Network.



Station Number	Station Name	Station Number	Station Name
1	Prosser Barricade	14	Washington Public Power Supply System
2	Emergency Operations Center	15	Franklin County
3	Army Loop Road	16	Gable Mountain
4	Rattlesnake Springs	17	Ringold Formation
5	Edna	18	Richland Airport
6	200 East Area	19P	Plutonium Finishing Plant
7	200 West Area	19S	Sagehill (inactive)
8B	Beverly	20	Rattlesnake Mountain
8W	Wahluke Slope (inactive)	21	Hanford Meteorological Station (125 m [410 ft])
9	Fast Flux Test Facility (60 m [197 ft])	22	Tri-Cities Airport
10	Yakima Barricade	23	Gable West
11	300 Area (60 m [197 ft])	24	100-F Area
12	Wye Barricade	25	Vernita Bridge
13	100-N Area (60 m [197 ft])	26	Benton City
		27	Vista

Note: All network stations are 9.1 m (29.9 ft) above the ground unless otherwise indicated.

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Figure 1-14. Topographical Features that Impact the Hanford Site Climate.

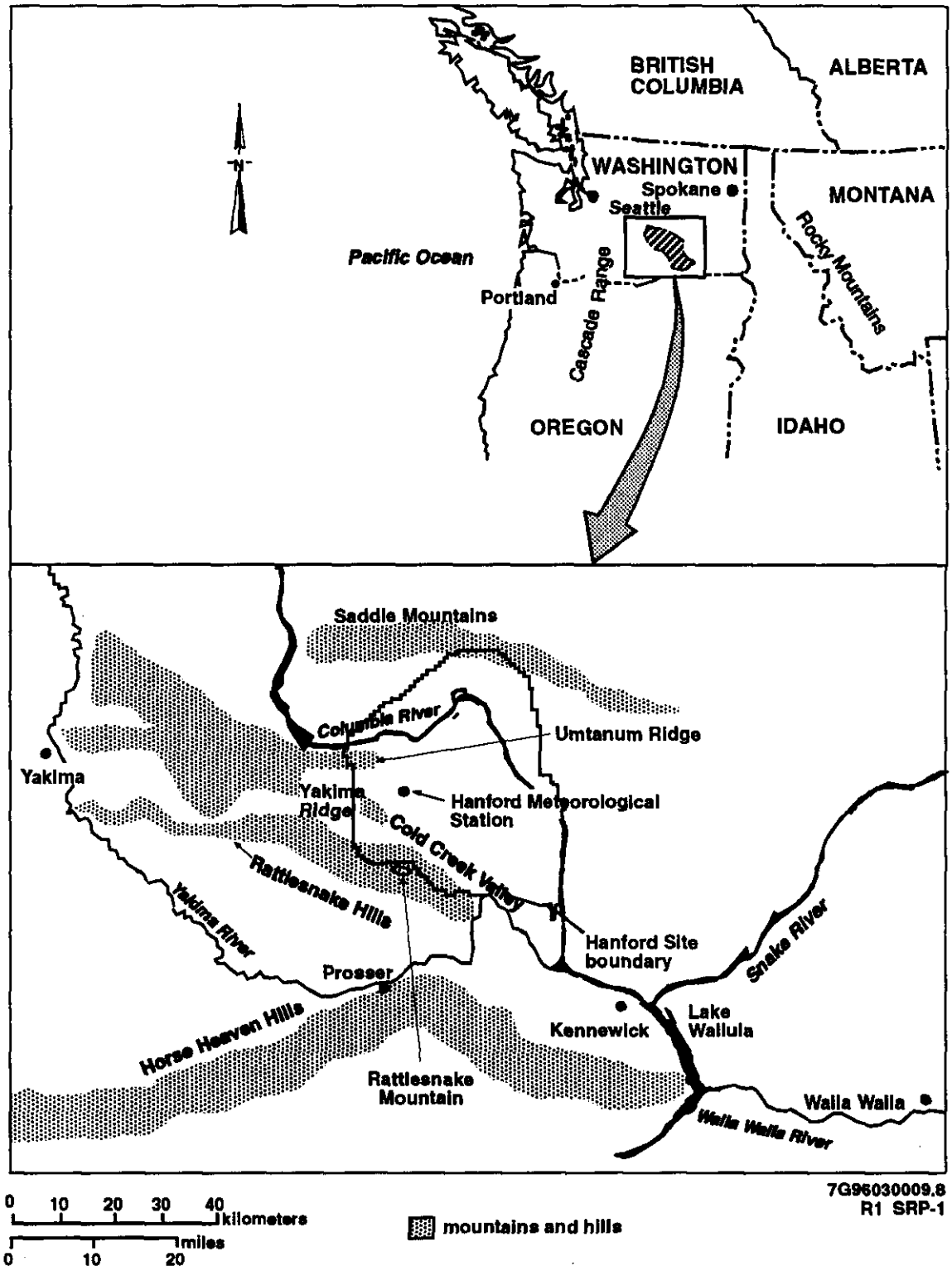
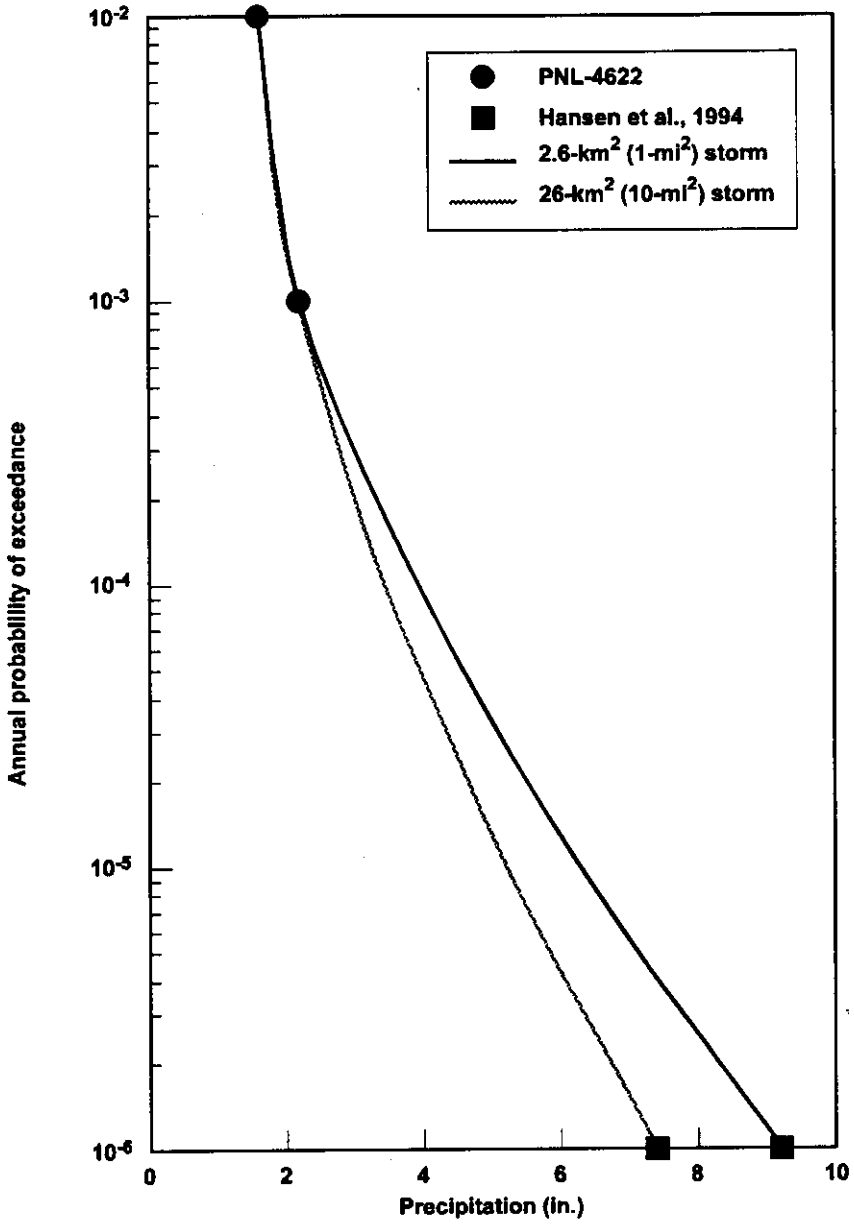


Figure 1-15. Maximum Probable Precipitation Hazard Curve.



Hansen, E. M., D. D. Fenn, P. Corrigan, J. L. Vogel, L. C. Schreiner, and R. W. Stoch, 1994, *Probable Maximum Precipitation – Pacific Northwest States*, Hydrometeorological Report No. 57, National Weather Service, Silver Spring, Maryland.

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To convert inches to millimeters, multiply by 25.4.

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Figure 1-16. Hanford Site Snow Depth Probabilities Based on the Greatest Depth of Snow on the Ground at the Site from Winter of 1946-1947 to Winter of 1980-1981.

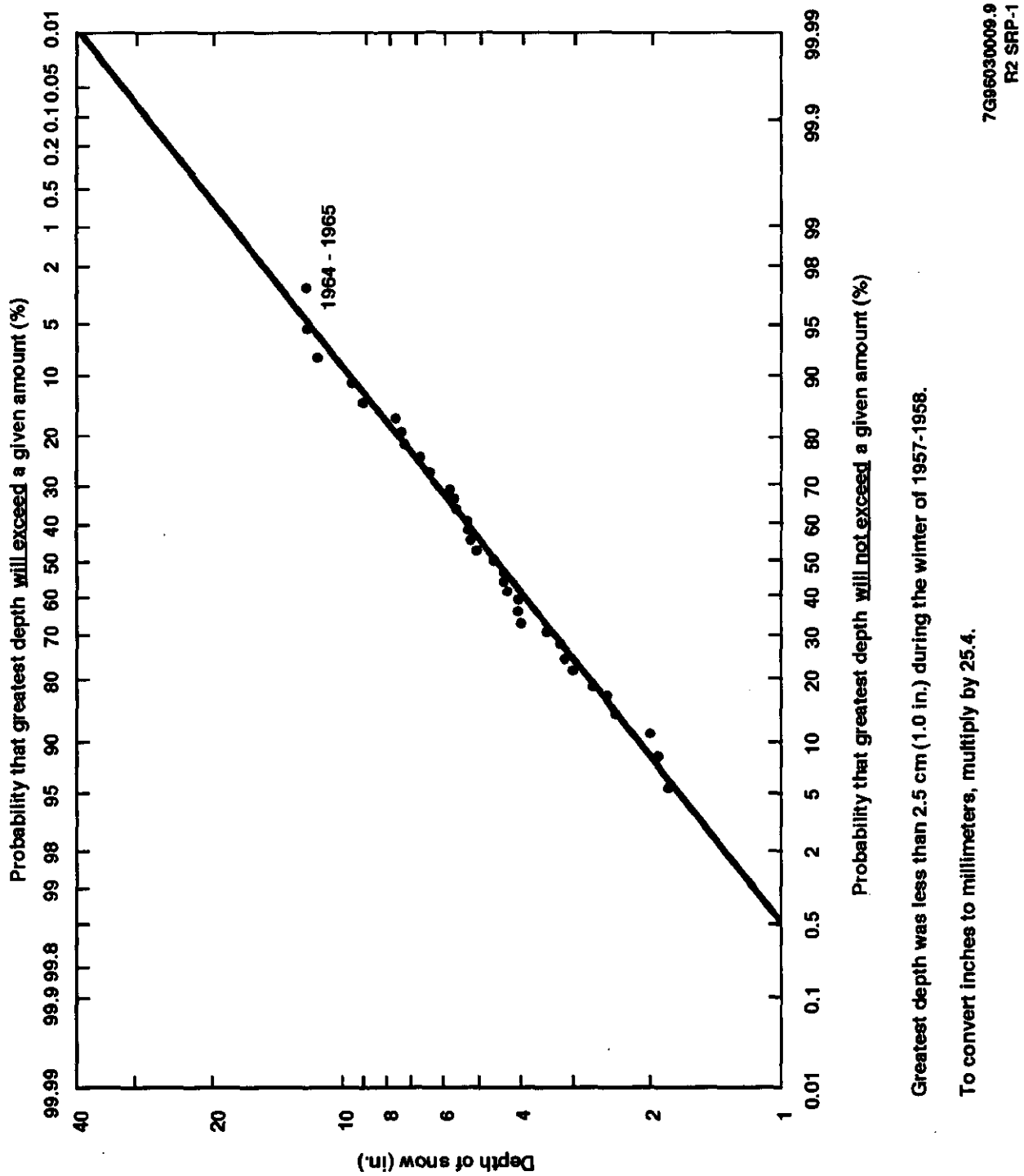
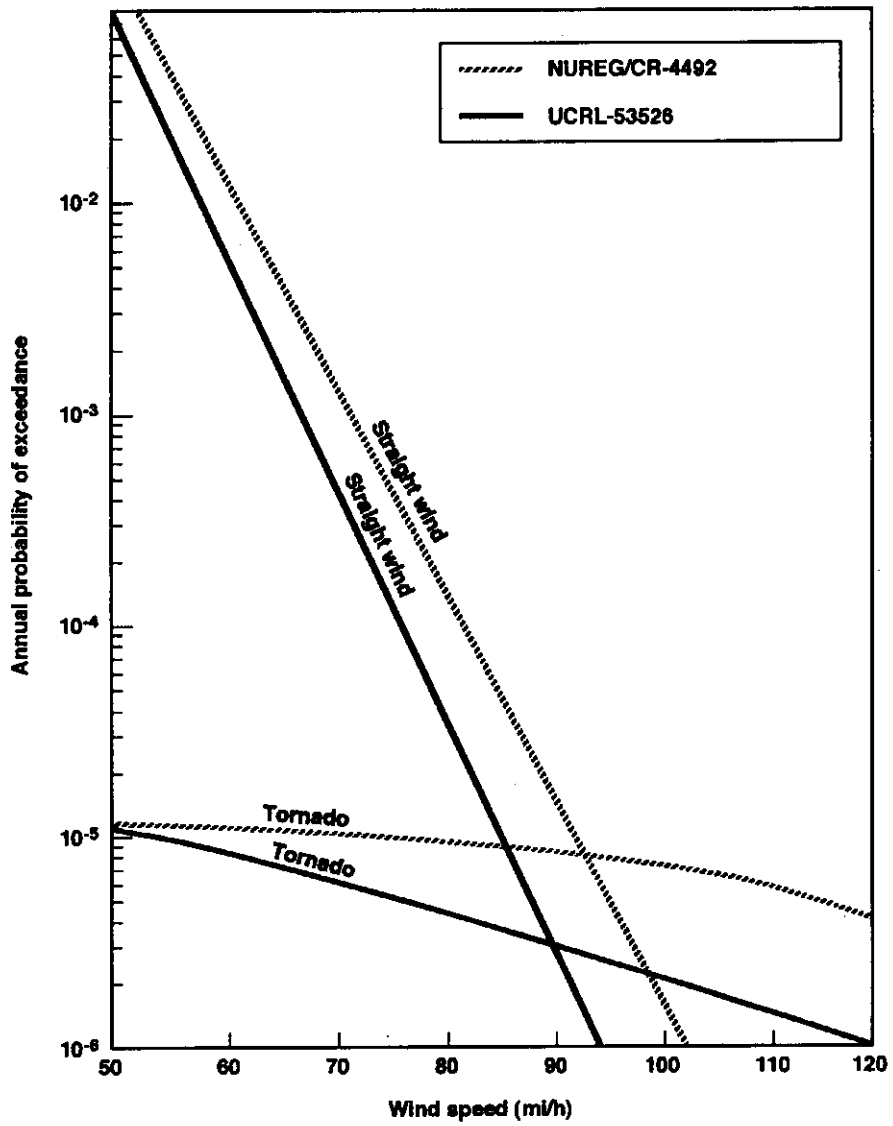


Figure 1-17. Hanford Site Wind Hazard Curves Based on Recommended Design Wind Speeds



UCRL-53526, 1985, ***Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites,*** Rev. 1, University of California Research Laboratory, Berkeley, California.

NUREG/CR-4492, 1986, ***Methodology for Estimating Extreme Winds for Probabilistic Risk Assessments,*** Rev. 0, U.S. Nuclear Regulatory Commission, Washington, D.C.

To convert mi/h to km/h, multiply by 1.609.

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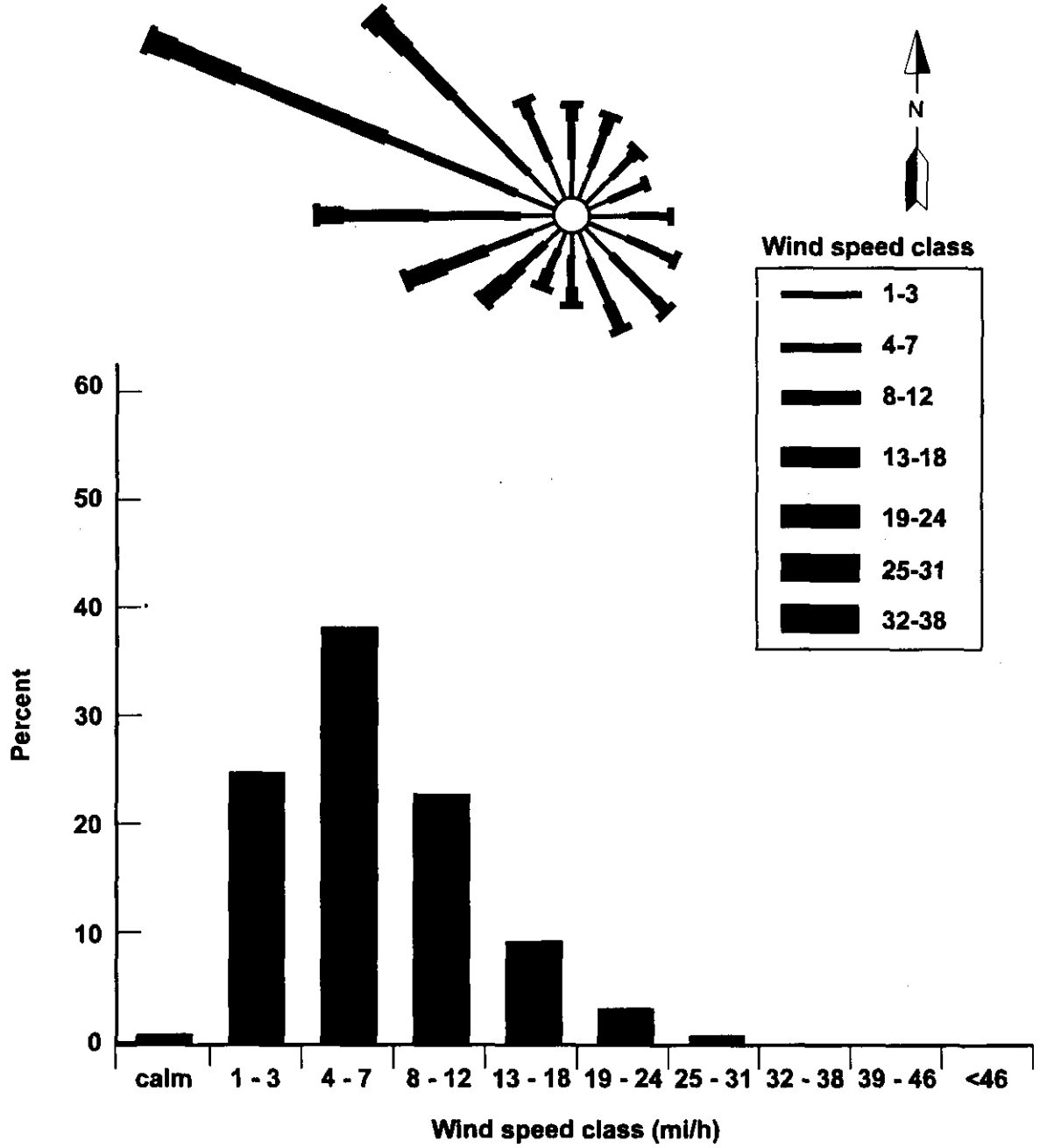
Figure 1-18. Wind Rose and Wind Speed Histogram for the 200 East Area.



To convert mi/h to km/h, multiply by 1.609.
Wind direction is toward the center of the wind rose.

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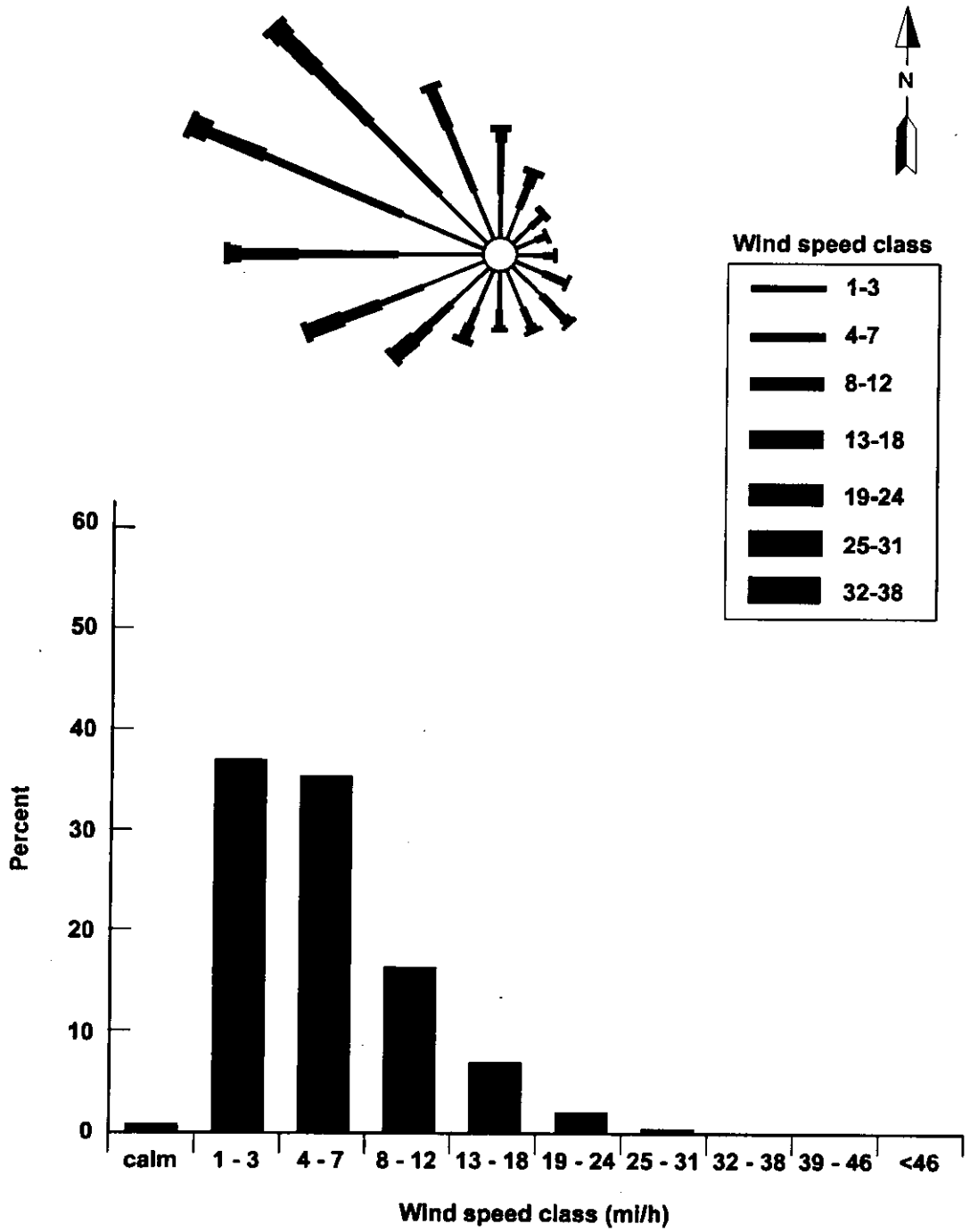
Figure 1-19. Wind Rose and Wind Speed Histogram for the 200 West Area.



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To convert mi/h to km/h, multiply by 1.609.
Wind direction is toward the center of the wind rose.

Figure 1-20. Location of Surface Water on the Hanford Site.

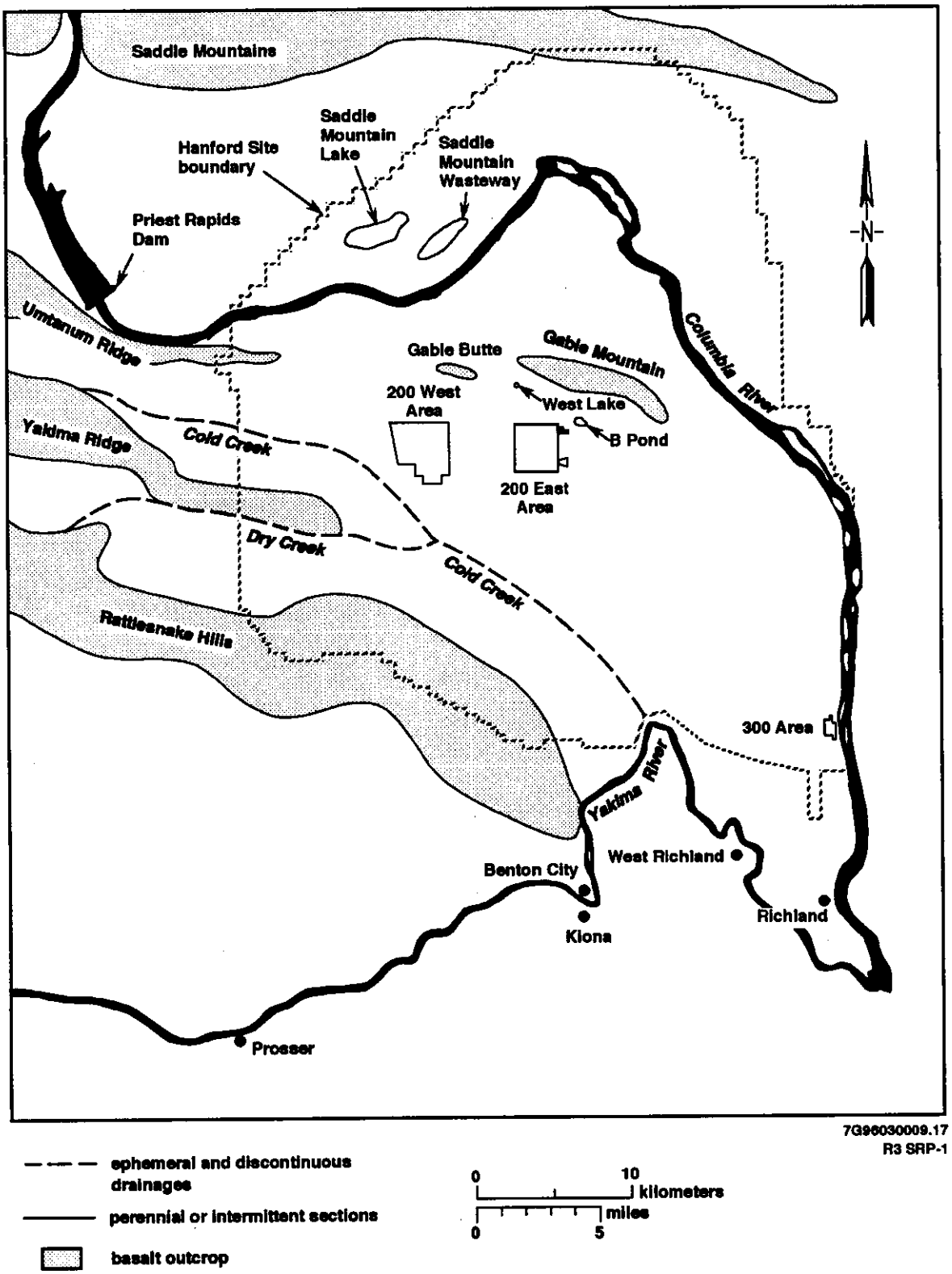


Figure 1-21. Location of Dams on the Columbia River and River Drainage Area.

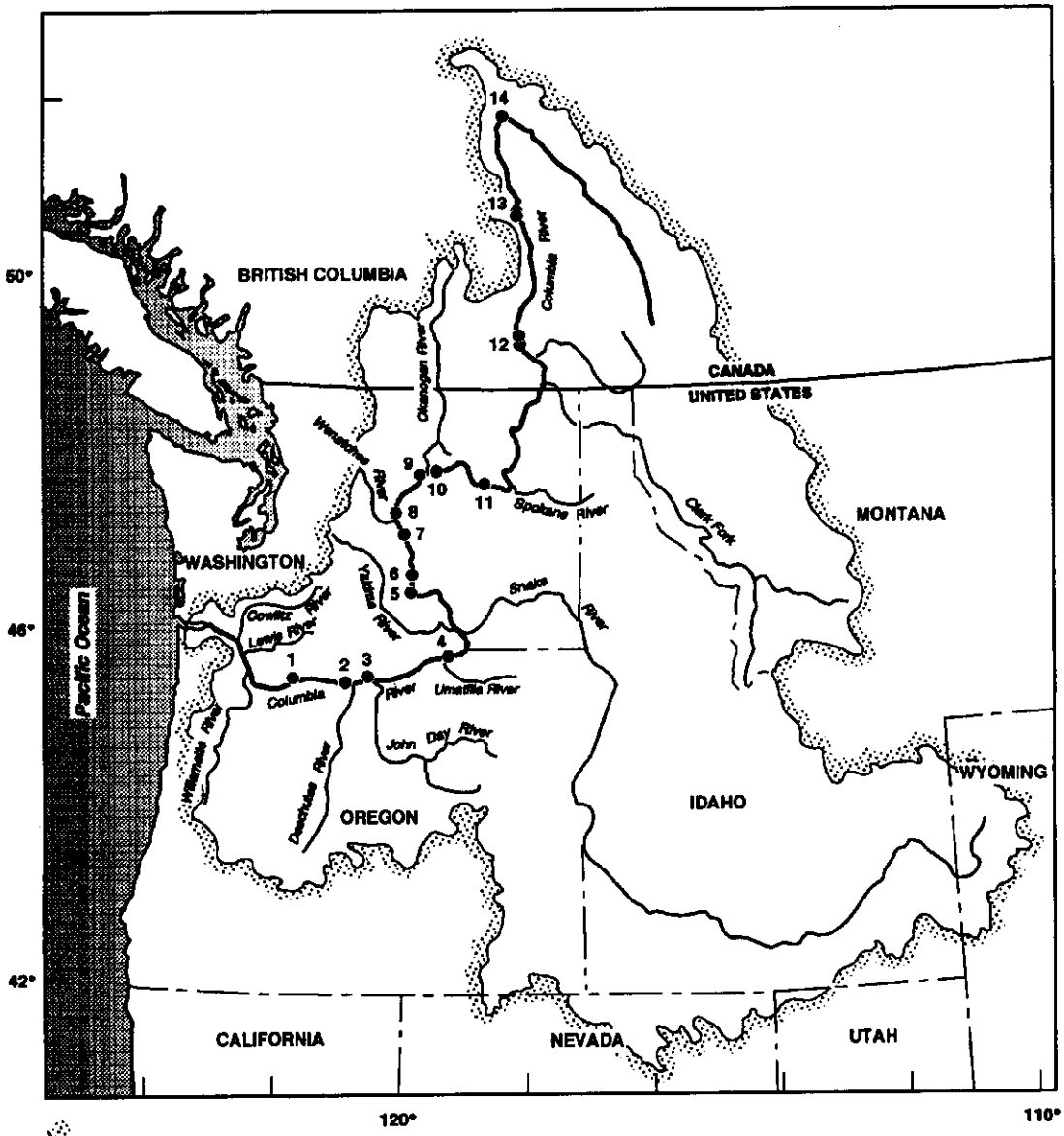


Figure 1-22. Location and Elevation of Columbia River Mile 365.

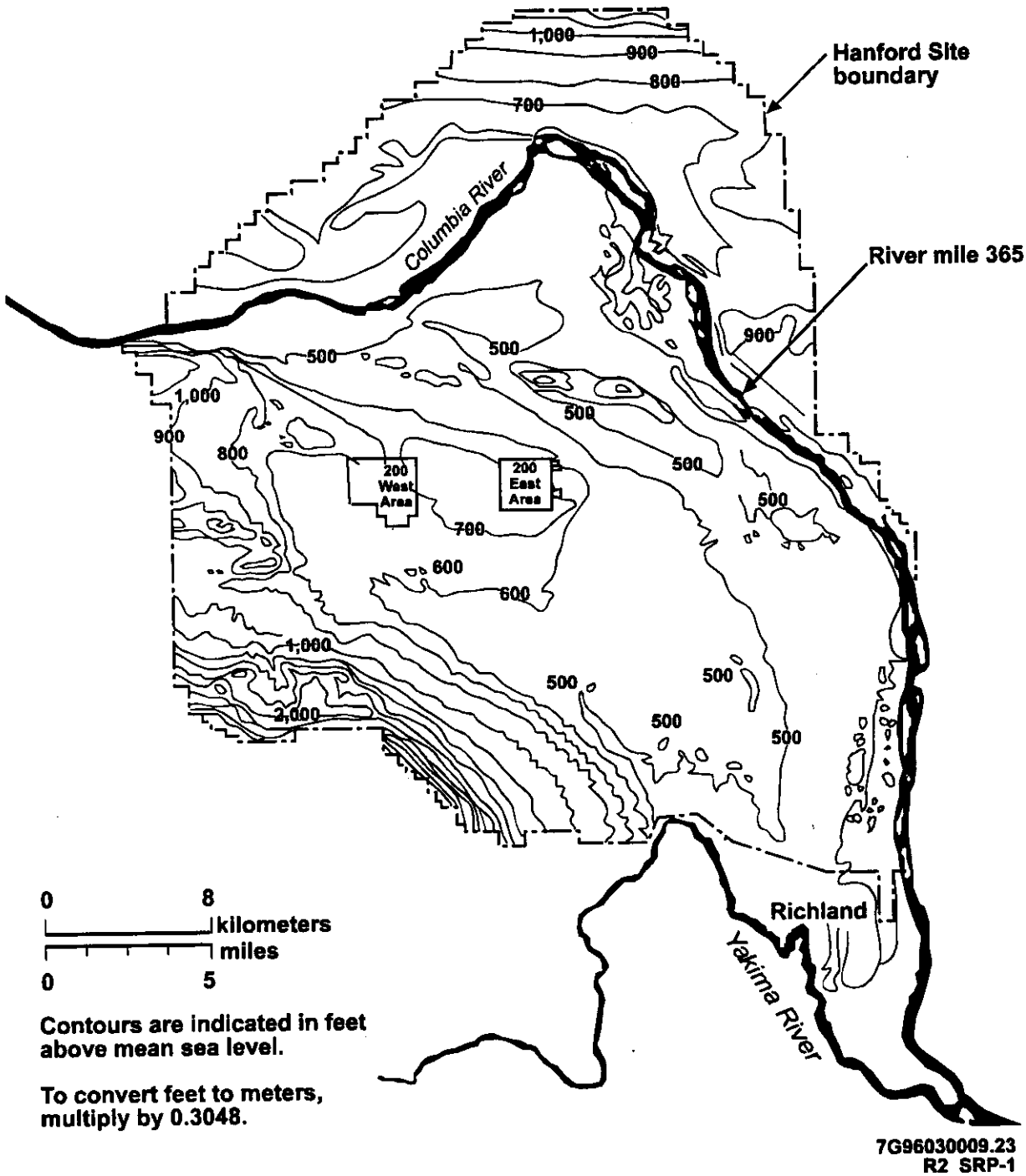


Figure 1-23. Location of Ephemeral and Discontinuous Cold Creek and Dry Creek and the Extent of the Probable Maximum Flood in the Cold Creek Area.

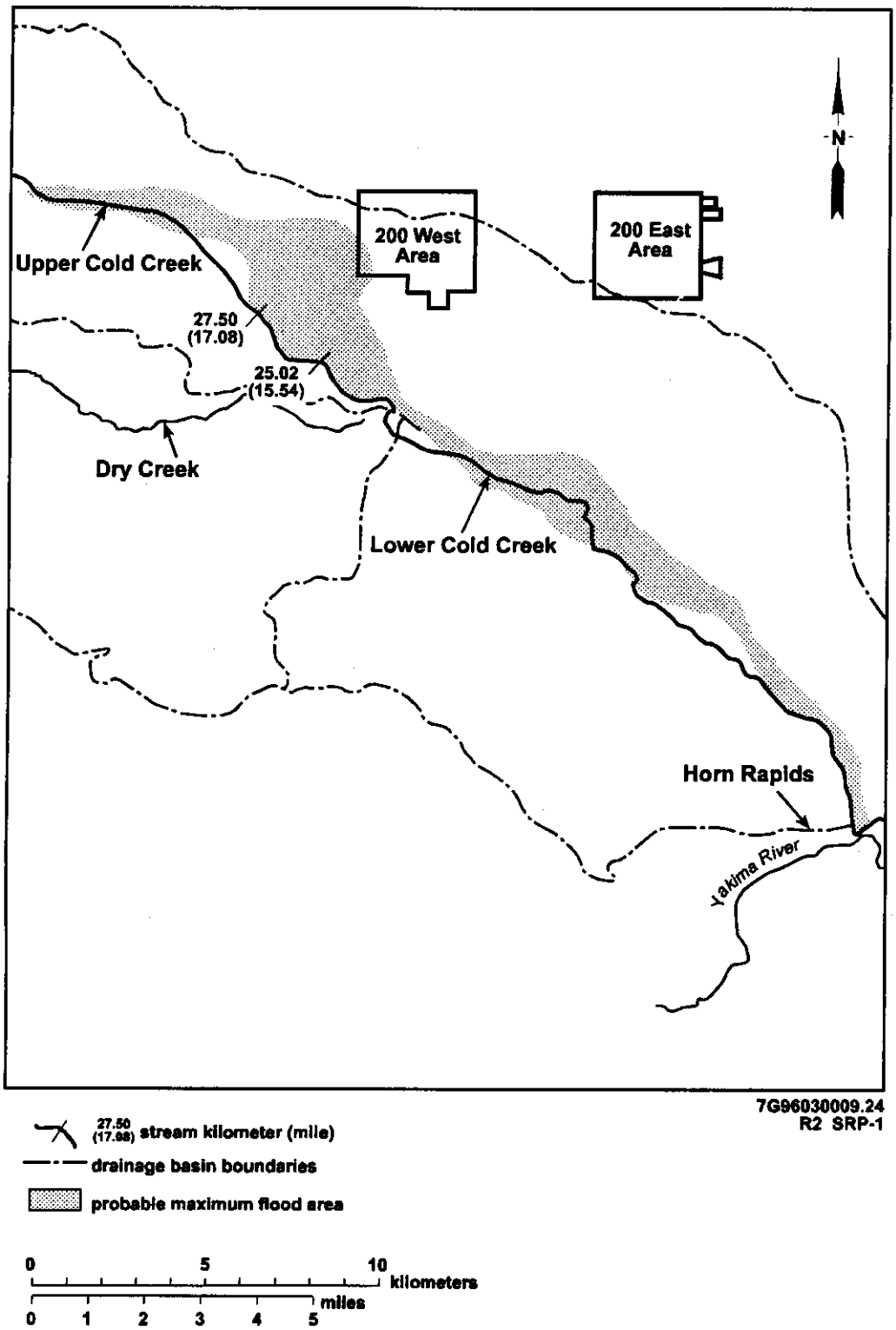
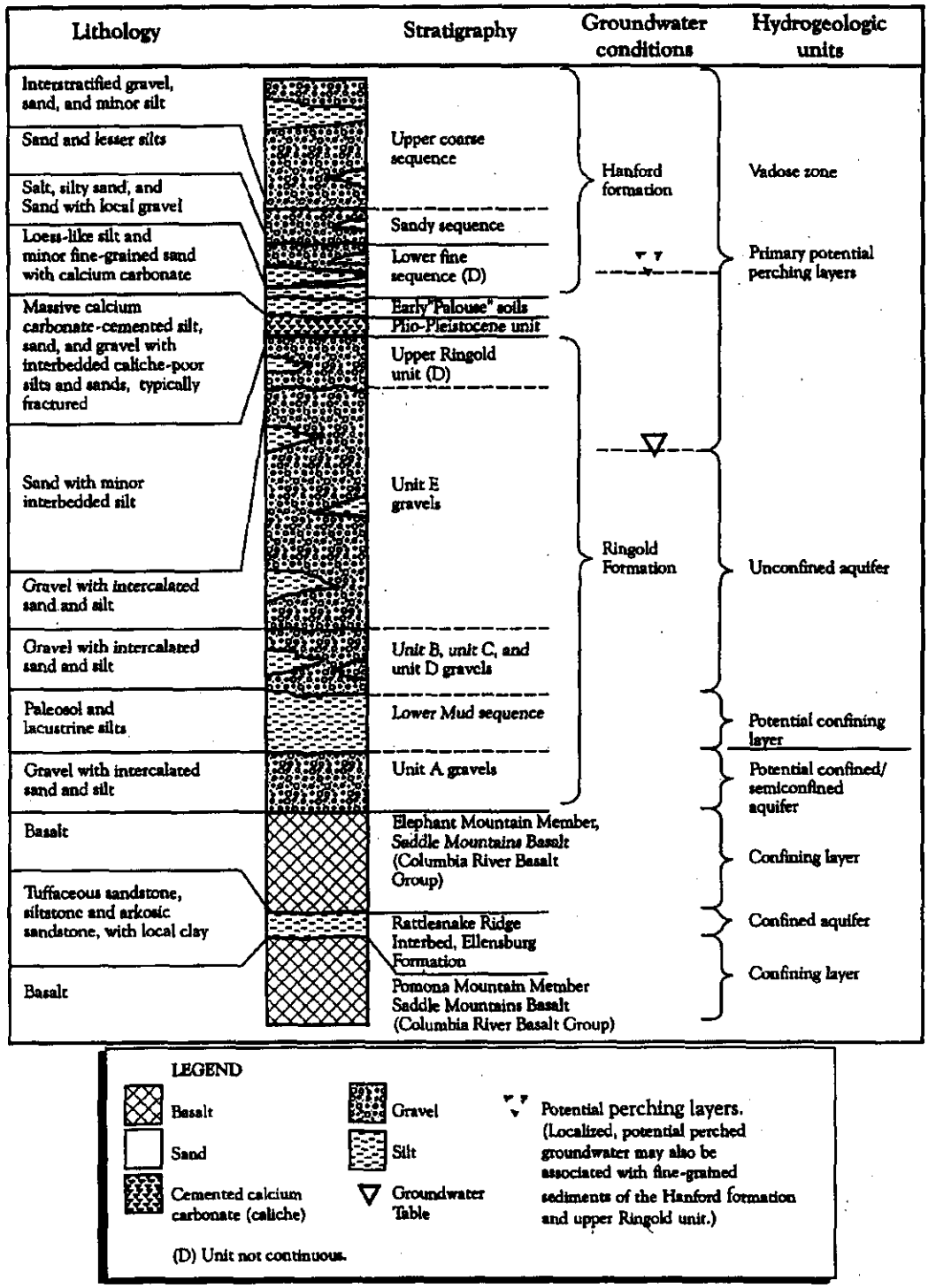


Figure 1-24. Conceptual Hydrologic Column for the Hanford Site.



Note: Lithology, stratigraphy, and groundwater conditions based on data from the following sources:

- WHC-SD-EN-TI-011, 1992, *Geology of the Northern Part of the Hanford Site: An Outline of Outsources and the Geology Setting of the Pot Area*, Westinghouse Hanford Company, Richland, Washington.
- WHC-SD-EN-TI-003, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Figure 1-25. Groundwater Contours and Steady Streamlines from the 200 East and 200 West Areas Waste Sites to the Columbia River.

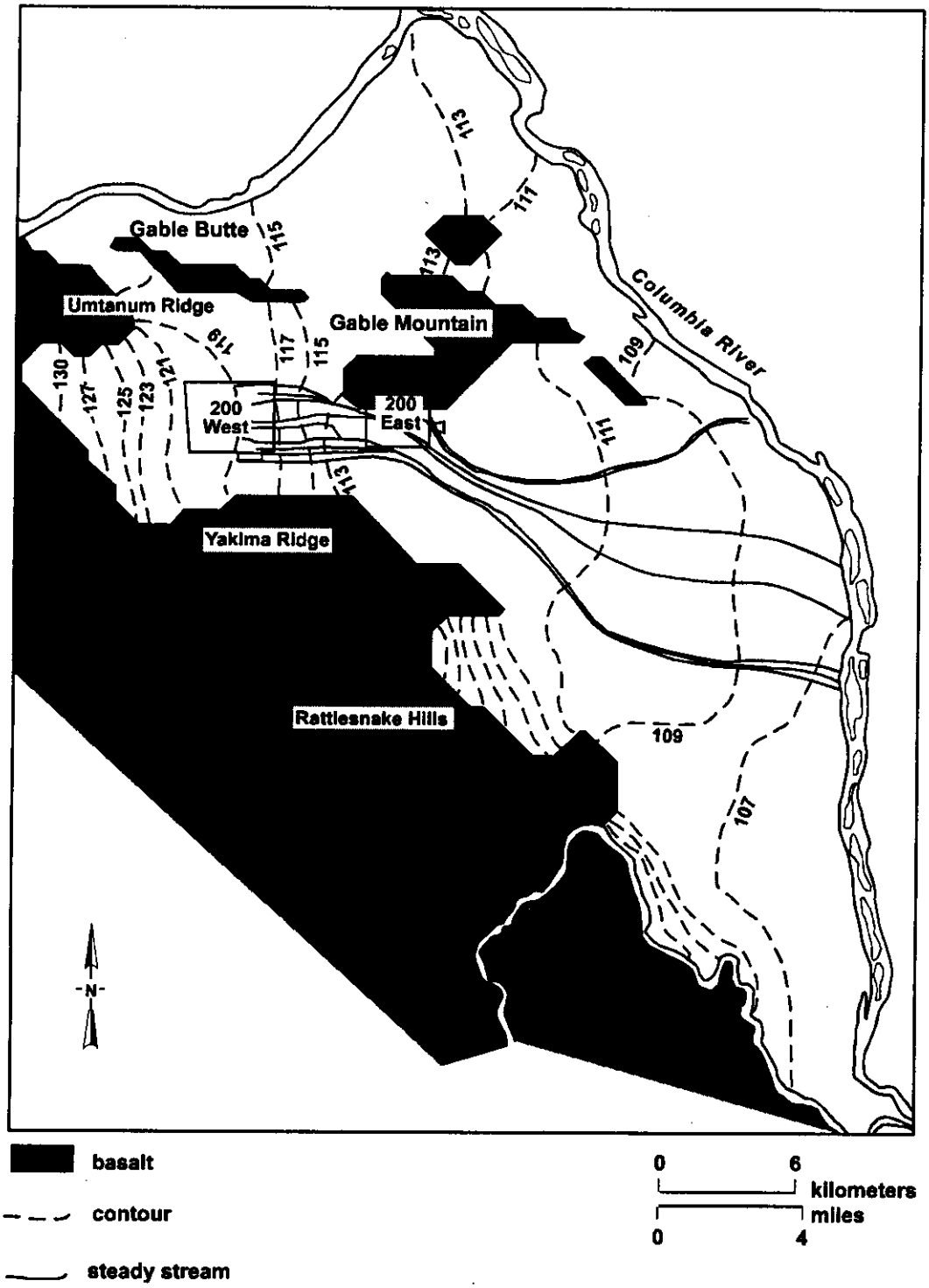


Figure 1-26. Location of the Hanford Site, Pasco Basin, and Columbia Plateau.

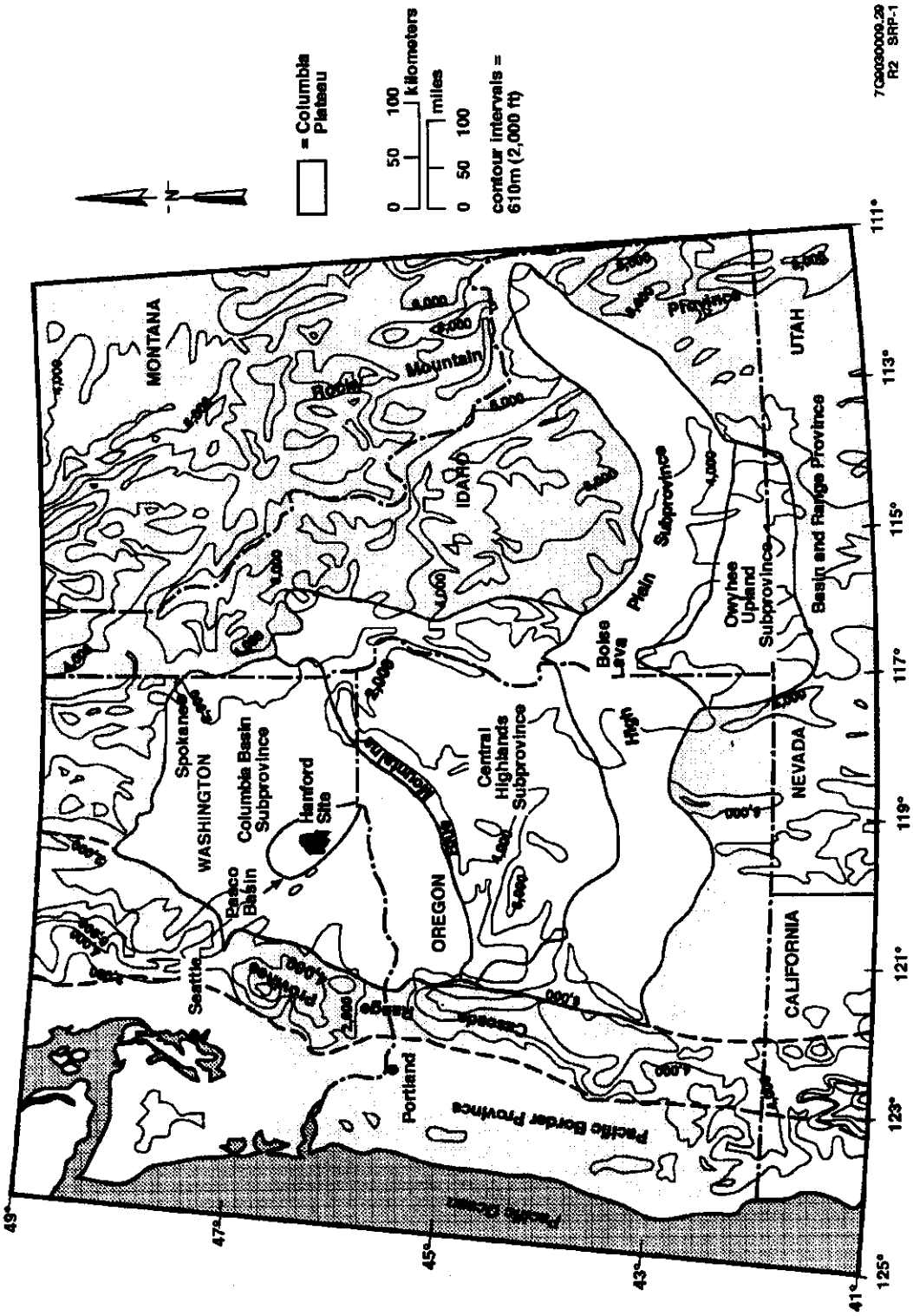


Figure 1-27. Physiographic Provinces of the Columbia Basin.

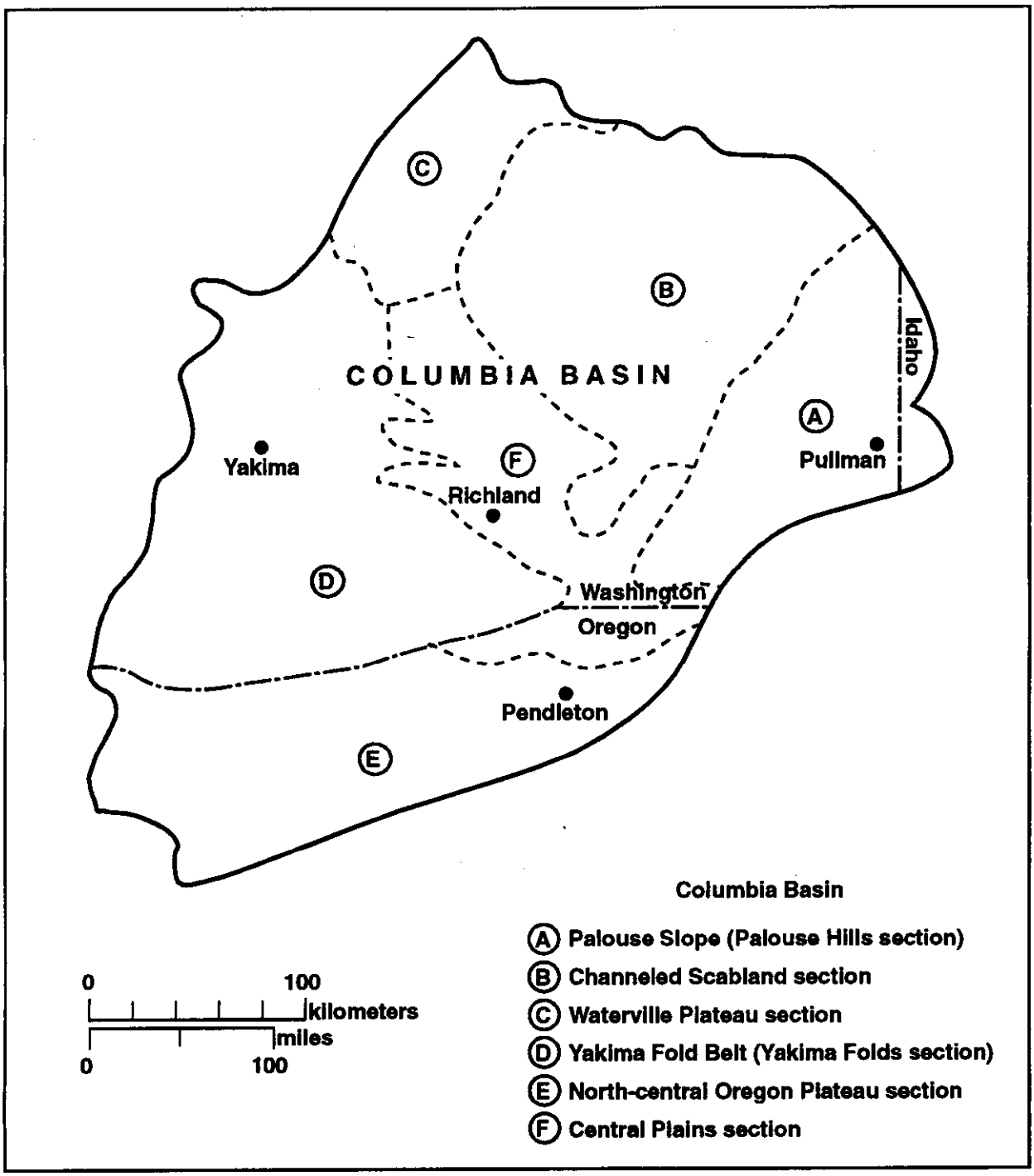


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Figure 1-28. Generalized Stratigraphy of the Columbia River Basalt Group.

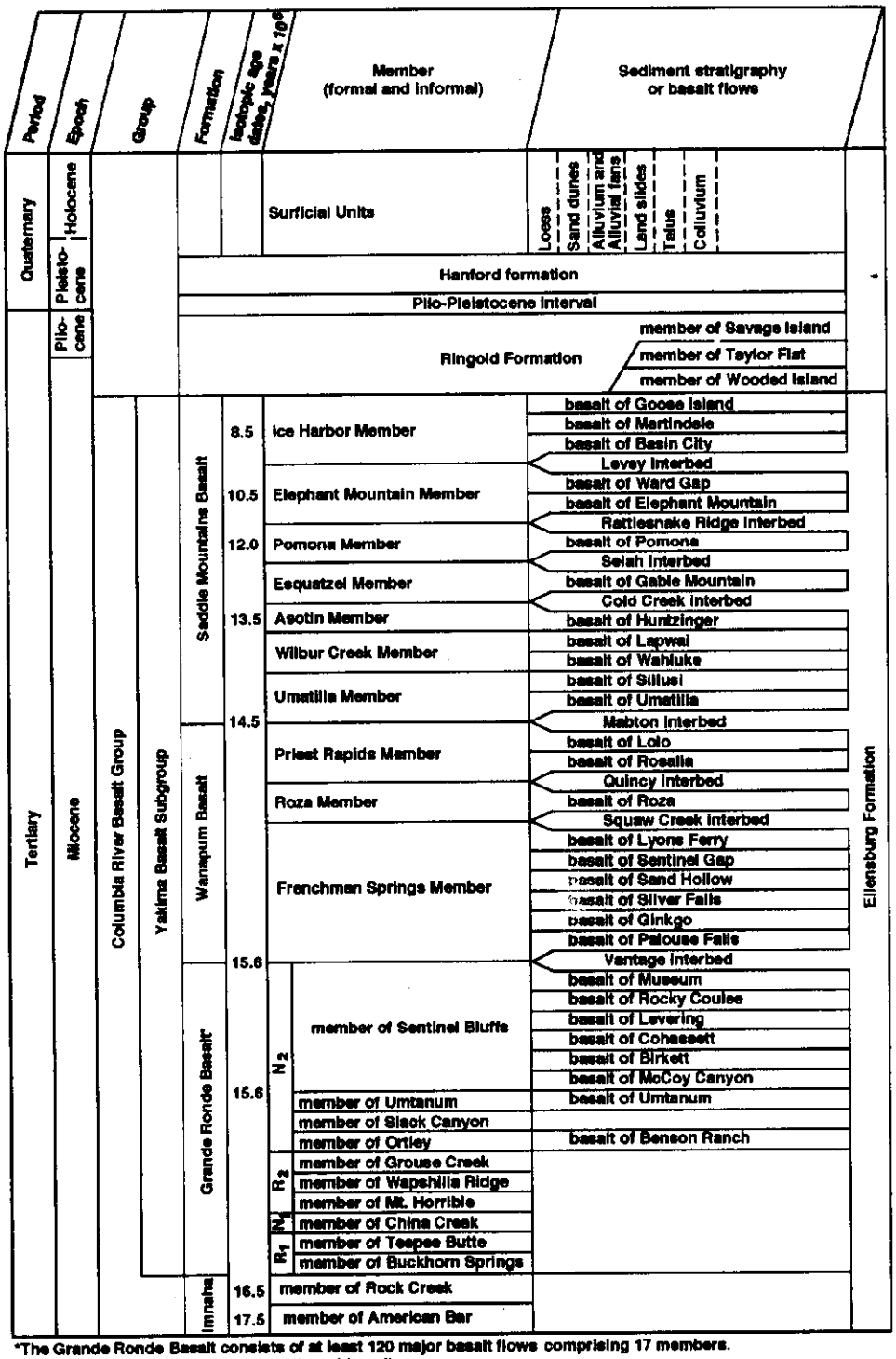

Figure 1-29. Idealized Suprabasalt Subsurface Stratigraphy of the Hanford Site.

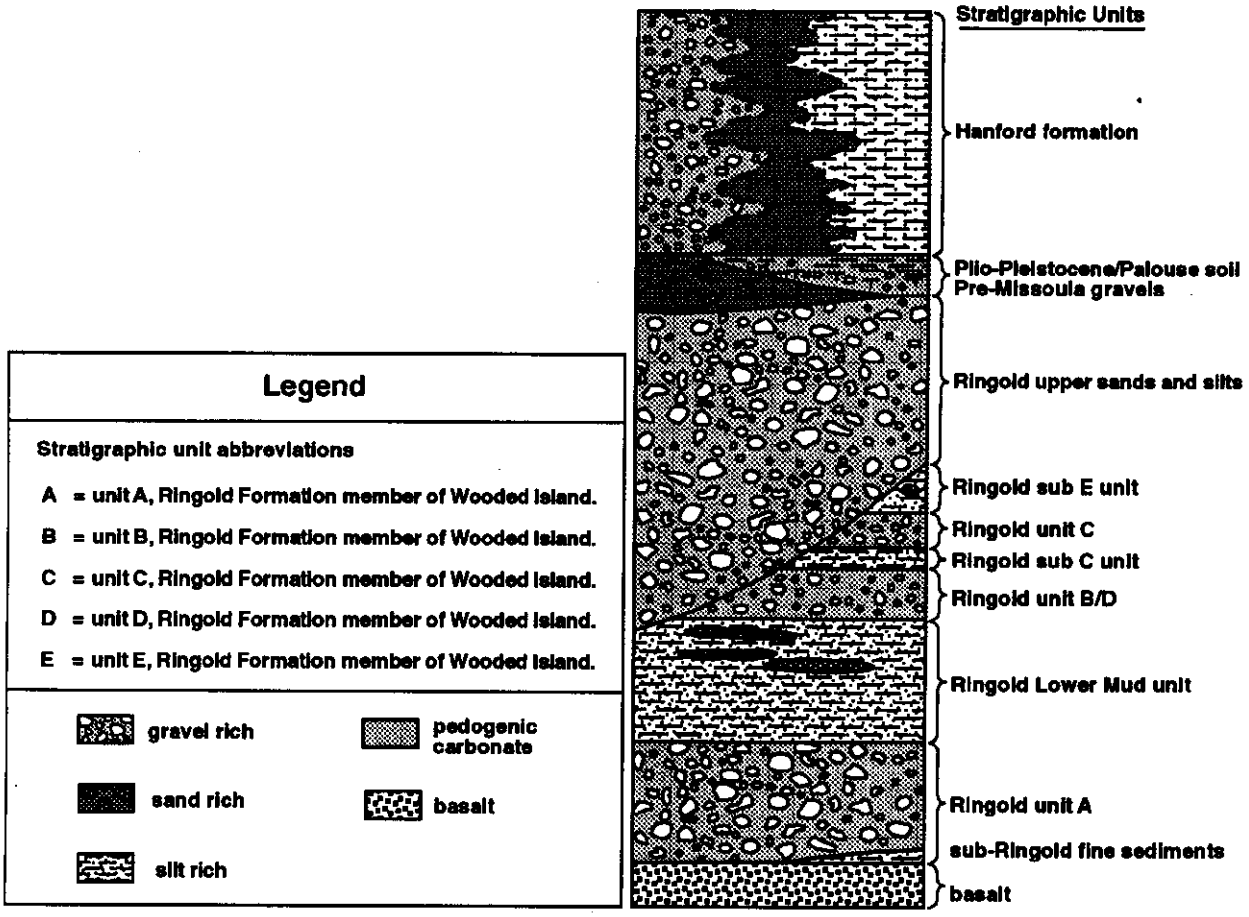

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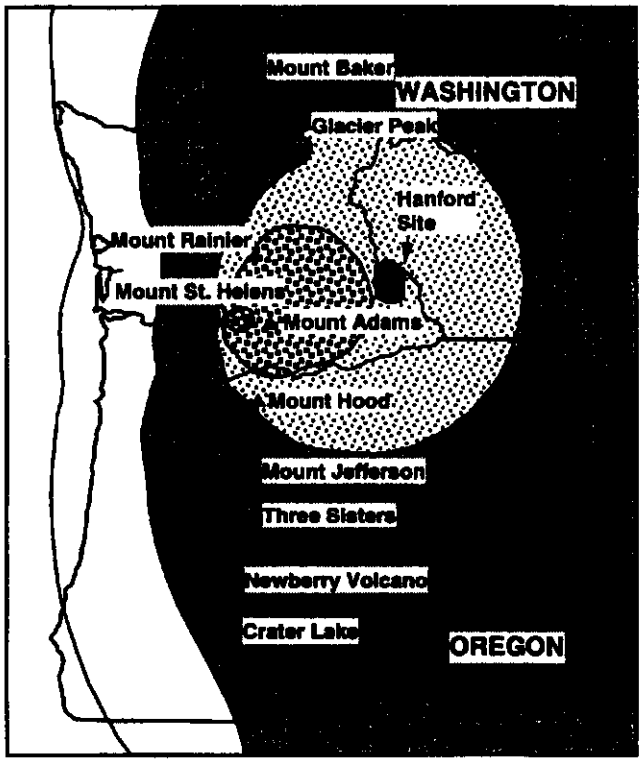
Figure 1-30. Annual Probability of Volcanic Ash Accumulation Greater than 10 mm (0.4 in.) on the Hanford Site.

Greater than 10 mm (0.4 in.)



1.00%
0.20%
0.10%
0.02%
0.01%
less than 0.01%

0 200 kilometers
0 100 miles

USGS, 1987b, *Volcanic Hazards with Regards to Siting Nuclear-Power Plants in the Pacific Northwest*, Open-File Report 87-297, U.S. Geological Survey, Cascades Volcano Observatory, Vancouver, Washington.

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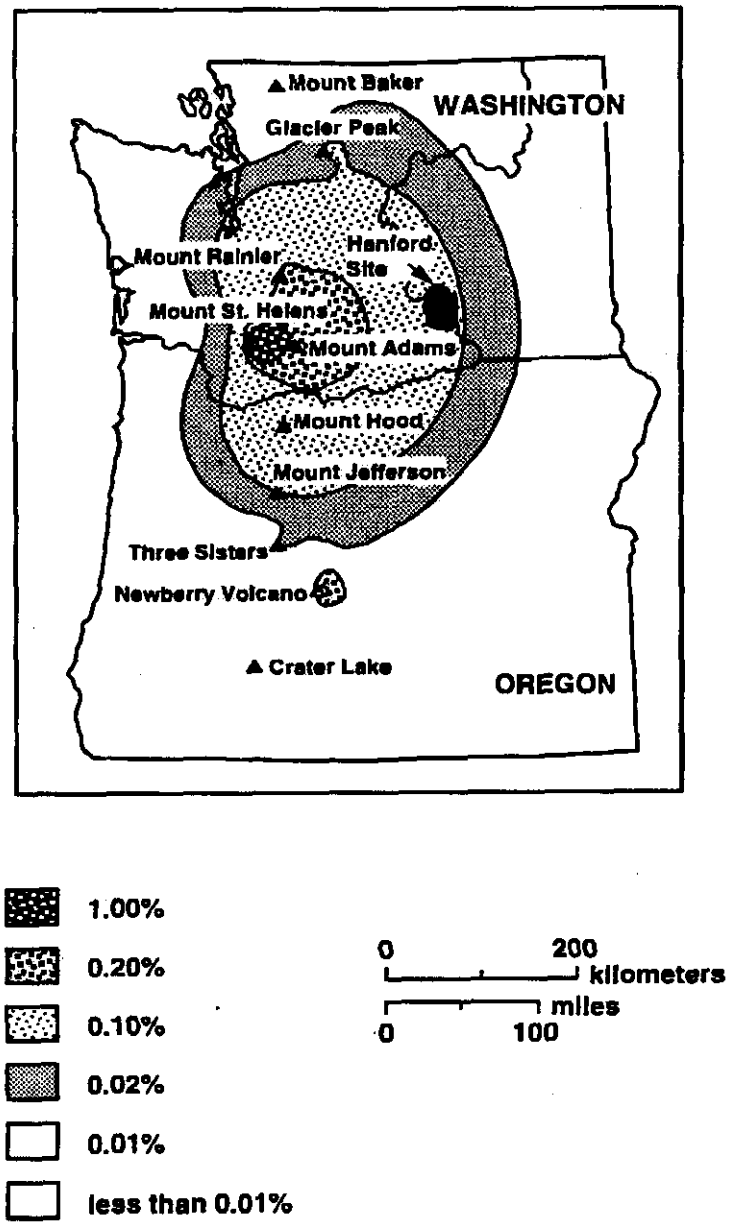
Figure 1-31. Annual Probability of Volcanic Ash Accumulation Greater than 100 mm (4 in.) on the Hanford Site.



USGS, 1987b, *Volcanic Hazards with Regards to Siting Nuclear-Power Plants in the Pacific Northwest*, Open-File Report 87-297, U.S. Geological Survey, Cascades Volcano Observatory, Vancouver, Washington.

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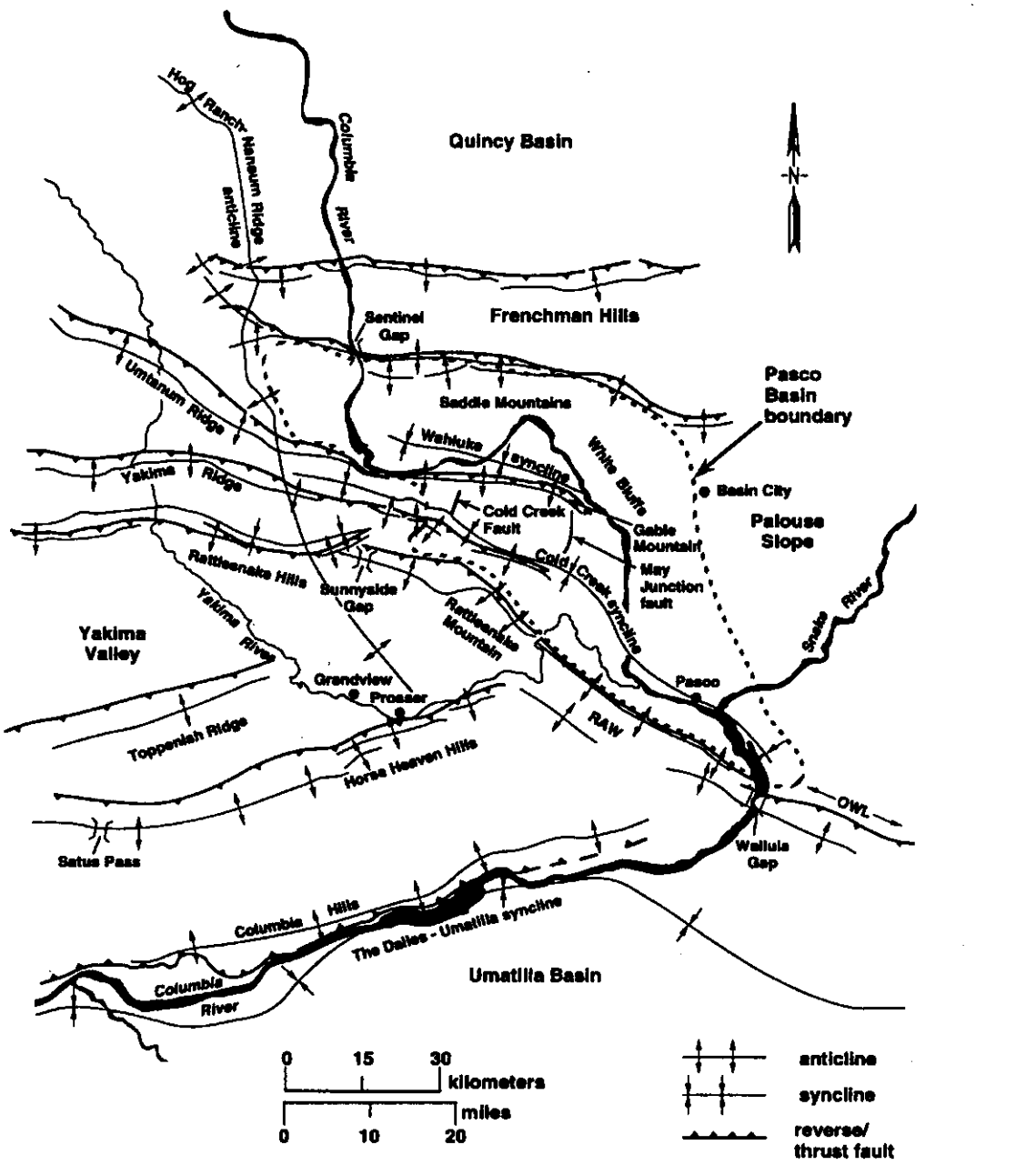
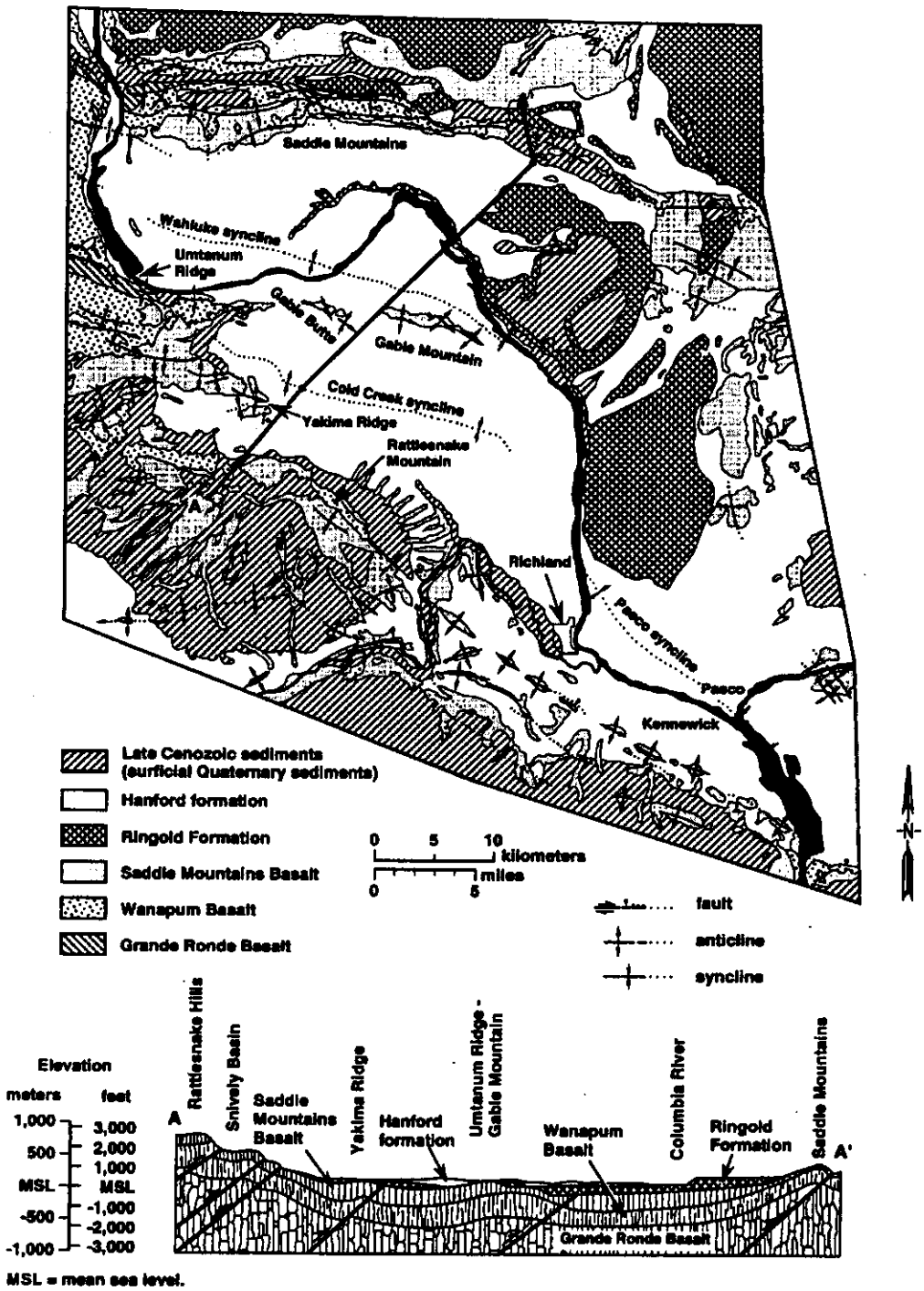
Figure 1-32. Structural Map of the Yakima Fold Belt.



DOE-RW-0164, 1988, *Site Characterization Plan Reference Repository Location, Hanford Site, Washington*, Vol. 2, U.S. Department of Energy, Washington, D.C.

Figure 1-33. Generalized Geologic Map of the Pasco Basin.

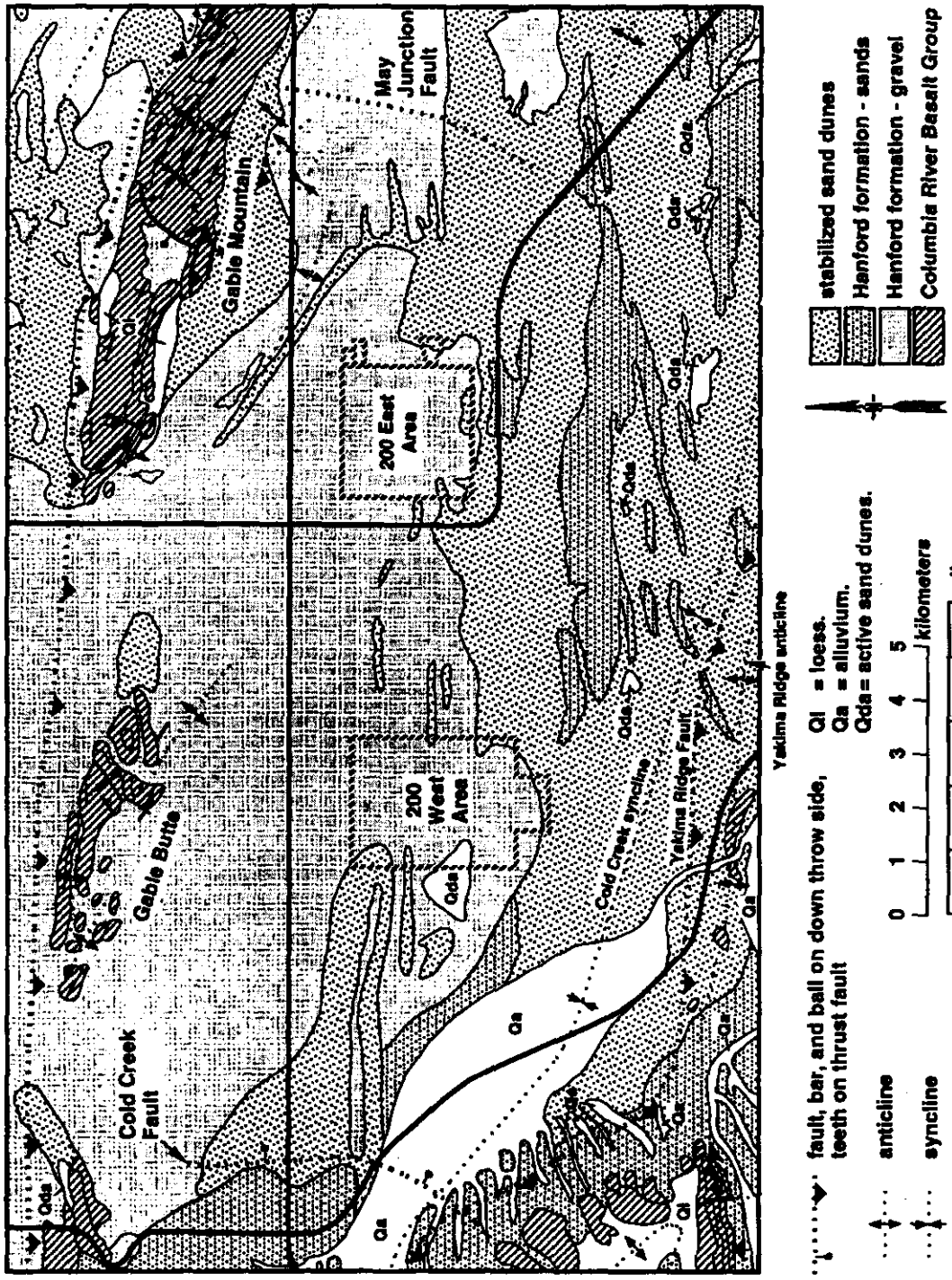


MSL = mean sea level.

RHO-BW-SA-563A, 1987, *Quaternary Geology of the Pasco Basin, Washington*, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

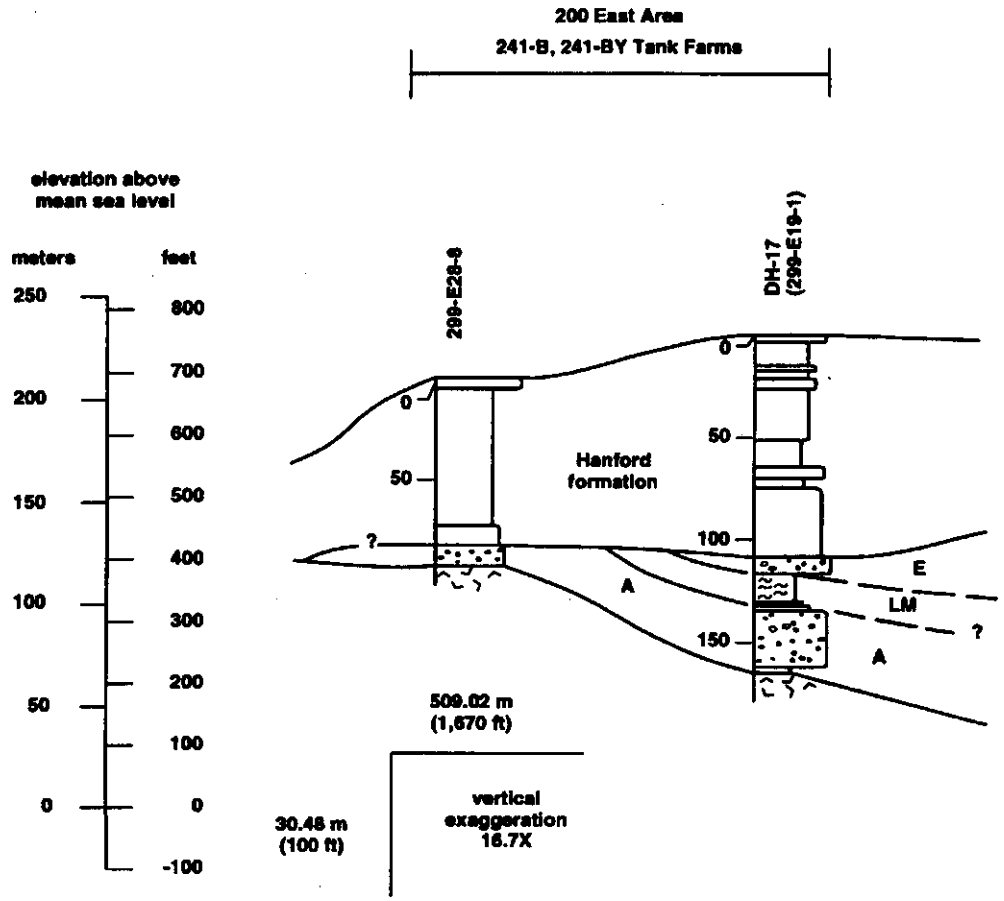
7G96030009.34
R3 SRP-1

Figure 1-34. Geology of the 200 East and 200 West Areas.



RHO-ST-23, 1979, *Geology of the Separations Areas, Hanford Site, South-Central Washington*, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

Figure 1-35. Geologic Stratigraphy of the 200 East Area.

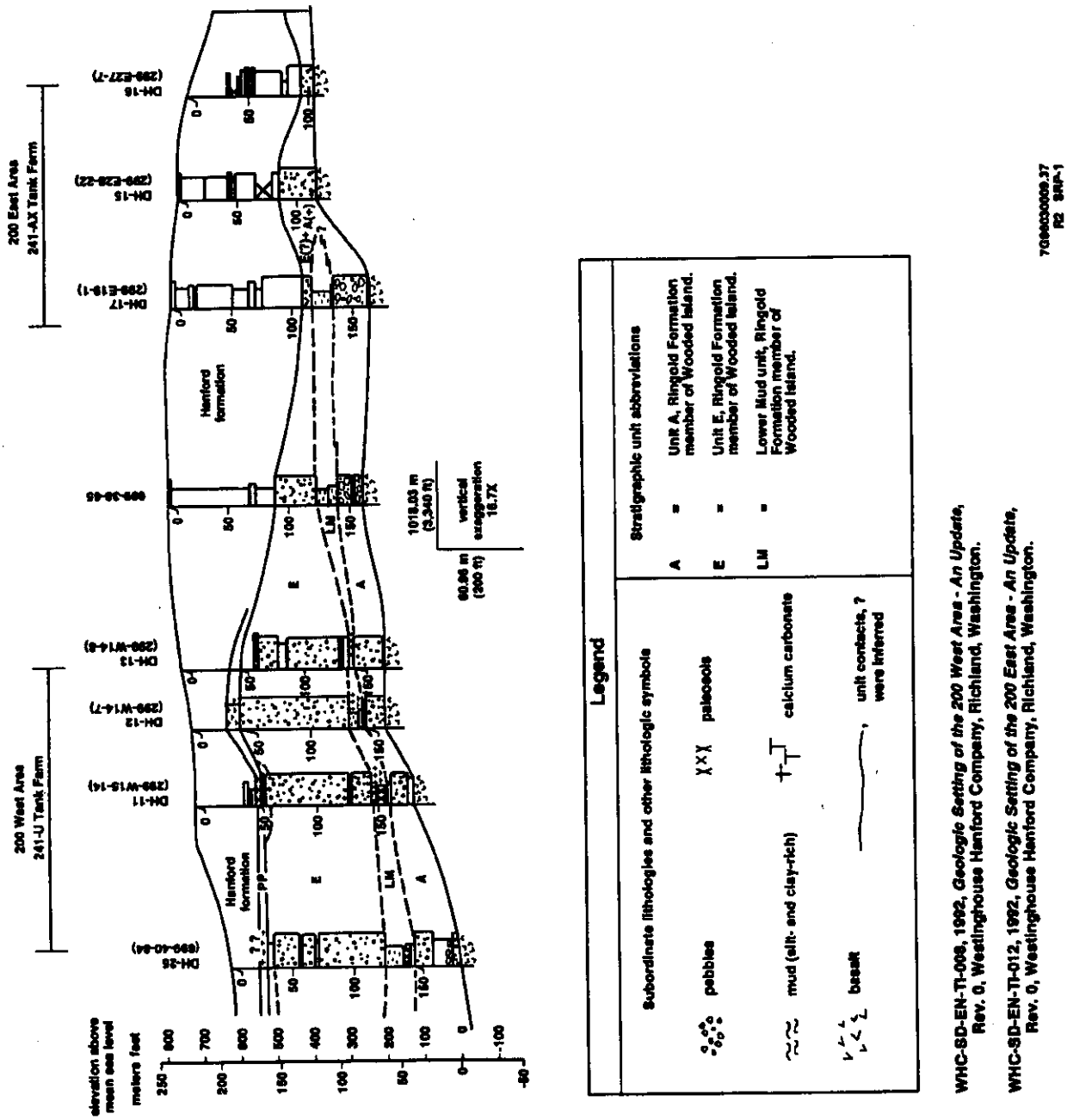


Legend	
Subordinate lithologies and other lithologic symbols	**Stratigraphic unit abbreviations**
pebbles	A = unit A, Ringold Formation member of Wooded Island.
mud (silt- and clay-rich)	E = unit E, Ringold Formation member of Wooded Island.
basalt	LM = Lower Mud unit, Ringold Formation member of Wooded Island.
unit contacts, ? were inferred	

WHC-SD-EN-TI-012, 1992, *Geologic Setting of the 200 East Area - An Update*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

7Q96030009.38
R3 SRP-1

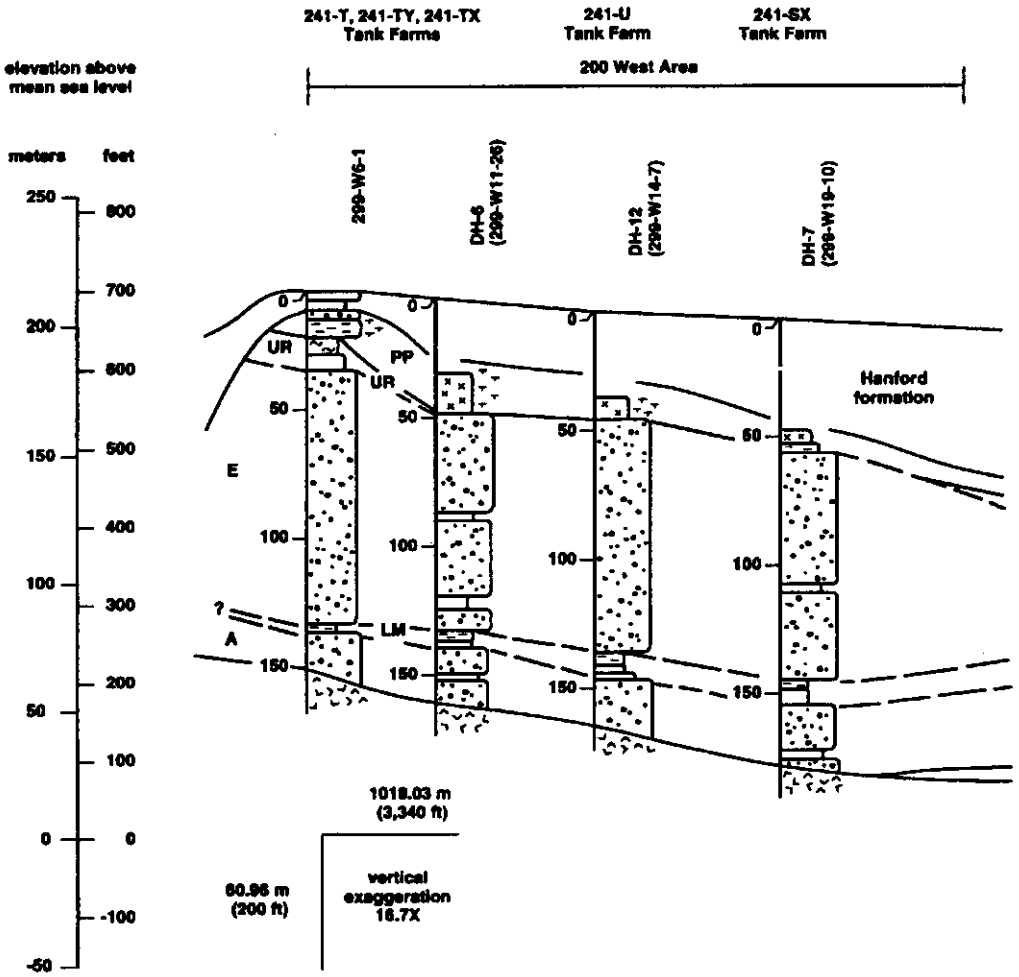
Figure 1-36. Geologic Stratigraphy of the 200 East and 200 West Areas.



WHC-SD-EN-TI-008, 1992, *Geologic Setting of the 200 West Area - An Update*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-012, 1992, *Geologic Setting of the 200 East Area - An Update*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Figure 1-37. Geologic Stratigraphy of the 200 West Area.

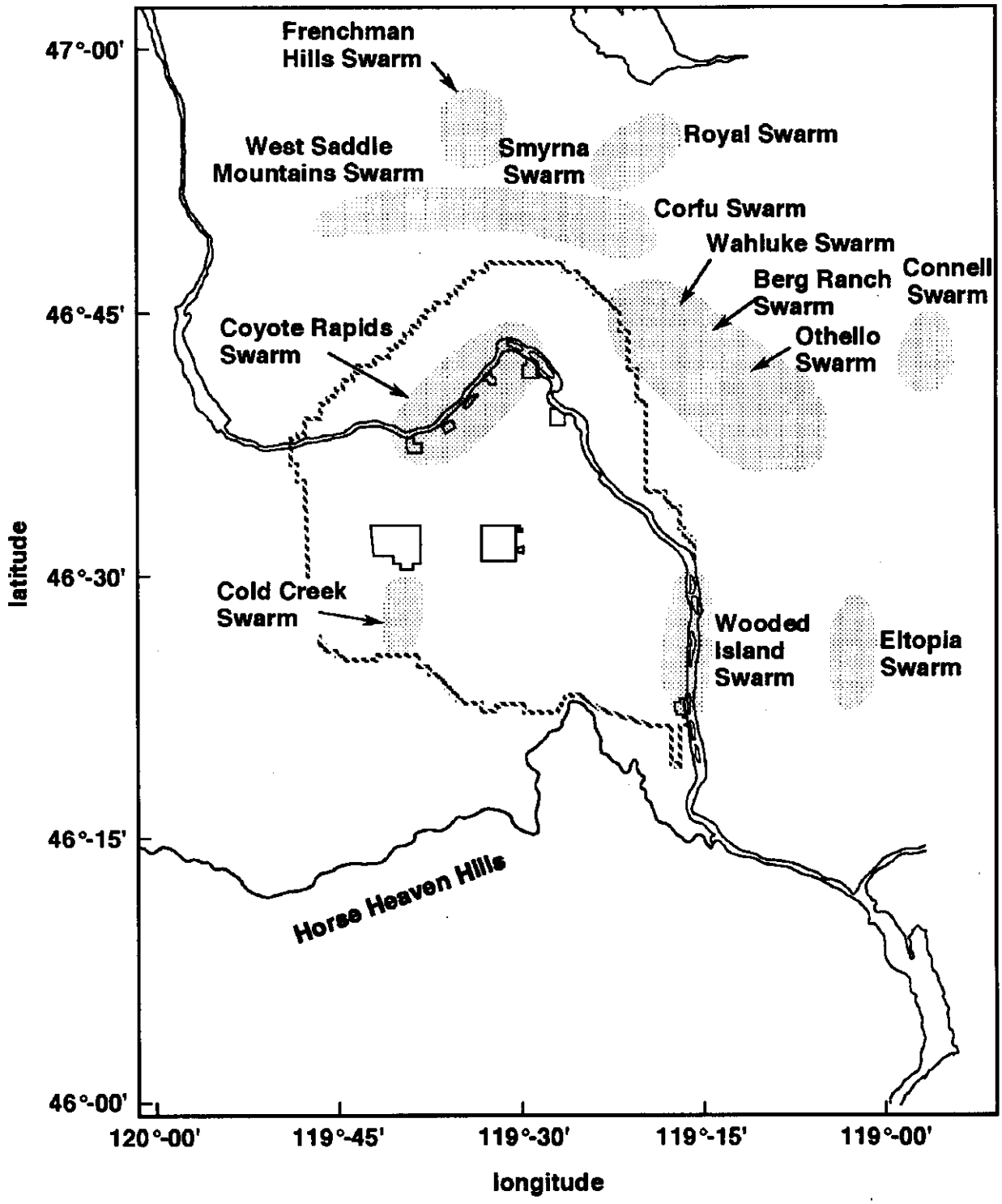


Legend

Subordinate lithologies and other lithologic symbols		Stratigraphic unit abbreviations		
pebbles	paleosols	A	=	Unit A, Ringold Formation member of Wooded Island.
mud (silt- and clay-rich)	calcium carbonate	E	=	Unit E, Ringold Formation member of Wooded Island.
basalt	unit contacts, ? were inferred	LM	=	Lower Mud unit, Ringold Formation member of Wooded Island.
		PP	=	Plio-Pleistocene
		UR	=	Upper Ringold, Ringold Formation member of Taylor Flat.

WHC-SD-EN-TI-008, 1992, *Geologic Setting of the 200 West Area - An Update*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

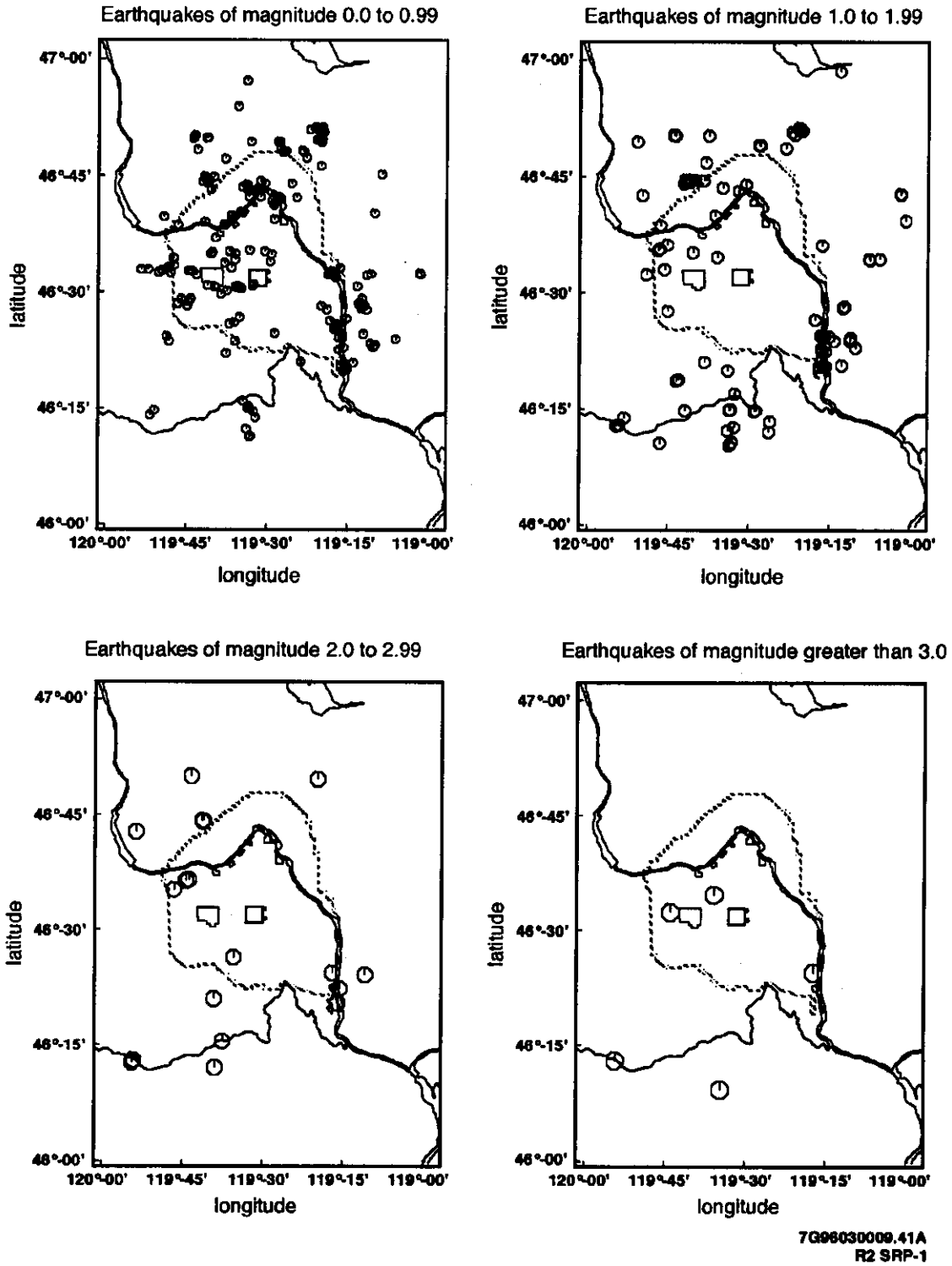
Figure 1-38. Location of Shallow and Intermediate Swarm Areas in the Hanford Site Vicinity.



Supply System, 1997, *Final Safety Analysis Report WPPSS Nuclear Project No. 2*, Amendment 52, Washington Public Power Supply System, Richland, Washington.

7G96030009.40
R4 SRP-1

Figure 1-39. Patterns of Earthquake Activity at the Hanford Site 1990 through 1995.*



*Magnitudes are Richter Magnitude.

Figure 1-40. Patterns of Subsidence in the Cold Creek Syncline.

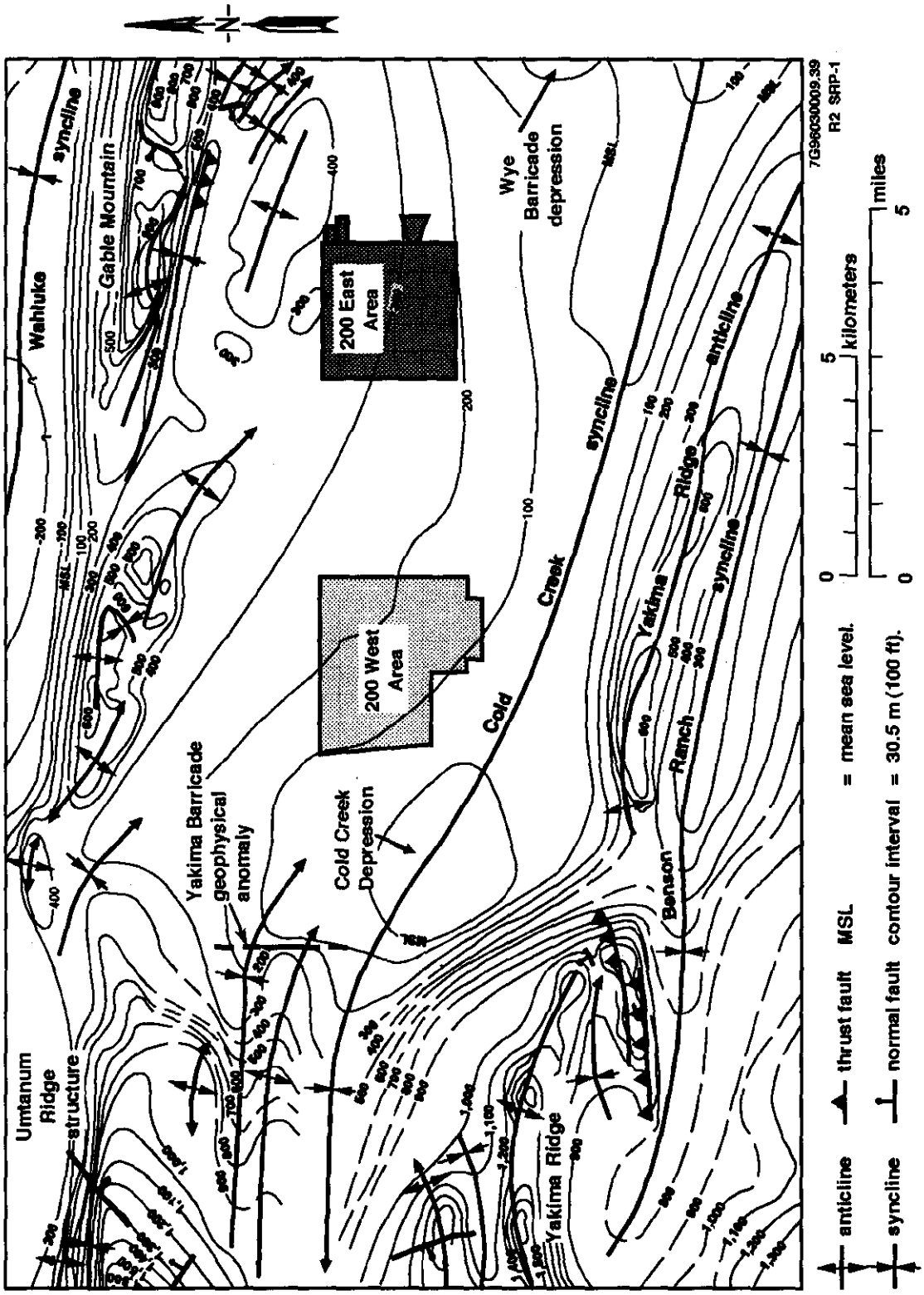
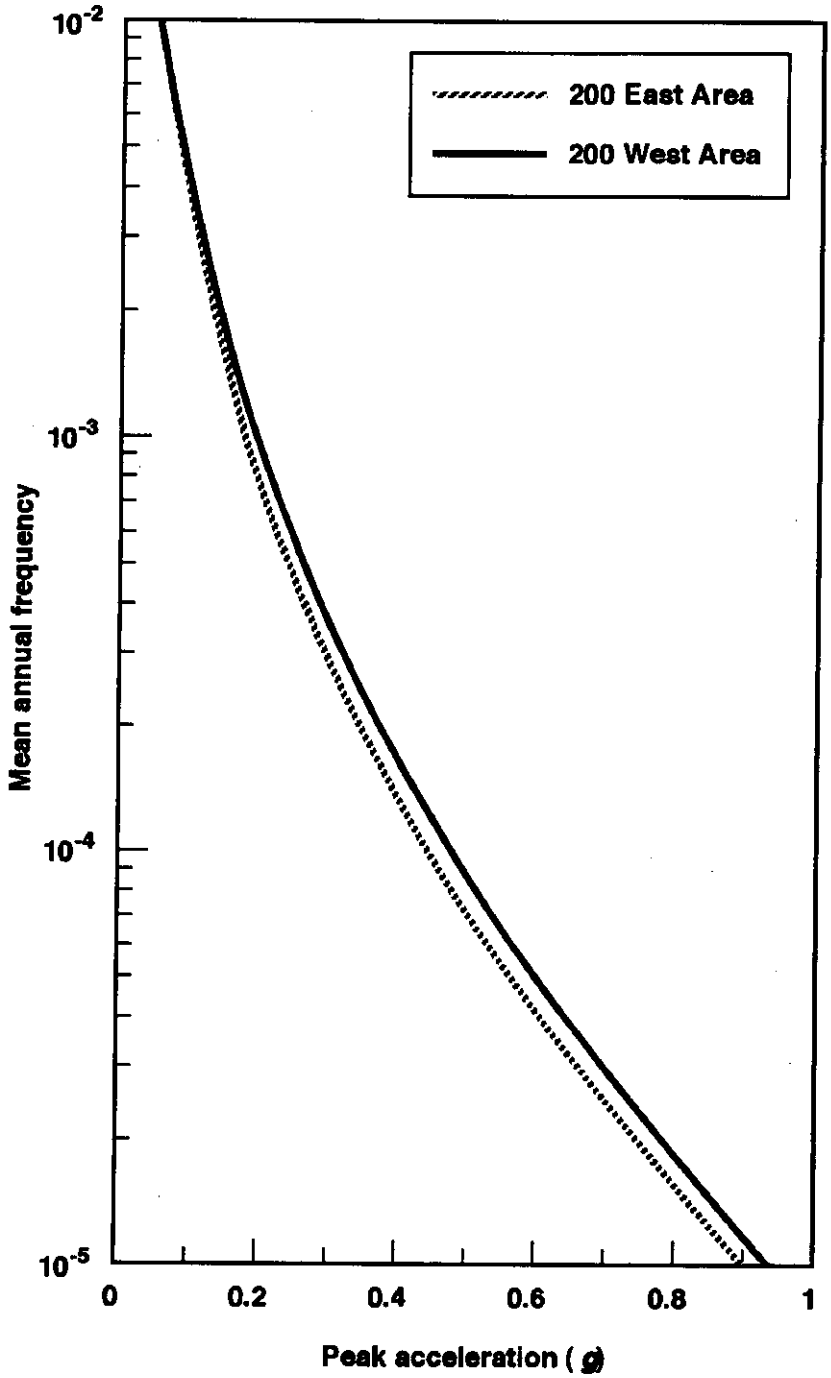
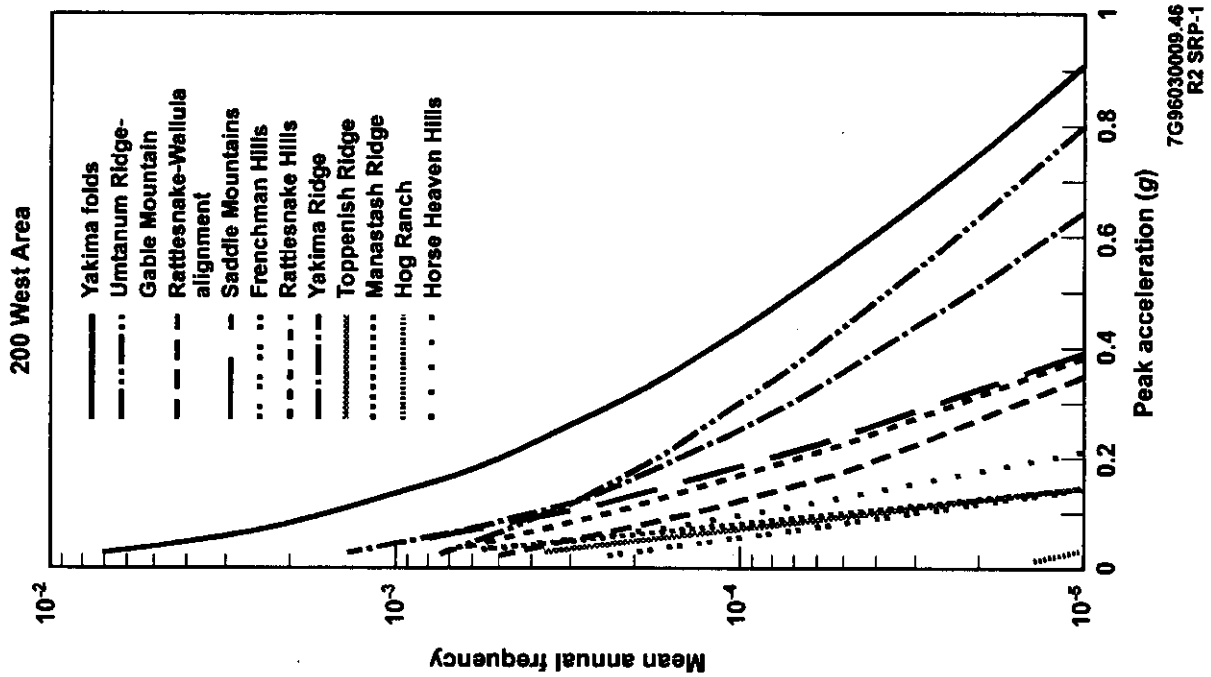


Figure 1-41. Mean Seismic Hazard Curves for the 200 East and 200 West Areas.



7G96030009.45
R2 SRP-1

Figure 1-42. Contributions of Individual Yakima Fold Belt Folds to the Mean Seismic Hazard.



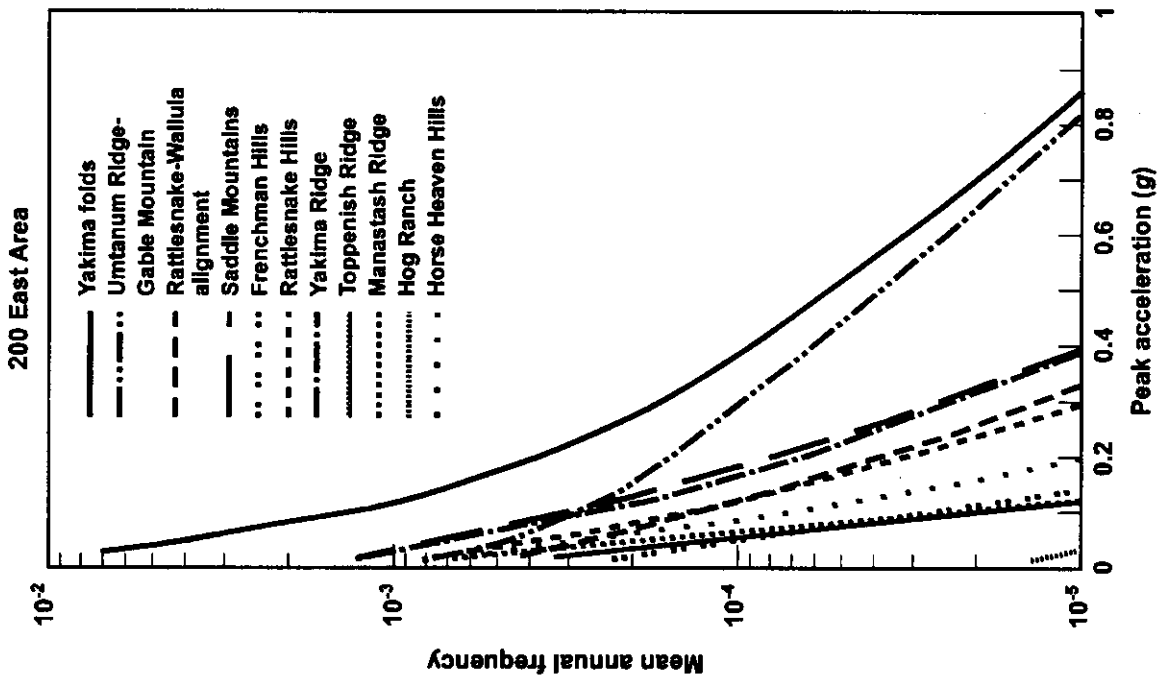
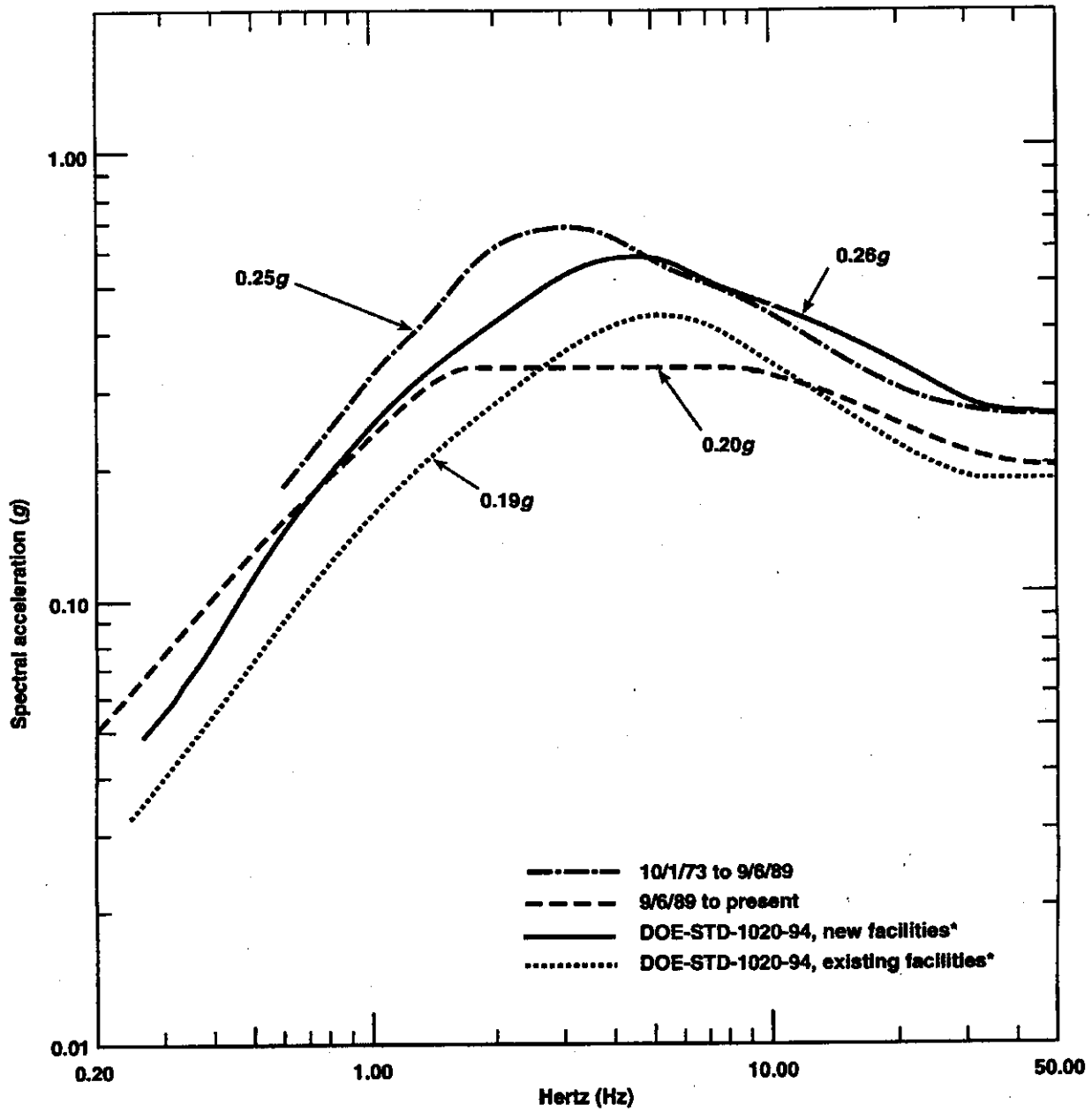


Figure 1-43. 200 West Area Performance Category 3 Response Spectra at 5% Damping.

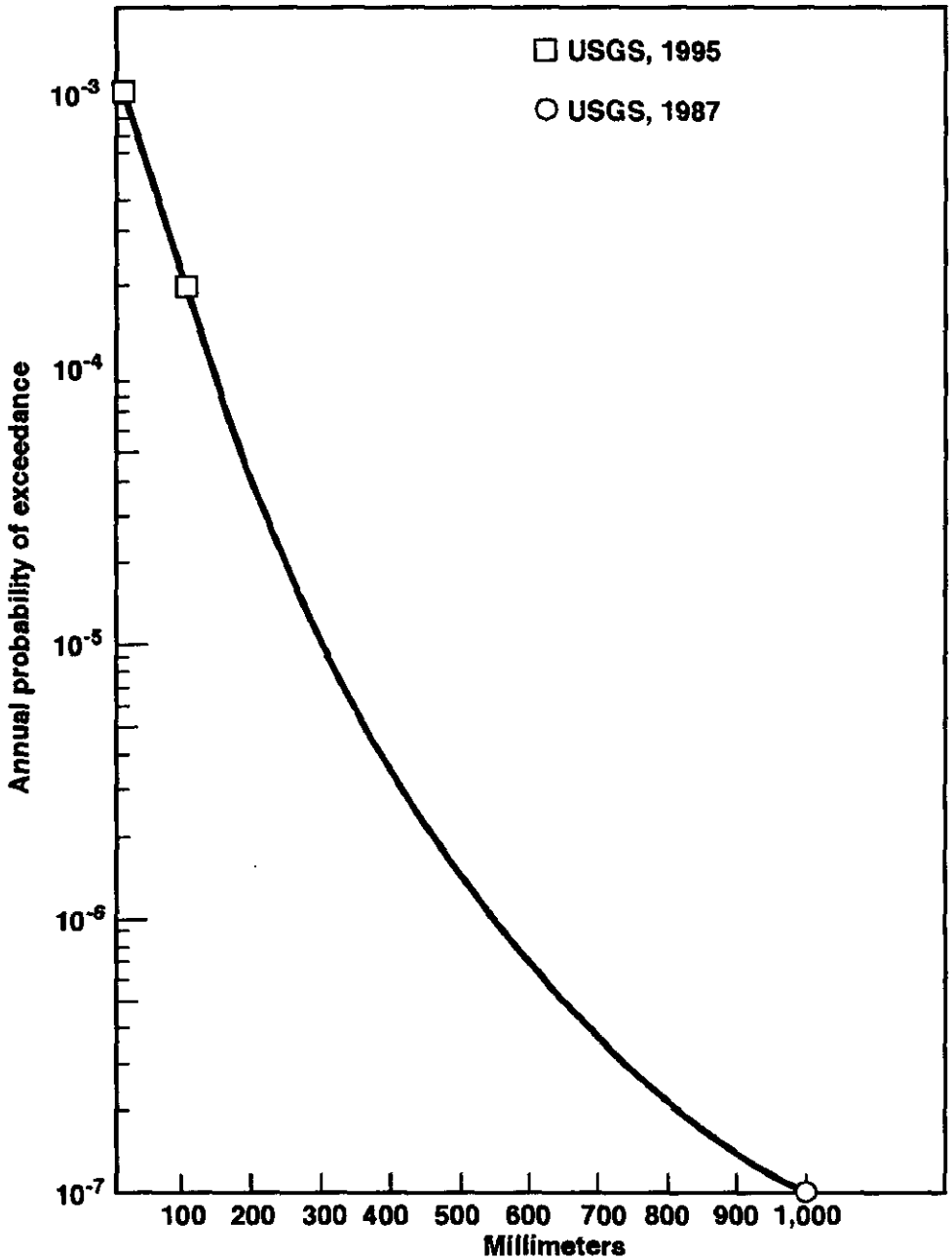


DOE-STD-1020-94, 1994, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, Change 1, U.S. Department of Energy, Washington, D.C.

*200 West Area response spectrum, shown, bounds 200 East Area response spectrum.

7G96030009.55
R3 SRP-1

Figure 1-44. Cascade Range Volcanic Ash Hazard Curve.



Note: To convert millimeters to inches, multiply by 0.04.

USGS, 1987b, Volcanic Hazards with Regards to Siting Nuclear-Power Plants in the Pacific Northwest, Open-File Report 87-297, U.S. Geological Survey, Cascades Volcano Observatory, Vancouver, Wahington.

USGS, 1995, Volcanic Hazards in the Mount Adams Region, Washington, Open-File Report 95-492, U.S. Geological Survey, Washington, D. C.

7G96030009.44
R5 SRP-1

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Figure 1-45. Range of a Rocket Launched from the Yakima Firing Center Multiple Launch Rocket System with Respect to the Hanford Site.

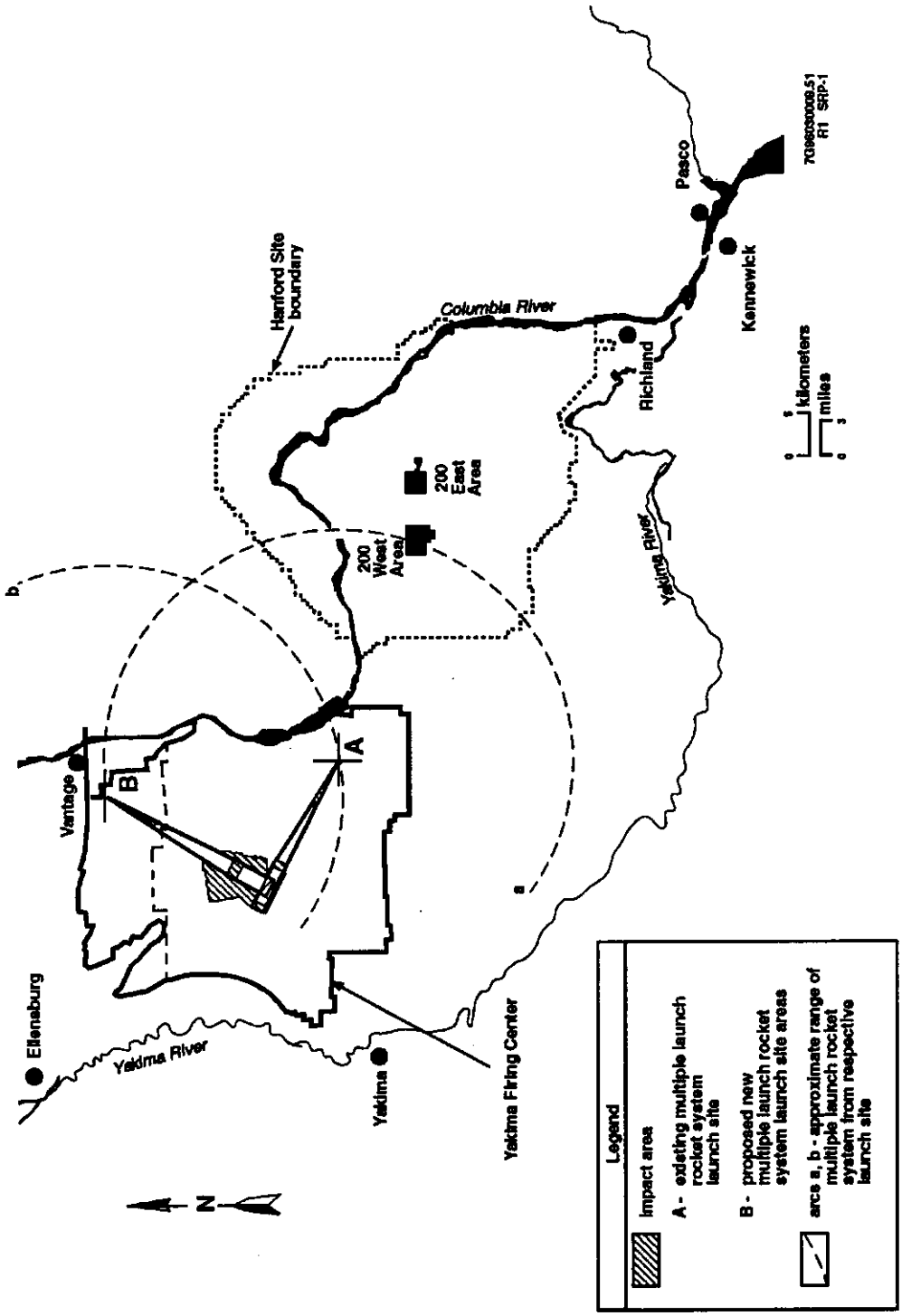

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Table 1-1. Population in the Kennewick-Pasco-Richland Metropolitan Statistical Area, 1980-1995.

Year	Metropolitan statistical area	Year	Metropolitan statistical area
1980	144,469	1988	139,600
1981	150,100	1989	138,300
1982	147,900	1990	150,030*
1983	144,700	1991	153,400
1984	144,000	1992	157,700
1985	140,900	1993	163,900
1986	139,300	1994	169,900
1987	139,600	1995	175,000

Source: DOE/EIS-0189, 1996, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site*, U.S. Department of Energy, Washington, D.C.

*Populations of Benton and Franklin counties were 112,560 and 37,473, respectively.

Table 1-2. Average Temperatures for 1961-1990 and Extreme Temperatures for 1945-1994 at the Hanford Meteorological Station.

Time span	Average temperature (1961-1990)						Extreme temperature (1945-1994)			
	Daily maximum		Daily minimum		Monthly		Maximum		Minimum	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
January	3	38	-4	24	-1	31	22	72	-30	-22
February	8	47	-2	29	3	38	22	72	-31	-23
March	14	57	1	34	8	46	28	83	-14	6
April	19	66	4	40	12	53	34	94	-6	21
May	24	75	8	47	16	61	40	104	-2	28
June	29	84	13	55	21	70	44	111	3	37
July	33	91	16	61	24	76	44	111	4	39
August	32	90	16	60	24	75	45	113	5	41
September	27	80	11	51	19	66	41	106	-1	30
October	19	66	4	40	12	53	32	89	-11	12
November	9	49	0	32	4	40	24	75	-25	-13
December	3	38	-4	25	-1	31	21	69	-26	-14
Year	--	--	--	--	12	53	45	113	-31	-23

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Table 1-3. Average Number of Days that Maximum and Minimum Temperatures at the Hanford Meteorological Station were Above or Below Specified Limits (1945-1995).

Time span	Maximum temperature			Minimum temperature	
	≥38 °C (≥100 °F)	≥32 °C (≥90 °F)	≥0 °C (≥32 °F)	≤0 °C (≤32 °F)	≤-18 °C (≤0 °F)
	Number of days				
January	0	0	10	26	2
February	0	0	3	20	*
March	0	0	*	14	0
April	0	*	0	4	0
May	*	3	0	*	0
June	1	8	0	0	0
July	6	19	0	0	0
August	4	16	0	0	0
September	*	6	0	*	0
October	0	*	*	4	0
November	0	0	2	15	*
December	0	0	9	24	1
Year	12	51	24	106	3

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

*Denotes less than half a day.

Table 1-4. Hanford Site Average Precipitation for 1945-1995 and Extreme Precipitation for Specified Years.

Average			Maximum			Minimum		
Time span	mm	in.	Year	mm	in.	Year	mm	in.
January	24.9	0.98	1970	62.7	2.47	1977	2.00	0.08
February	15.7	0.62	1961	53.3	2.10	1988	T*	T*
March	12.7	0.50	1957	47.2	1.86	1968	0.50	0.02
April	11.7	0.46	1995	39.1	1.54	1986	T*	T*
May	13.5	0.53	1972	51.6	2.03	1992	T	T
June	13.7	0.54	1950	74.2	2.92	1986	T*	--
July	5.6	0.22	1993	44.7	1.76	1980	T*	T*
August	6.4	0.25	1977	34.5	1.36	1988	0.00*	0.00*
September	8.1	0.32	1947	34.0	1.34	1991	0.00*	0.00
October	13.7	0.54	1957	69.1	2.72	1987	T*	T*
November	21.8	0.86	1973	67.1	2.64	1976	T	T
December	24.9	0.98	1964	59.4	2.34	1976	2.8	0.11
Year	170.9	6.73	1995	312.7	12.31	1976	75.9	2.99

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

*Most recent of multiple occurrences.

T = trace (0.1 mm [0.005 in.] or less).

Table 1-5. Hanford Site Probable Maximum Precipitation Estimates and Average Return Estimates for Specified Precipitation Durations.

Duration	PMP 24-h general storm (10 mi²)[a]		PMP local storm (1 mi²)[a]		PMP local storm (10 mi²)[a]		25-yr average return period[b]		100-yr average return period[b]		1,000-yr average return period[b]	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
15 min	--	--	102.0	4.0	81.0	3.2	--	--	--	--	--	--
20 min	--	--	--	--	--	--	11.9	0.47	15.2	0.60	20.3	0.80
30 min	--	--	152.0	6.0	122.0	4.8	--	--	--	--	--	--
45 min	--	--	183.0	7.2	147.0	5.8	--	--	--	--	--	--
1 h	41.0	1.6	203.0	8.0	163.0	6.4	15.8	0.62	20.6	0.81	28.2	1.11
6 h	119.0	4.7	234.0	9.2	188.0	7.4	30.7	1.21	40.4	1.59	55.9	2.20
24 h	203.0	8.0	--	--	--	--	39.6	1.56	50.6	1.99	68.1	2.68
48 h	244.0	9.6	--	--	--	--	--	--	--	--	--	--
72 h	264.0	10.4	--	--	--	--	--	--	--	--	--	--

[a]Hansen, E. M., D. D. Fenn, P. Corrigan, J. L. Vogel, L. C. Schreiner, and R. W. Stoch, 1994, *Probable Maximum Precipitation - Pacific Northwest States*, Hydrometeorological Report No. 57, National Weather Service, Silver Spring, Maryland.

[b]PNL-4622, 1983, *Climatological Summary for the Hanford Area*, Pacific Northwest Laboratory, Richland, Washington.

PMP = probable maximum precipitation.

Table 1-6. Monthly Average and Seasonal Maximum Recorded Snowfall at the Hanford Site (1945-1995).

Time span	Average		Seasonal maximum			24-h maximum		
	mm	in.	Year	mm	in.	Year	mm	in.
January	127.0	5.0	1950	594.0	23.4	1954	180.0	7.1
February	64.0	2.5	1989	432.0	17.0	1993	259.0	10.2
March	13.0	0.5	1951	107.0	4.2	1989	69.0	2.7
April	T	T	1982	25.0	1.0	--	*	*
May	0.0	0.0	--	0.0	0.0	--	0.0	0.0
June	0.0	0.0	--	0.0	0.0	--	0.0	0.0
July	0.0	0.0	--	0.0	0.0	--	0.0	0.0
August	0.0	0.0	--	0.0	0.0	--	0.0	0.0
September	0.0	0.0	--	0.0	0.0	--	0.0	0.0
October	3.0	0.1	1973	38.0	1.5	1973	38.0	1.5
November	38.0	1.5	1985	465.0	18.3	1985	224.0	8.8
December	135.0	5.3	1992	533.0	21.0	1985	168.0	6.6
Year	381.0	15.0	1992-1993	1,425.0	56.1	February 1993	259.0	10.2

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

*No value given for maximum 24-h snowfall.

T = trace (0.1 mm [0.005 in.] or less).

Table 1-7. Average Number of Thunderstorm Days Recorded at the Hanford Meteorological Station (1945-1995).

Time span	Thunderstorm days
January	0.0
February	≤0.1
March	0.2
April	0.8
May	1.6
June	2.4
July	2.1
August	2.1
September	0.8
October	0.2
November	0.0
December	≤0.1
Year	10.1

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Table 1-8. Maximum Peak Gusts Recorded 15 m (50 ft) Aboveground at the Hanford Meteorological Station (1945-1995).

Time span	Peak gust speed		Direction of peak	Year measured
	km/h	mi/h		
January	129	80	SW	1970, 1972
February	105	65	SW	1971
March	113	70	SW	1956
April	118	73	SSW	1972
May	114	71	SSW	1948
June	116	72	SW	1957
July	111	69	WSW	1979
August	106	66	SW	1961
September	105	65	SSW	1953
October	101	63	SSW	1950
November	108	67	WSW	1993
December	114	71	SW	1955

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Table 1-9. Average Number of Days of Dust or Blowing Dust Recorded at the Hanford Meteorological Station (1945-1995).

Time span	Days of dust or blowing dust
January	0.4
February	0.4
March	0.5
April	0.6
May	0.7
June	0.4
July	0.4
August	0.3
September	0.5
October	0.3
November	0.2
December	0.2
Year	4.6

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Table 1-10. Monthly and Annual Number of Days with Fog and Dense Fog at the Hanford Site (1945-1995).

Time span	Days with fog			Days with dense fog		
	Average	Maximum	Minimum	Average	Maximum	Minimum
January	11.3	25.0	0.0	6.1	15.0	0.0
February	6.6	20.0	0.0	3.2	11.0	0.0
March	2.1	10.0	0.0	1.1	5.0	0.0
April	0.4	3.0	0.0	0.1	1.0	0.0
May	0.2	3.0	0.0	<0.1	1.0	0.0
June	0.1	2.0	0.0	<0.1	1.0	0.0
July	<0.1	1.0	0.0	0.0	0.0	0.0
August	0.1	1.0	0.0	<0.1	1.0	0.0
September	0.3	2.0	0.0	0.1	1.0	0.0
October	2.0	9.0	0.0	1.0	7.0	0.0
November	9.5	19.0	0.0	5.4	13.0	0.0
December	14.2	25.0	2.0	7.7	17.0	2.0
Year	46.8	84.0	22.0	24.5	42.0	9.0

Source: PNNL-11107, 1996, Climatological Data Summary 1995, with Historical Data, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Table 1-11. Average Monthly Sky Cover, Sunrise to Sunset, Recorded at the Hanford Meteorological Station (1946-1994).

Time span	Sky cover (in tenths)		
	Maximum	Minimum	Average
January	9.2	4.3	8.0
February	9.3	6.1	7.6
March	8.5	4.9	6.8
April	8.1	3.7	6.4
May	8.1	3.6	5.9
June	7.0	2.8	5.2
July	5.0	0.9	3.1
August	5.9	0.6	3.3
September	6.7	1.4	3.9
October	8.0	3.3	5.7
November	9.1	5.2	7.5
December	9.3	6.4	8.0
Year	6.6	5.1	5.9

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Table 1-12. Average Number of Clear, Partly Cloudy, and Cloudy Days Recorded at the Hanford Meteorological Station (1954-1995).

Time span	Number of clear days	Number of partly cloudy days	Number of cloudy days
January	3	5	22
February	4	5	19
March	6	8	17
April	6	9	15
May	8	11	12
June	10	10	10
July	19	8	5
August	18	8	5
September	16	7	7
October	10	8	13
November	5	6	20
December	4	4	23
Year	110	89	166

Source: PNNL-11107, 1996, *Climatological Data Summary 1995, with Historical Data*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Table 1-13. Occurrence of Mixing-Layer Thicknesses at the Hanford Site by Season and Time of Day.

Mixing layer		Winter percent frequency		Summer percent frequency	
m	ft	Night	Day	Night	Day
<250	<820	65.7	35.0	48.5	1.2
250-500	820-1,640	24.7	39.8	37.1	9.0
>500	>1,640	9.6	25.2	14.4	89.9

Source: PNL-6415, 1994, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 6, Pacific Northwest Laboratory, Richland, Washington.

Table 1-14. Percent Probabilities for Extended Periods of Surface-Based Inversions.

Time span	Inversion duration		
	12 h (%)	24 h (%)	48 h (%)
January and February	54.00	2.50	0.28
March and April	50.00	<0.10	<0.10
May and June	10.00	<0.10	<0.10
July and August	18.00	<0.10	<0.10
September and October	64.00	0.11	<0.10
November and December	50.00	1.20	0.13

Source: PNL-6415, 1994, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 6, Pacific Northwest Laboratory, Richland, Washington.

Table 1-15. Joint Frequency Distribution of Hourly Averaged Wind Data for the 200 East Area (January 1983 to December 1991). (3 sheets)

Wind speed class	Stability class	Percentage of time wind blows from the indicated direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.89	A	0.28	0.23	0.26	0.30	0.31	0.26	0.19	0.10	0.08	0.06	0.07	0.07	0.08	0.10	0.16	0.24
	B	0.10	0.13	0.12	0.11	0.12	0.10	0.08	0.04	0.04	0.02	0.01	0.03	0.03	0.06	0.08	0.10
	C	0.10	0.10	0.10	0.13	0.10	0.11	0.07	0.04	0.03	0.02	0.03	0.02	0.04	0.05	0.11	0.11
	D	0.68	0.62	0.69	0.64	0.59	0.58	0.50	0.34	0.21	0.21	0.24	0.22	0.33	0.50	0.64	0.62
	E	0.30	0.27	0.34	0.29	0.35	0.39	0.37	0.33	0.27	0.24	0.31	0.33	0.38	0.50	0.51	0.41
	F	0.18	0.14	0.16	0.16	0.24	0.26	0.32	0.29	0.26	0.25	0.26	0.31	0.37	0.41	0.36	0.25
	G	0.07	0.05	0.09	0.08	0.10	0.14	0.15	0.15	0.13	0.10	0.12	0.10	0.17	0.16	0.16	0.10
2.70	A	0.53	0.48	0.34	0.36	0.46	0.54	0.51	0.30	0.17	0.14	0.20	0.20	0.19	0.31	0.49	0.52
	B	0.16	0.15	0.07	0.10	0.13	0.14	0.15	0.09	0.06	0.05	0.04	0.06	0.06	0.10	0.19	0.17
	C	0.15	0.13	0.08	0.09	0.10	0.14	0.21	0.10	0.05	0.02	0.04	0.05	0.06	0.10	0.22	0.16
	D	0.64	0.52	0.46	0.37	0.52	0.63	0.85	0.53	0.27	0.20	0.29	0.34	0.53	1.14	1.22	0.80
	E	0.25	0.17	0.13	0.14	0.24	0.38	0.55	0.55	0.36	0.24	0.35	0.60	1.27	1.83	1.25	0.39
	F	0.10	0.05	0.05	0.07	0.12	0.22	0.45	0.47	0.34	0.24	0.33	0.57	1.25	1.83	0.92	0.24
	G	0.03	0.02	0.02	0.03	0.07	0.10	0.22	0.24	0.15	0.10	0.12	0.25	0.64	0.75	0.34	0.08
4.70	A	0.20	0.26	0.11	0.04	0.06	0.10	0.12	0.14	0.09	0.08	0.18	0.36	0.25	0.35	0.44	0.18
	B	0.06	0.06	0.03	0.01	0.02	0.04	0.05	0.05	0.02	0.02	0.06	0.08	0.07	0.14	0.14	0.06
	C	0.06	0.05	0.03	0.01	0.02	0.02	0.05	0.04	0.04	0.02	0.04	0.07	0.07	0.13	0.13	0.04
	D	0.23	0.21	0.10	0.04	0.09	0.12	0.29	0.28	0.18	0.14	0.27	0.44	0.63	1.50	0.93	0.22
	E	0.13	0.08	0.04	0.01	0.04	0.06	0.18	0.27	0.16	0.13	0.22	0.53	1.51	2.70	0.87	0.13
	F	0.03	0.05	0.01	0.01	0.01	0.03	0.07	0.18	0.11	0.04	0.08	0.30	0.92	1.69	0.40	0.05
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.05	0.01	0.03	0.16	0.42	0.86	0.16	0.01

Table 1-15. Joint Frequency Distribution of Hourly Averaged Wind Data for the 200 East Area (January 1983 to December 1991). (3 sheets)

Wind speed class	Stability class	Percentage of time wind blows from the indicated direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
7.20	A	0.05	0.06	0.06	0.01	0.00	0.00	0.01	0.03	0.03	0.04	0.13	0.27	0.18	0.24	0.35	0.05
	B	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.05	0.09	0.05	0.07	0.09	0.01
	C	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.03	0.08	0.04	0.06	0.07	0.01
	D	0.07	0.08	0.03	0.01	0.00	0.01	0.03	0.08	0.07	0.12	0.29	0.43	0.42	1.13	0.56	0.06
	E	0.06	0.09	0.02	0.00	0.00	0.00	0.02	0.05	0.05	0.08	0.20	0.33	0.48	1.75	0.49	0.02
	F	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.05	0.09	0.03	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
9.80	A	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.17	0.07	0.10	0.25	0.00
	B	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.02	0.03	0.06	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.01	0.03	0.05	0.00
	D	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.07	0.19	0.23	0.09	0.47	0.33	0.01
	E	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.05	0.13	0.14	0.04	0.35	0.14	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.02	0.02	0.04	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.01	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.02	0.00
	D	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.09	0.02	0.06	0.08	0.00
	E	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.02	0.01	0.04	0.03	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1-15. Joint Frequency Distribution of Hourly Averaged Wind Data for the 200 East Area (January 1983 to December 1991). (3 sheets)

Wind speed class	Stability class	Percentage of time wind blows from the indicated direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
16.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.01	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1-16. Joint Frequency Distribution of Hourly Averaged Wind Data for the 200 West Area (January 1983 to December 1991). (3 sheets)

Wind speed class	Stability class	Percentage of time wind blows from the indicated direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.89	A	0.31	0.29	0.27	0.29	0.27	0.28	0.29	0.22	0.16	0.13	0.13	0.12	0.08	0.11	0.16	0.21
	B	0.14	0.12	0.10	0.10	0.15	0.11	0.10	0.08	0.05	0.05	0.05	0.04	0.06	0.06	0.09	0.10
	C	0.13	0.12	0.11	0.10	0.11	0.12	0.10	0.08	0.04	0.06	0.06	0.05	0.06	0.06	0.08	0.12
	D	0.74	0.59	0.52	0.42	0.45	0.51	0.68	0.59	0.52	0.50	0.64	0.59	0.61	0.69	0.71	0.70
	E	0.41	0.25	0.20	0.17	0.26	0.29	0.49	0.48	0.50	0.58	0.70	0.88	1.10	1.17	0.90	0.56
	F	0.31	0.20	0.16	0.16	0.17	0.23	0.41	0.43	0.44	0.46	0.61	0.91	1.28	1.45	0.98	0.53
	G	0.17	0.12	0.08	0.10	0.10	0.13	0.17	0.17	0.19	0.20	0.28	0.39	0.71	0.90	0.52	0.27
2.70	A	0.65	0.32	0.21	0.15	0.20	0.26	0.32	0.20	0.19	0.20	0.27	0.35	0.22	0.18	0.53	0.73
	B	0.26	0.13	0.08	0.05	0.05	0.11	0.11	0.07	0.04	0.04	0.08	0.08	0.07	0.09	0.18	0.29
	C	0.27	0.12	0.10	0.05	0.07	0.12	0.13	0.07	0.05	0.05	0.06	0.06	0.05	0.07	0.17	0.30
	D	0.94	0.54	0.32	0.24	0.31	0.43	0.57	0.33	0.20	0.23	0.35	0.45	0.78	1.15	1.33	1.11
	E	0.38	0.18	0.12	0.08	0.09	0.24	0.30	0.19	0.13	0.17	0.34	0.79	1.91	2.52	1.34	0.52
	F	0.19	0.10	0.03	0.02	0.03	0.08	0.17	0.10	0.06	0.06	0.11	0.34	1.00	2.03	1.02	0.30
	G	0.07	0.04	0.02	0.01	0.01	0.03	0.05	0.03	0.01	0.02	0.04	0.08	0.32	0.90	0.33	0.08
4.70	A	0.20	0.18	0.06	0.01	0.02	0.04	0.08	0.03	0.03	0.09	0.23	0.40	0.28	0.17	0.52	0.42
	B	0.07	0.04	0.02	0.01	0.01	0.03	0.03	0.01	0.01	0.03	0.06	0.11	0.07	0.05	0.18	0.14
	C	0.05	0.04	0.01	0.00	0.01	0.01	0.02	0.01	0.02	0.05	0.06	0.10	0.09	0.05	0.17	0.15
	D	0.20	0.15	0.05	0.02	0.04	0.10	0.13	0.07	0.08	0.23	0.38	0.61	0.74	0.85	1.08	0.54
	E	0.11	0.07	0.03	0.00	0.01	0.04	0.08	0.05	0.07	0.14	0.26	0.48	1.13	1.42	1.04	0.31
	F	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.06	0.23	0.24	0.19	0.13
	G	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.03	0.05	0.03	0.02

Table 1-16. Joint Frequency Distribution of Hourly Averaged Wind Data for the 200 West Area (January 1983 to December 1991). (3 sheets)

Wind speed class	Stability class	Percentage of time wind blows from the indicated direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
7.20	A	0.03	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.15	0.37	0.19	0.10	0.44	0.13
	B	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.11	0.06	0.03	0.13	0.03
	C	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.11	0.04	0.02	0.10	0.03
	D	0.04	0.05	0.02	0.00	0.00	0.00	0.01	0.02	0.04	0.14	0.42	0.49	0.25	0.27	0.83	0.13
	E	0.02	0.09	0.02	0.00	0.00	0.00	0.01	0.00	0.03	0.08	0.23	0.27	0.18	0.31	0.59	0.06
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.80	A	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.11	0.07	0.02	0.21	0.03
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.04	0.02	0.01	0.05	0.01
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.03	0.01	0.00	0.03	0.00
	D	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.23	0.17	0.06	0.05	0.36	0.02
	E	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.07	0.02	0.04	0.17	0.01
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.02	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.06	0.03	0.00	0.03	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1-16. Joint Frequency Distribution of Hourly Averaged Wind Data for the 200 West Area (January 1983 to December 1991). (3 sheets)

Wind speed class	Stability class	Percentage of time wind blows from the indicated direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
16.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1-17. Percent Frequency of Occurrence of Atmospheric Stability Classes A Through G in the 200 East and 200 West Areas (1983 to 1991).

Class	Occurrence per year (%)
A (extremely unstable)	13.9
B (moderately unstable)	4.5
C (slightly unstable)	4.3
D (neutral)	27.9
E (slightly stable)	26.0
F (moderately stable)	15.7
G (extremely stable)	6.9

Note: Due to rounding, values may not total to 100%.

Table 1-18. Isotopes, Metals, and Organic Chemicals of Potential Concern at the 200 Areas. (2 sheets)

Transuranic Isotopes	**Fission Products and Other Radioisotopes (cont'd)**	**Volatile Organic Compounds**
Americium-241	Niobium-93	Acetone
Americium-242	Polonium-210	Carbon disulfide[a]
Americium-243	Polonium-214	Carbon tetrachloride
Curium-244	Polonium-218	Chloroform
Curium-245	Potassium-40	Cyclohexanone[b]
Neptunium-237	Promethium-147[b]	1,1-Dichloroethane
Neptunium-239	Protactinium-231	1,2-Dichloroethane
Plutonium-238	Radium-223	cis-1,2-Dichloroethene[b]
Plutonium-239	Radium-225	trans-1,2-Dichloroethane[b]
Plutonium-240	Radium-226	Methylene chloride
Plutonium-241	Radium-228	Methyl ethyl ketone (MEK)[b]
	Radon-222	Methyl isobutyl ketone hexone (MIBK)[b]
Uranium Isotopes	Rhodium-106	Styrene[b]
Uranium-233	Ruthenium-106	Tetrachloroethylene
Uranium-234	Samarium-151	Toluene
Uranium-235	Selenium-79	1,1,1-Trichloroethane
Uranium-236	Strontium-90	1,1,2-Trichloroethane[b]
Uranium-238	Technetium-99	Trichloroethylene
	Thallium-207	Trichloromonofluoromethane[b]
Fission Products and Other Radioisotopes	Thorium-227	Hexone (MIBK)
Actinium-225	Thorium-229	Tributyl phosphate[a]
Actinium-227	Thorium-230	Xylenes[a]
Antimony-125	Thorium-231	
Antimony-126	Thorium-232[a]	**Semivolatile Organic Compounds**
Antimony-126m	Thorium-234	Aldrin
Barium-133[a]	Tritium	gamma-BHC
Barium-137m	Yttrium-90	Bisphenol A[a]
Bismuth-210	Zirconium-93	Bis(2-ethylhexyl) phthalate
Bismuth-211		Butyl phosphate
Bismuth-213	**Metals**	p-Chloro-m-cresol[b]
Bismuth-214	Antimony[b]	Cresols[a]
Carbon-14	Barium	2-Chlorophenol
Cesium-134	Beryllium	DDD
Cesium-135	Cadmium	DDT
Cesium-137	Chromium	Dibutyl phosphate
Cobalt-60	Copper	2,4-Dichlorophenol
Europium-154	Lead	Dieldrin
Europium-155	Manganese	Dimethoate
Francium-221	Mercury	2,4-Dimethylphenol
Iodine-129	Nickel	2,4-Dinitrophenol[b]
Krypton-85[a]	Silver	2,4-Dinitrotoluene[b]
Lead-209	Thallium[b]	Endrin
Lead-210	Titanium[b]	Heptachlor
Lead-211	Uranium	Hydrazine[b]
Lead-214	Vanadium	n-Nitrodimethylamine[a]
Nickel-59[a]	Zinc	Pentachlorophenol
Nickel-63		

Table 1-18. Isotopes, Metals, and Organic Chemicals of Potential Concern at the 200 Areas. (2 sheets)

Semivolatile Organic Compounds (cont'd)	**Other Organic Compounds**	**Other Organic Compounds (cont'd)**
Phenol	Ammonia	Hydrofluoric acid[b]
Pyrene	Ammonium carbonate[b]	Nitrate
1,2-Propanedial[b]	Ammonium nitrate	Nitrite
2,3,4,5-Tetrachlorophenol[b]	Arsenic	Nitric acid[b]
2,4,5-Trichlorophenol[b]	Boron	Selenium[b]
Tributyl phosphate[b]	Cyanide	Sodium dichromate[b]
	Ferrocyanide	Sulfuric acid[a]
	Fluoride	

Notes:

(1) Modified from DOE-RL-92-16, 1993, *200 West Groundwater Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland, Washington, and DOE-RL-92-19, 1993, *200 East Groundwater Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland, Washington.

(2) This table has been excerpted directly from DOE/EIS-0189, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington*. Minor corrections, which have not affected the intended technical content, have been made to minimize potential reader confusion and to enhance the usage of this table within this safety analysis report (i.e., with regard to vadose zone information). This results in some necessary differences between the information presented in this table and the source documentation. (Other changes have not been made because they would impact the tie between DOE/EIS-0189 and its source documentation.)

(3) The information contained in this table was not used in the performance of the hazard and accident analyses documented in Chapter 3.0.

[a]200 West Area only.
[b]200 East Area only.

Table 1-19. Hydraulic Conductivity of Suprabasalt Aquifer System Units Under the 200 East and 200 West Areas.

Interval	Hydraulic conductivity		Transmissivity		Data source
	m/day	ft/day	m^2/day	ft^2/day	
Both 200 East and 200 West Areas					
Elephant Mountain Member interflow zone	--	--	0.70 to 569.00	2.30 to 1,866.80	RHO-ST-42, 1981, *Hydrology of the Separations Area*, Rev. 0, Rockwell Hanford Operations, Richland, Washington
Rattlesnake Ridge interbed	--	--	0.74 to 108.00	2.43 to 354.33	RHO-RE-ST-12P, 1984, *An Assessment of Aquifer Intercommunication with B Pond-Gable Mountain Pond Area of the Hanford Site*, Rev. 0, Rockwell Hanford Operations, Richland, Washington
200 East Area					
Top of unconfined aquifer (Hanford and Ringold)	8.00 to 7,600.00	26.25 to 24,934.38	--	--	WHC-SD-EN-TI-019, 1992, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington
200 West Area					
Ringold unconfined aquifer	0.20 to 61.00	0.66 to 200.13	--	--	PNL-6820, 1989, *Hydrogeology of the 200 Areas Low Level Burial Grounds*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington
	0.09 to 475.00	0.30 to 1,558.40	--	--	WHC-SD-EN-TI-019, 1992, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington
Ringold Lower Mud	1.60×10^{-5}	5.24×10^{-5}	--	--	PNL-6820, 1989, *Hydrogeology of the 200 Areas Low Level Burial Grounds*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington

Table 1-20. Three Crustal Layers Related to Earthquakes at the Hanford Site.

Layer	Depth	
	km	mi
Columbia River Basalt Group	0-5	0-3
Prebasalt sediments	8.5	5
Crystalline basement	>8.5	>5

Table 1-21. Five General Sources of Earthquakes at the Hanford Site.

Area	Layer
Major reverse faults on ridges	Mainly basalt, also prebasalt sediments
Secondary faults on ridges	Basalt
Swarm area	Basalt
Basement	Crystalline basement
Cascadia Subduction Zone	Lithosphere—plate tectonic boundary

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
Earthquakes with magnitude ≥3, 1969 to 1995					
April 19, 1969	05:46:03.20	3.1	45.889°N 119.742°W	3.00	--
April 20, 1969	02:19:16.04	3.2	48.250°N 119.272°W	5.72	--
May 11, 1969	05:50:11.92	3.1	48.194°N 119.228°W	3.0	--
August 2, 1969	03:04:16.35	3.4	47.198°N 117.375°W	15.22	--
August 31, 1969	16:27:35.05	3.1	46.286°N 120.776°W	1.50	--
January 1, 1970	06:44:28.24	3.0	46.324°N 118.396°W	0.68	--
July 11, 1970	10:24:31.17	3.0	48.180°N 121.311°W	34.20	--
July 29, 1970	20:42:31.56	3.0	48.176°N 119.313°W	3.00	--
August 23, 1970	11:11:40.67	3.3	46.745°N 119.345°W	2.08	HS
September 11, 1970	02:20:54.11	3.5	46.642°N 120.386°W	9.67	--
October 2, 1970	15:56:24.73	3.3	46.760°N 119.371°W	3.78	HS
October 19, 1970	07:15:08.09	3.2	46.904°N 117.684°W	3.00	--
November 6, 1970	18:15:16.77	3.1	46.691°N 118.884°W	3.00	--
January 26, 1971	10:17:05.02	3.2	46.921°N 119.554°W	1.36	HS
May 22, 1971	15:57:10.83	3.3	47.788°N 118.964°W	14.54	--
July 13, 1971	23:29:24.49	3.5	44.922°N 117.946°W	3.00	--
August 18, 1971	23:44:25.96	3.2	47.610°N 120.083°W	1.86	--
October 25, 1971	18:52:49.98	3.8	46.709°N 119.548°W	0.07	HS
November 23, 1971	02:12:15.42	4.1	48.233°N 121.248°W	18.20	--

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

	Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
	Earthquakes with magnitude ≥3, 1969 to 1995					
1	June 19, 1972	23:57:57.57	3.2	48.131°N 121.186°W	9.00	--
2	February 6, 1973	07:17:06.89	3.0	46.936°N 120.896°W	8.00	--
3	September 4, 1973	17:56:49.92	3.7	48.239°N 121.165°W	6.10	--
4	December 20, 1973	01:08:28.24	4.4	46.869°N 119.354°W	2.35	--
5	June 15, 1975	17:51:31.49	3.1	46.237°N 119.104°W	0.07	--
6	June 28, 1975	16:33:43.66	3.3	46.129°N 119.702°W	10.67	--
7	June 28, 1975	22:17:52.65	3.8	46.118°N 119.697°W	10.35	--
8	July 1, 1975	05:28:02.24	3.6	45.628°N 120.002°W	1.50	--
9	July 7, 1975	20:41:17.79	3.2	46.074°N 118.449°W	2.50	--
10	September 18, 1975	12:19:28.51	3.5	47.796°N 118.231°W	0.50	--
11	April 13, 1976	00:47:17.1	4.8 ML 4.5 MB	45.22°N 120.77°W	15.	--
12	April 17, 1976	02:11:44.1	4.2 ML	45.08°N 120.79°W	15.	--
13	May 15, 1976	13:04:53.56	3.0	47.707°N 120.033°W	4.58	--
14	June 15, 1976	01:01:45.68	3.0	46.488°N 117.683°W	0.90	--
15	June 15, 1976	09:08:04.90	3.0	47.627°N 120.296°W	0.55	--
16	July 23, 1976	17:59:36.78	3.0	46.080°N 118.745°W	2.70	--
17	August 30, 1976	16:34:01.55	3.0	47.649°N 120.177°W	3.00	--
18	December 13, 1976	08:47:29.41	3.1	47.643°N 120.129°W	5.60	--
19	January 27, 1977	07:47:29.20	3.2	46.939°N 119.593°W	1.40	HS

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

	Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
	Earthquakes with magnitude ≥3, 1969 to 1995					
1	March 11, 1977	22:50:11.41	3.1	45.895°N 119.675°W	0.08	--
2	July 13, 1977	07:15:05.68	3.8	47.058°N 121.046°W	0.10	--
3	January 25, 1978	01:09:20.80	3.3	47.892°N 120.108°W	1.03	--
4	March 22, 1978	03:08:59.57	3.3	48.090°N 119.492°W	11.96	--
5	April 16, 1978	19:45:16.90	3.3	47.752°N 120.234°W	0.71	--
6	June 11, 1978	02:43:55.05	3.1	46.841°N 120.955°W	0.10	--
7	June 27, 1978	02:19:00.26	3.4	46.938°N 121.137°W	3.10	--
8	October 10, 1978	12:04:27.93	3.1	47.901°N 119.682°W	2.43	--
9	January 19, 1979	14:55:16.97	3.9	47.896°N 119.686°W	6.69	--
10	January 21, 1979	20:40:06.14	3.0	47.895°N 119.682°W	3.19	--
11	January 30, 1979	16:06:45.71	3.0	47.662°N 120.120°W	5.06	--
12	February 17, 1979	08:36:21.41	3.6	46.169°N 119.935°W	9.10	--
13	April 7, 1979	03:47:23.62	3.0	46.956°N 120.412°W	9.83	--
14	April 8, 1979	07:29:37.81	4.2	45.995°N 118.447°W	4.70	--
15	July 28, 1979	02:19:06.94	3.7	46.670°N 120.591°W	0.10	--
16	November 10, 1979	04:53:29.82	3.2	47.720°N 120.057°W	0.09	--
17	November 18, 1979	02:08:45.53	3.1	46.887°N 119.567°W	1.10	HS
18	November 24, 1979	11:51:14.98	3.4	46.931°N 119.566°W	0.45	HS
19	December 10, 1979	05:40:07.46	3.4	46.657°N 120.575°W	5.10	--

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

	Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
	Earthquakes with magnitude ≥3, 1969 to 1995					
1	November 19, 1980	21:35:24.07	3.3	46.950°N 119.469°W	0.86	HS
2	February 2, 1981	01:23:18.30	4.0	46.263°N 120.989°W	1.98	--
3	February 18, 1981	06:09:38.71	4.2	47.197°N 120.892°W	3.37	--
4	March 15, 1981	07:23:66.85	3.6	47.987°N 121.493°W	5.35	--
5	May 28, 1981	08:55:62.54	4.6	46.530°N 121.398°W	2.98	--
6	May 28, 1981	09:10:45.90	5.0	46.525°N 121.394°W	3.22	--
7	June 14, 1981	13:12:56.81	3.2	45.962°N 120.507°W	13.58	--
8	July 22, 1981	06:05:50.38	3.0	47.777°N 120.288°W	9.53	--
9	October 25, 1981	03:20:63.67	3.2	47.758°N 120.196°W	7.58	--
10	January 23, 1982	15:31:37.16	3.2	46.546°N 121.378°W	3.33	--
11	September 26, 1982	10:09:23.58	3.4	46.867°N 121.048°W	3.25	--
12	March 22, 1983	12:47:02.37	3.8	45.992°N 118.403°W	7.53	--
13	April 25, 1983	15:48:20.43	3.0	48.630°N 119.567°W	8.03	--
14	October 20, 1983	09:44:58.46	3.4	46.717°N 119.584°W	1.86	HS
15	November 14, 1983	11:18:60.40	3.8	46.655°N 120.600°W	7.87	--
16	December 5, 1983	07:24:18.61	3.8	46.915°N 120.713°W	7.76	--
17	January 31, 1984	05:29:17.96	4.0	45.496°N 116.673°W	5.65	--
18	April 11, 1984	03:07:42.05	4.3	47.535°N 120.185°W	8.02	--
19	June 18, 1984	19:34:08.93	3.1	45.486°N 118.840°W	5.96	--

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

	Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
	Earthquakes with magnitude ≥3, 1969 to 1995					
1	August 24, 1984	04:42:67.21	3.0	47.649°N 120.955°W	0.75	--
2	October 10, 1984	03:24:18.24	3.0	47.904°N 119.079°W	15.39	--
3	January 9, 1985	05:46:13.26	3.3	47.064°N 120.094°W	0.34	--
4	January 25, 1985	07:28:54.49	3.1	46.500°N 120.632°W	16.63	--
5	January 31, 1985	03:02:35.09	3.3	47.059°N 120.084°W	0.29	--
6	February 10, 1985	20:29:31.72	3.9	45.704°N 119.634°W	18.41	--
7	March 9, 1985	01:31:24.44	3.3	46.984°N 118.590°W	3.41	--
8	April 19, 1985	10:52:44.29	3.2	46.897°N 120.284°W	5.35	--
9	June 9, 1985	01:24:51.45	3.2	46.675°N 118.977°W	3.21	--
10	June 17, 1985	07:00:17.26	3.0	47.058°N 120.077°W	0.28	--
11	July 16, 1985	21:13:16.33	3.2	46.189°N 121.009°W	0.02	--
12	October 1, 1985	05:21:60.00	3.0	46.796°N 120.048°W	1.09	--
13	October 1, 1985	06:53:11.58	3.0	46.789°N 120.047°W	1.71	--
14	October 10, 1985	10:06:40.72	3.2	47.749°N 120.265°W	7.04	--
15	November 22, 1986	18:09:56.76	3.2	47.263°N 119.351°W	20.82	--
16	February 4, 1986	01:58:67.17	3.2	46.044°N 118.810°W	7.80	--
17	April 8, 1986	10:57:37.58	3.3	47.770°N 120.230°W	13.76	--
18	September 1, 1986	21:32:43.95	3.4	46.719°N 119.285°W	14.09	--
19	June 11, 1987	19:50:16.98	3.0	46.778°N 120.694°W	17.23	--

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

	Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
	Earthquakes with magnitude ≥3, 1969 to 1995					
1	December 2, 1987	07:12:57.46	4.1	46.675°N 120.675°W	18.20	--
2	December 2, 1987	09:02:24.27	4.3	46.679°N 120.673°W	17.80	--
3	February 6, 1988	12:51:44.81	3.0	47.666°N 120.024°W	7.15	--
4	May 28, 1988	09:02:45.95	3.46	46.806°N 119.420°W	3.96	HS
5	July 9, 1988	01:18:11.55	3.7	46.838°N 119.694°W	0.03	HS
6	July 14, 1988	12:45:33.46	3.3	46.888°N 119.413°W	1.79	HS
7	July 29, 1988	04:59:47.27	4.1	46.855°N 121.914°W	11.83	--
8	July 29, 1988	06:00:08.70	3.8	46.851°N 121.921°W	10.80	--
9	August 12, 1988	12:11:54.32	3.0	46.844°N 121.921°W	10.89	--
10	September 29, 1988	08:09:19.55	3.5	45.850°N 120.260°W	13.92	--
11	March 27, 1989	20:17:22.28	3.1	45.816°N 120.262°W	12.25	--
12	June 13, 1989	23:18:08.79	3.0	46.948°N 118.536°W	11.29	--
13	September 15, 1989	10:28:00.84	3.5	45.373°N 121.707°W	5.22	--
14	March 26, 1990	01:27:18.34	3.0	46.851°N 121.913°W	10.74	--
15	April 29, 1990	00:32:03.14	3.22	46.542°N 119.733°W	19.47	HS
16	June 19, 1990	10:20:31.64	3.3	46.840°N 119.322°W	2.71	--
17	July 28, 1990	09:33:20.70	3.0	46.858°N 121.763°W	0.38	--
18	October 19, 1990	14:13:58.16	3.5	45.341°N 121.686°W	3.5	--

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

	Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
	Earthquakes with magnitude ≥3, 1969 to 1995					
1	October 23, 1990	23:43:04.53	3.0	46.627°N 118.888°W	0.98	--
2	December 22, 1990	03:14:24.45	3.4	46.799°N 119.992°W	3.31	--
3	December 30, 1990	02:20:56.99	3.5	47.474°N 121.812°W	17.07	--
4	January 1, 1991	20:19:15.35	3.4	46.813°N 120.558°W	6.55	--
5	February 14, 1991	19:00:42.05	3.1	47.978°N 119.991°W	7.97	--
6	February 22, 1991	20:57:04.49	3.2	46.871°N 120.652°W	13.26	--
7	February 26, 1991	09:16:15.64	3.0	46.718°N 119.884°W	1.52	--
8	March 28, 1991	00:54:34.15	3.3	47.680°N 120.327°W	0.60	--
9	May 16, 1991	02:39:49.35	3.0	46.763°N 121.896°W	11.34	--
10	December 15, 1991	22:14:53.12	3.3	47.595°N 118.329°W	7.98	--
11	January 24, 1992	09:09:54.34	3.4	47.659°N 120.132°W	7.36	--
12	February 18, 1992	16:04:42.79	3.2	46.951°N 119.550°W	2.22	HS
13	April 27, 1992	00:48:58.12	3.0	46.624°N 118.906°W	1.04	--
14	July 14, 1992	20:01:51.50	4.1	45.993°N 118.309°W	11.62	--
15	August 7, 1992	17:23:17.83	3.9	45.860°N 119.590°W	0.57	--
16	October 26, 1992	07:56:35.25	3.5	46.857°N 120.721°W	0.04	--
17	January 7, 1993	22:06:42.01	3.4	47.595°N 121.515°W	14.44	--
18	December 16, 1993	12:21:34.50	3.0	45.196°N 120.090°W	6.69	--

Table 1-22. Instrumentally Located Earthquake Catalog for the Hanford Site and Columbia Plateau (see Figure 1-39) from 1969 to 1995. (8 sheets)

	Date	Universal time	Magnitude[a]	Coordinates	Depth[b] (km)	Remarks[c]
	Earthquakes with magnitude ≥3, 1969 to 1995					
1	June 18, 1994	07:01:07.28	4.3	47.621°N 121.270°W	0.04	--
2	September 10, 1994	07:43:11.37	3.9	47.185°N 121.965°W	17.73	--
3	November 13, 1994	16:50:47.20	3.3	46.592°N 119.584°W	28.22	HS
4	January 13, 1995	19:38:23.02	3.2	46.579°N 120.711°W	13.17	--
5	March 9, 1995	07:22:36.62	3.0	47.191°N 120.955°W	1.61	--
6	May 20, 1995	12:48:48.20	4.1	46.881°N 121.941°W	13.42	--
7	June 12, 1995	01:48:24.40	3.3	46.405°N 119.263°W	1.05	--
8	June 30, 1995	22:17:05.06	3.0	47.107°N 120.528°W	11.23	--
9	July 13, 1995	10:28:50.27	3.7	46.819°N 121.878°W	8.29	--
10	August 29, 1995	13:02:48.76	3.1	46.208°N 119.576°W	15.34	--
11	November 2, 1995	14:30:14.44	3.62	46.150°N 119.579°W	23.31	--

12 Note: Latitude and longitude are used to define the location of historical earthquakes.
13 [a]Unless otherwise noted, all magnitudes are Richter magnitudes from coda seismic waves
14 (Rayleigh waves).
15 [b]Depth is given in kilometers; to convert kilometers to miles, multiply by 0.622.
16 [c]HS - Hanford Site within 46°15'N to 47°0'N (46.250°N to 47.000°N) and 119°20'W to
17 119°45'W (119.333°W to 119.750°W).
18 MB = Body-wave magnitude.
19 ML = Local (Richter) magnitude.
20

Table 1-23. Seismic Hazard Exceedance Probabilities and Peak Horizontal Surface Ground Accelerations for Each Performance Category.

Performance Category	Exceedance probability	Return period (yr)	Horizontal ground surface acceleration	
			200 West Area (g)	200 East Area (g)
1	2.0 E-03	500	0.13	0.13
2	1.0 E-03	1,000	0.19	0.18
3	5.0 E-04	2,000	0.26	0.24
4	1.0 E-04	10,000	0.48	0.44

Table 1-24. Safety-Class Hanford Site Response Spectra—10/01/73 to 09/06/89 (Fast Flux Test Facility Design Basis).

Frequency (hertz)	Damping				
	0.5%	1%	2%	5%	7%
0.500	0.280	0.248	0.210	0.147	0.115
0.700	0.415	0.358	0.306	0.212	0.167
1.000	0.607	0.522	0.457	0.308	0.245
1.5	0.900	0.785	0.680	0.450	0.350
2.000	1.150	1.000	0.860	0.552	0.410
2.500	1.300	1.120	0.980	0.600	0.440
3.000	1.400	1.200	1.040	0.616	0.455
4	1.430	1.210	1.050	0.610	0.455
5	1.390	1.150	1.000	0.580	0.430
6.500	1.230	1.030	0.870	0.520	0.400
8	1.020	0.870	0.720	0.473	0.376
10.000	0.810	0.710	0.606	0.425	0.355
15.000	0.540	0.500	0.445	0.355	0.315
20.000	0.405	0.385	0.360	0.310	0.290
33	0.250	0.250	0.250	0.250	0.250
100.000	0.250	0.250	0.250	0.250	0.250

Note: Vertical response spectra are two-thirds the horizontal response spectra.

Table 1-25. Safety-Class Hanford Site Response Spectra—9/06/89 to 03/31/96.

Control point	Frequency (hertz)	Damping				
		2%	5%	7%	10%	12%
E	0.10	0.0120	0.0102	0.0095	0.0088	0.0083
	0.16	0.0310	0.0260	0.0240	0.0230	0.0210
D	0.26	0.0840	0.0650	0.0590	0.0520	0.0480
	0.40	0.1290	0.1040	0.0950	0.0870	0.0800
	0.60	0.1920	0.1550	0.1420	0.1300	0.1200
	1.10	0.3510	0.2830	0.2610	0.2370	0.2200
C	1.73	0.5500	0.4200	0.3800	0.3300	0.3000
B	8.00	0.5500	0.4200	0.3800	0.3300	0.3000
	12.00	0.4120	0.3400	0.3160	0.2860	0.2670
	20.00	0.2860	0.2600	0.2510	0.2390	0.2310
A	33.00	0.2000	0.2000	0.2000	0.2000	0.2000
A'	100.00	0.2000	0.2000	0.2000	0.2000	0.2000

Note: Vertical response spectra are two-thirds the horizontal response spectra.

Table 1-26. Design Response Spectra for New Performance Category 3, 200 West Area.

Frequency (hertz)	Damping					
	0.5%	2%	5%	7%	10%	12%
Horizontal response spectra (*g*)						
0.25	0.08	0.06	0.05	0.05	0.04	0.04
0.50	0.22	0.17	0.13	0.12	0.11	0.10
1.00	0.45	0.34	0.26	0.23	0.21	0.19
2.00	0.74	0.55	0.41	0.37	0.33	0.30
3.30	0.98	0.72	0.54	0.48	0.42	0.39
5.00	1.04	0.76	0.58	0.52	0.45	0.42
10.00	0.77	0.59	0.47	0.43	0.38	0.36
13.30	0.57	0.48	0.41	0.38	0.36	0.35
33.30	0.26	0.26	0.26	0.26	0.26	0.26
100.00	0.26	0.26	0.26	0.26	0.26	0.26
Vertical response spectra (*g*)						
0.25	0.06	0.05	0.04	0.03	0.03	0.03
0.50	0.14	0.11	0.08	0.07	0.07	0.06
1.00	0.19	0.14	0.11	0.10	0.09	0.08
2.00	0.32	0.24	0.18	0.16	0.14	0.13
3.30	0.48	0.36	0.27	0.24	0.21	0.19
5.00	0.60	0.44	0.33	0.30	0.26	0.24
10.00	0.66	0.49	0.37	0.33	0.29	0.27
13.30	0.60	0.46	0.37	0.33	0.30	0.28
50.00	0.18	0.18	0.18	0.18	0.18	0.18
100.00	0.18	0.18	0.18	0.18	0.18	0.18

Source: WHC-SD-W236A-TI-002, 1996, *Probabilistic Seismic Hazard Analysis, DOE Hanford Site, Washington*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Note: 200 West Area response spectra envelope 200 East Area.

Table 1-27. Response Spectra for Existing Performance Category 3, 200 West Area.

Frequency (hertz)	Damping					
	0.5%	2%	5%	7%	10%	12%
Horizontal response spectra (*g*)						
0.25	0.06	0.04	0.04	0.03	0.03	0.03
0.50	0.17	0.12	0.10	0.09	0.08	0.08
1.00	0.33	0.25	0.19	0.18	0.15	0.13
2.00	0.54	0.40	0.30	0.27	0.24	0.22
3.30	0.70	0.51	0.39	0.35	0.30	0.28
5.00	0.74	0.54	0.41	0.37	0.32	0.30
10.00	0.55	0.42	0.33	0.30	0.27	0.25
13.30	0.43	0.34	0.28	0.26	0.24	0.23
33.30	0.19	0.19	0.19	0.19	0.19	0.19
100.00	0.19	0.19	0.19	0.19	0.19	0.19
Vertical response spectra (*g*)						
0.25	0.04	0.03	0.03	0.02	0.02	0.02
0.50	0.10	0.07	0.06	0.05	0.05	0.04
1.00	0.15	0.11	0.08	0.08	0.07	0.06
2.00	0.21	0.16	0.12	0.11	0.09	0.09
3.30	0.36	0.26	0.20	0.18	0.15	0.14
5.00	0.41	0.30	0.23	0.21	0.18	0.17
10.00	0.44	0.32	0.24	0.22	0.19	0.17
13.30	0.37	0.29	0.23	0.21	0.18	0.17
50.00	0.12	0.12	0.12	0.12	0.12	0.12
100.00	0.12	0.12	0.12	0.12	0.12	0.12

Source: WHC-SD-W236A-TI-002, 1996, *Probabilistic Seismic Hazard Analysis, DOE Hanford Site, Washington*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Note: 200 West Area response spectra envelope 200 East Area.

Table 1-28. Summary of Static Soil Properties West of 200 East Area.

Material (El. in ft)	Dry density (lb/ft^3)	Moist density (lb/ft^3)	Moisture content (%)	Friction angle (degree)	Elastic[a,b] modulus (E) (ton/ft^2)	Bulk[a,b] modulus (B) $\left(\frac{kips\ 1{,}000\ lb}{in^2}\right)$	Horizontal modulus of subgrade reaction (n_h)[b] (lb/in^3)	Coefficient of subgrade reaction[a,b] (K_n) (lb/in^3)	Vertical modulus of subgrade reaction[b,c] (lb/in^3)
Stratum 2 (gravel) El. 727 to 706	110	112	2	45	720	5	30[d1]	250	30[d1] 25[d2] 100[d3]
Stratum 3 (sand) Surface structures[e] El. 706 to 676 El. 676 to 250 (rock)	110	113 (design) 115 (mean) ±3 (range)	3.0	37 (design) 41 (mean) ±4 (range)	1,440 5,760	10 40	40 50	500 2,000	100[d3]
Stratum 3 (sand) Tank structures[f] El. 663 to 613 El. 613 to 250 (rock)	110	113 (design) 115 (mean) ±3 (range)	3.0	37 (design) 41 (mean) ±4 (range)	1,440 5,760	10 40	40 50	500 2,000	100[d4]
Backfill Depth below surface 0-20 ft 20-50 ft >50 ft	115	112	12.5[g]	38	720 1,440 5,760	5 10 40	30 40 50	250 500 2,000	25[d2]

Note: To convert feet to meters, multiply by 0.30; to convert pounds to grams, multiply by 453.6; to convert inches to millimeters, multiply by 25.4.
[a]Moduli have been adjusted to be compatible with strain levels anticipated with structural loadings.
[b]Modulus values may be considered approximate with ± standard deviation values corresponding to ±25%.
[c]Range of data (±) based on test data from this report and review of other reports in the 200 East and 200 West Areas.
[d]Design moduli of subgrade reaction have been adjusted for anticipated foundation size and location.
[d1]Piping within 6.1 m (20 ft) of ground surface.
[d2]Surface structures and floor slabs.
[d3]Exhaust stack mat.
[d4]Tank mat foundation.
[e]Parameters apply to soils beneath surface structures.
[f]Parameters apply to soils beneath tank foundation.
[g]Moisture content anticipated during field compaction of backfill.
E = Young's modulus of elasticity.
El. = elevation.

Table 1-29. Summary of Static Soil Properties Southwest of 200 West Area.

Material (El. in ft)	Dry density (lb/ft^3)	Moist density (lb/ft^3)	Moisture content (%)	Friction angle (degree)	Elastic[a], modulus (E) (ton/ft^2)	Bulk[a] modulus (B) $\left(\frac{kips\ 1{,}000\ lb}{in^2}\right)$	Horizontal modulus of subgrade reaction (n_h) (lb/in^3)	Coefficient of subgrade reaction[a] (K_n) (lb/in^3)	Vertical modulus of subgrade reaction[b,c] (lb/in^3)
Stratum 2 (sand with gravel) El. 685 to 670	110	113	3	37	720	5	30	250	25[d2] 100[d3]
Stratum 3 (sand) Surface structures[e] El. 670 to 640 El. 640 to 135 (rock)	110	113 (design) 115 (mean) ±3 (range)	3.0	37 (design) 41 (mean) ±4 (range)	1,440 5,760	10 40	40 50	500 2,000	100[d3]
Stratum 3 (sand) Tank structures[f] El. 631 to 581 El. 581 to 135 (rock)	110	113 (design) 115 (mean) ±3 (range)	3.0	37 (design) 41 (mean) ±4 (range)	1,440 5,760	10 40	40 50	500 2,000	100[d4]
Backfill Depth below surface 0-20 ft 20-50 ft >50 ft	116	130	12.5[g]	40	720 1,440 5,760	5 10 40	30 40 50	250 500 2,000	25[d2]

Note: To convert feet to meters, multiply by 0.30; to convert pounds to grams, multiply by 453.6; to convert inches to millimeters, multiply by 25.4.

[a]Moduli have been adjusted to be compatible with strain levels anticipated with structural loadings.

[b]Range of data (±) based on test data from this report and review of other reports in the 200 East and 200 West Areas.

[c]Modulus values may be considered approximate with ± standard deviation values corresponding to ±25%.

[d]Design moduli of subgrade reaction have been adjusted for anticipated foundation size and location.

[d1]Piping within 6.1 m (20 ft) of ground surface.

[d2]Surface structures and floor slabs.

[d3]Exhaust stack mat.

[d4]Tank mat foundation.

[e]Parameters apply to soils beneath surface structures.

[f]Parameters apply to soils beneath tank foundation.

[g]Moisture content anticipated during field compaction of backfill.

E = Young's modulus of elasticity.

El. = elevation.

Table 1-30. Summary of Dynamic Soil Properties West of 200 East Area.

Material (El. in ft)	Moist density (lb/in³)	Friction angle (degree)	Poissons[a] ratio		Small strain[b] parameters								Large strain[c] parameters			
					V_s (ft/s)		V_p (ft/s)		G $\frac{\text{kips}}{\text{in}^2}$ (1,000 lb)		G $\frac{\text{kips}}{\text{in}^2}$ (1,000 lb)		G[d] $\frac{\text{kips}}{\text{in}^2}$ (1,000 lb)		E[d] $\frac{\text{kips}}{\text{in}^2}$ (1,000 lb)	
			Design	Approx. range	Design	Approx. range	Design	Approx. range	Design	Approx. range	Design	Approx. range	Design	Approx. range	Design	Approx. range
Stratum 2 (gravel) El. 727 to 706	112	45	0.27	±0.06	1,200	±250	2150	±500	30	±15	90	±30	10	±5	30	±10
Stratum 3 (sand) El. 706 to 663	113 (design) 115 (mean) ±3 (range)	37 (design) 41 (mean) ±4 (range)	0.27	±0.06	1,500	±250	2,650	±500	50	±15	140	±30	20	±5	50	±10
El. 666 to 613					1,750	±200	3,100	±500	70	±10	190	±20	25	±5	65	±10
El. 613 to 477					2,000	±200	3,550	±500	100	±15	250	±30	35	±5	85	±10
El. 477 to 250[d,e]					2500	±200	3700	±500	150	±15	390	±30	55	±5	135	±10
Bedrock[e]	140	45	0.27	–	4,000[f]	–	7,400[f]	–	480	–	1,230	–	–	–	–	–
Backfill[e]	130	38	0.30	–	1,000	–	1,900	–	30	–	70	–	10	–	25	–

Note: To convert feet to meters, multiply by 0.30; to convert pounds to grams, multiply by 453.6; to convert inches to millimeters, multiply by 25.4.

[a]Computed from large strain geophysical crosshole test.

[b]Small strain parameters at 10^{-4}% shear strain.

[c]Large strain parameters at 10^{-1}% shear strain.

[d]Groundwater elevation approximately 121.9 m (400 ft).

[e]Estimated soil properties include native soils and rock below a depth of 42.7 m (140 ft) (maximum depth of site borings) and backfill.

[f]Shear and compressional wave relocation estimated from measurements in Shannon and Wilson, 1993, *Geologic Studies of the Columbia River Basalt Structures and Age of Deformation, The Dalles-Umatilla Region, Boardman Nuclear Project*, Shannon and Wilson, Inc., Seattle, Washington. Shear wave velocities in the basalt ranged from 3,000 to 10,000 ft/s, while compressional wave velocities ranged from 5,700 to 79,000 ft/s.

E = young's modulus of elasticity.

El. = elevation.

G = shear modulus.

V_s = shear wave velocity.

V_p = compressional wave velocity.

Table 1-31. Summary of Dynamic Soil Properties Southwest of 200 West Area.

Material (El. in ft)	Moist density (lb/in^3)	Friction angle (degree)	Poissons[a] ratio	Low-strain[b] parameters				High-strain[c] parameters	
				V_s (ft/s)	V_p (ft/s)	G $\left(\frac{\text{kips 1,000 lb}}{\text{in}^2}\right)$	E $\left(\frac{\text{kips 1,000 lb}}{\text{in}^2}\right)$	G[a] $\left(\frac{\text{kips 1,000 lb}}{\text{in}^2}\right)$	E[a] $\left(\frac{\text{kips 1,000 lb}}{\text{in}^2}\right)$
Stratum 2 (sand with gravel) El. 685 to 670	113	37	0.27 ± 0.06	1,300 ± 300	2,300 ± 500	40 ± 15	100 ± 40	15 ± 5	40 ± 15
Stratum 3 (sand)									
El. 670 to 640	113 (design)	37 (design)	0.27 ± 0.06	1,600 ± 300	2,900 ± 500	60 ± 20	160 ± 50	20 ± 10	55 ± 20
El. 640 to 590	115 (mean)	41 (mean)		1,800 ± 250	3,300 ± 500	80 ± 20	200 ± 50	30 ± 10	70 ± 20
El. 590 to 500	±3 (range)	±4 (range)		2,000 ± 200	3,600 ± 500	100 ± 20	250 ± 50	35 ± 10	90 ± 20
El. 550 to 440[d,e]				2,250 ± 200	4,000 ± 500	120 ± 20	310 ± 50	45 ± 10	115 ± 20
El. 440 to 135[d,e]				2,500 ± 200	4,500 ± 500	150 ± 20	390 ± 50		
Bedrock[e]	140	45	0.27	4,000[f]	7,400[f]	480	1,220	--	--
Backfill[e]	130	38	0.30	1,000	1,900	30	70	15	35

Note: To convert feet to meters, multiply by 0.30; to convert pounds to grams, multiply by 453.6; to convert inches to millimeters, multiply by 25.4.

[a]Computed from large-strain geophysical crosshole test.

[b]Low-strain parameters at 10^{-4}% shear strain.

[c]High-strain parameters at 10^{-1}% shear strain.

[d]Groundwater elevation approximately 76.2 m (250 ft).

[e]Estimated soil properties include native soils below a depth of 42.7 m (140 ft) (maximum depth of site borings) and backfill.

[f]Shear and compressional wave relocation estimated from measurements in Shannon and Wilson, 1993, *Geologic Studies of the Columbia River Basalt Structures and Age of Deformation, The Dalles-Umatilla Region, Boardman Nuclear Project*, Shannon and Wilson, Inc., Seattle, Washington. Shear wave velocities in the basalt ranged from 3,000 to 10,000 ft/s, while compressional wave velocities ranged from 5,700 to 79,000 ft/s.

Range of values indicated on this table are approximate.

E = Young's modulus of elasticity.

El. = elevation.

G = shear modulus.

V_s = shear wave velocity.

V_p = compressional wave velocity.

Table 1-32. Natural Phenomena Design and Evaluation Criteria for New and Existing Facilities Hazard Category 2 Facilities. (3 sheets)

Natural phenomena hazard	Structural design criteria					
	Safety function	Safety designation[a]		Performance Category[b]		Bases for criteria[c]
				New facilities	Existing facilities	
Seismic	Protect offsite public	Safety-Class (radiological impacts)	Safety-Significant (toxicological impacts)	PC3 h = 0.26 g v = 0.18 g[d]	PC3 h = 0.19 g v = 0.12 g[d]	DOE-STD-1020-94, equal hazard spectrum
	Protect onsite worker	Safety-Significant		PC2[e] h = 0.20 g v = NA	PC2[e] h = 0.13 g v = NA	UBC essential facilities
	Protect facility worker/ occupant	General use	Safety-Significant (facility worker)	PC1[e] h = 0.20 g v = NA	PC1[e] h = 0.10 g v = NA	UBC standard occupancy
Tornado		Not applicable for all designations				DOE-STD-1020-94
Wind loads	Protect offsite public	Safety-Class (radiological impacts)	Safety-Significant (toxicological impacts)	PC3 - "fastest mile" 80 mi/h, missile - 2x4 timber plank 15 lb @ 30 ft	PC3 - "fastest mile" 70 mi/h, missile - NA	DOE-STD-1020-94
	Protect onsite worker	Safety-Significant		PC2 - "fastest mile" 70 mi/h, missile - NA	PC2 - "fastest mile" 60 mi/h, missile - NA	DOE-STD-1020-94
	Protect facility worker/ occupant	General use	Safety-Significant (facility worker)	PC1 - "fastest mile" 70 mi/h, missile - NA	PC1 - "fastest mile" 60 mi/h, missile - NA	DOE-STD-1020-94
Peak gusts	All	All		All - 80 mi/h	All - 80 mi/h	Maximum measured Table 1-8
Snow loads	All	All		PC3 - roof loads 20 lb/ft^2, ground loads 15 lb/ft^2	NA	DOE-STD-1020-94, ASCE-7
Ashfall loads	All	All		PC3 - 15 lb/ft^2 (ground loads)	NA	WHC-SD-GN-ER-30038

Table 1-32. Natural Phenomena Design and Evaluation Criteria for New and Existing Facilities Hazard Category 2 Facilities. (3 sheets)

Natural phenomena hazard	Structural design criteria					
	Safety function	Safety designation[a]		Performance Category[b]		Bases for criteria[c]
				New facilities	Existing facilities	
Suspended ashfall	All	All		All - 1.38 E-02 lb/ft^3	All - 1.38 E-02 lb/ft^3	WHC-SD-GN-ER-30038, Supply System 1977
Columbia River flood loads	Protect offsite public	Safety-Class (radiological impacts)	Safety-Significant (toxicological impacts)	PC3 - NA	NA	DOE-STD-1020-94, WHC-SD-GN-ER-501—all 200 East, 200 West, and 600 Area facilities are above flood level
	Protect onsite worker	Safety-Significant		PC2 - NA	NA	DOE-STD-1020-94, WHC-SD-GN-ER-501—all 200 East, 200 West, and 600 Area facilities are above flood level
	Protect facility worker/ occupant	General use	Safety-Significant (facility worker)	PC1 - NA	NA	DOE-STD-1020-94, WHC-SD-GN-ER-501—all 200 East, 200 West, and 600 Area facilities are above flood level
Cold Creek flash flood	All	All		All - rainfall greater than 1 in. per rainday	All - rainfall greater than 1 in. per rainday	Section 1.4.2
Other natural phenomena						
Lightning	All	All		All—probability of lightning strike per facility 1.0 E-02 strikes/yr	All—probability of lightning strike per facility 1.0 E-02 strikes/yr	Section 1.4.1

Table 1-32. Natural Phenomena Design and Evaluation Criteria for New and Existing Facilities Hazard Category 2 Facilities. (3 sheets)

Natural phenomena hazard	Structural design criteria				
	Safety function	Safety designation[a]	Performance Category[b]		Bases for criteria[c]
			New facilities	Existing facilities	
Maximum precipitation	All	All	All—probability of greater than 1 in. rainfall 2.0 E-04/yr	All—probability of greater than 1 in. rainfall 2.0 E-04/yr	Section 1.4.1

Note: To convert feet to meters, multiply by 0.30; to convert pounds to grams, multiply by 453.6; to convert inches to millimeters, multiply by 25.4; to convert miles to kilometers, multiply by 1.61.

[a]Safety-Significant may be designed to PC3, PC2, or PC1 requirements based on receptor and hazardous material released.

[b]Criteria are derived from DOE-STD-1020-94, 1994, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, Change 1, U.S. Department of Energy, Washington, D.C.

[c]Bases for established design/evaluation criteria.

[d]Horizontal is 70% of vertical.

[e]Earthquake load design of PC1 structures, systems, and components shall comply with the UBC, Seismic Zone 2B, for standard occupancy facilities. Earthquake load design of PC2 structures, systems, and components shall comply with the UBC, Seismic Zone 2B, for essential facilities.

ASCE-7, 1996, *Minimum Design Loads for Buildings and Other Structures*, American Society of Civil Engineers, New York, New York.

Supply System, 1977, *Preliminary Safety Analysis Report, WNP 1/4*, Washington Public Power Supply System, Richland, Washington.

UBC, 1994, *Uniform Building Code*, International Conference of Building Officials, Whittier, California.

WHC-SD-GN-ER-501, 1996, *Natural Phenomena Hazards, Hanford Site, South Central Washington*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-GN-ER-30038, 1996, *Volcanic Ashfall Loads for the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

h = horizontal.
NA = not applicable.
PC = Performance Category.
UBC = Uniform Building Code.
v = vertical.

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Section 2 of 14

Document Information			
Document #	**SD-WM-SAR-067**	**Revision**	**1**
Title	TWRS FSAR		
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FACILITY DESCRIPTION

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FACILITY DESCRIPTION

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LIST OF TERMS

A	alarm
AGING	aging waste
AL	assumed leaker
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWF	Aging Waste Facility
ATM	atmosphere
Bld.	building
Bldg.	building
BPA	Bonneville Power Administration
C	catch tank
CAM	continuous air monitor
CASS	Computerized-Automated Surveillance System
CC	concentrated complexant
COB	cleanout box
CP	concentrated phosphate (waste)
CS	carbon steel
DACS	Data Acquisition and Control System
DB	diversion box
DC	dilute complexed waste
DT	decontamination tank
DCRT	double-contained receiver tank
det	detector
DMS	demister
DN	dilute noncomplexed waste
DOE	U.S. Department of Energy
DOV	diaphragm-operated valve
dP	differential pressure
DPI	differential pressure indicator
DR	drain
DSS	double-shell slurry
DSSF	double-shell slurry feed
DST	double-shell tank
DV	diverter station
EB	hydrogen activating switch
ETF	Effluent Treatment Facility
F	filter
FC	flow controller
FE	flow element
FIC	Food Instrument Corporation
FIT	flow indicator transmitter

LIST OF TERMS (Cont'd)

FIV	vacuum flow indicator
fld.	flood
FSAR	Final Safety Analysis Report
FSL	flow switch low
FT	flush tank
G	sampler switch
Ga	gauge or gauge thickness
GTF	Grout Treatment Facility
H	high
HEPA	high-efficiency particulate air (filter)
HGR	heat generation rate
HTR	heater
HVAC	heating, ventilation, and air conditioning
I	isolated
IS	interim stabilized
JB	jet booster
JP	jet pump
K	data controller
ksi	kips (kilopounds) per square inch
L	low
LD	leak-detection
LDE	leak detection element
LDUA	light-duty utility arm
LEF	low-efficiency filter
LERF	Liquid Effluent Retention Facility
LFL	lower flammability limit
LIQW	liquid waste
LS	limit switch
ltg.	lighting
M	motor
MISF	miscellaneous inactive storage facility
MO	mobile office
mon.	monitor
N	neutralization tank
NA	not applicable (Table 2-7)
NA	not available (Tables 2-22 and 2-23)
NCAW	neutralized current acid waste
NC	normally closed
NCPLX	noncomplexed waste
NE	hydrogen indicator
NI	none identified
NIT	hydrogen transmitter

LIST OF TERMS (Cont'd)

NO	normally open
P	pump
PB	power button (Figure 2-23)
PB	push button (Figure 2-61)
PD	PUREX decladding
PDAH	pressure differential high alarm
PDAL	pressure differential low alarm
PDI	pressure differential instrument
PDIS	pressure differential indicating switch
PDS	pressure differential switch
PF	prefilter
PFP	Plutonium Finishing Plant
PLC	programmable logic controller
PS	pressure switch
PT	Plutonium Finishing Plant transuranic solids
PUREX	Plutonium Uranium Extraction (Facility)
pwr.	power
R	receiver tank
RC	reinforced concrete
REDOX	Reduction Oxidation (Facility)
rcpt.	receptacle
RL	U.S. Department of Energy, Richland Operations Office
RW	raw water
S	settling tank
SACS	Surveillance Analysis Computer System
scfm	standard cubic feet per minute
SGI	specific gravity indicator
SGT	specific gravity transmitter
SPG	specific gravity
SS	stainless steel
SSC	structure, system, and component
SST	single-shell tank
SSTL	stainless steel
ST BY	stand by
SU	steel unspecified
SW	sanitary water
SWP	Salt Well Pumping
SZC	silver zeolite cartridge
T	trailer
TBX	terminal box
TC	temperature controller
TE	temperature element

LIST OF TERMS (Cont'd)

TI	temperature indicator
TK	tank
TMACS	Tank Monitoring and Control System
trlr	trailer
TSL	temperature switch low
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
TYP	typical
UBC	Uniform Building Code
USQ	Unreviewed Safety Question
V	valve
VP	valve pit
VT	vault tank
WESF	Waste Encapsulation and Storage Facility
WF	weight factor
WFA	weight factor alarm
WFAS	weight factor alarm switch
WFI	weight factor indicator
WFT	weight factor transmitter
WRAP	Waste Receiving and Processing (Facility)
WRSS	waste retrieval sluicing system

2.0 FACILITY DESCRIPTION

2.1 INTRODUCTION

In this chapter, the Tank Waste Remediation System (TWRS) tank farm facilities and operations are described to support assumptions used in Chapter 3.0. The structures, systems, and components (SSCs) described are necessary to the TWRS mission and provide the means to manage tank farm wastes. This includes the safe storage and treatment of tank waste (e.g., pH adjustment). The design, siting, and operation of these SSCs, in conjunction with the institutional and safety programs discussed in Chapters 6.0 through 17.0, provide layers of physical and administrative protection to prevent or mitigate unwanted releases of radioactive or hazardous materials. Those systems that are directly relied upon to protect the facility worker, the onsite worker, or offsite individuals are identified in Chapter 3.0. These SSCs (i.e., Defense-in-Depth, Safety-Class, and Safety-Significant) are discussed further in Chapters 3.0 and 4.0.

As shown in Figures 2-1 and 2-2, the TWRS facilities are located in the 200 East, 200 West, and 600 Areas of the Hanford Site (Figure 2-3). The TWRS facilities comprise the single-shell tank (SST) farms, the double-shell tank (DST) farms, and associated support facilities, systems, and transfer equipment. All SSTs no longer receive waste. The DSTs, however, may receive liquid waste from processing activities or other tanks and are considered in service. Even though all SSTs at TWRS are not currently receiving waste, waste tank monitoring and surveillance activities, waste storage in the tanks, and waste transfer out of the tanks will continue until final waste disposal.

The TWRS facilities within the scope of this chapter include 177 single-shell and double-shell underground waste storage tanks; double-contained receiver tanks (DCRTs); active catch tanks; all waste transfer pipelines and associated equipment used in waste transfers (e.g., diversion boxes and valve pits); miscellaneous inactive storage facilities; waste-handling and storage facilities; miscellaneous support and administrative facilities; and in-tank; out-of-tank, and liquid transfer monitoring systems. Although inactive facilities (e.g., inactive miscellaneous underground storage tanks) are within the scope of this Final Safety Analysis Report (FSAR), no inactive facility can be activated without the performance of an Unreviewed Safety Question (USQ) screening or determination, as appropriate.

The physical scope of the TWRS FSAR is limited to the following facilities and systems as defined in Section 2.4:

- SSTs
- DSTs
- Catch tanks
- DCRTs

- Miscellaneous inactive storage facilities
- 204-AR Waste Unloading Facility
- 244-AR Vault Facility
- Cribs, ditches, and ponds
- 209-E Storage Area (*Resource Conservation and Recovery Act of 1976* waste storage pad and Intermediate Holding Area for low-level radioactive waste)
- Vertical storage units
- 2727-W Sodium Storage Facility
- 213-W Compactor Facility
- Waste transfer system.
- Light-duty utility arm
- Cone Penetrometer
- Instrumentation, waste sampling, and surveillance monitoring systems.

The *TWRS Mission Analysis* (WHC-SD-WM-MAR-008) identifies a number of operations or functions required to manage and immobilize new and existing wastes in a safe, environmentally sound, and cost-effective manner. The objective is to isolate waste from the environment and to protect the health and safety of the facility worker, onsite individuals, and the public. The operations addressed in Section 2.5 of this FSAR are summarized below. These activities, although focused on the storage or handling of liquid wastes, are also applicable to solid waste storage and handling activities at TWRS:

- Store in-tank liquid wastes and monitor in-tank liquid wastes and waste storage systems
- Transfer existing in-tank liquid waste internal to TWRS (e.g., from SST to DST, DST to DST) and transfer or receive new liquid waste from operating facilities or transition facilities to TWRS facilities
- Identify the type, form, and quantity of radiological and chemical constituents in the liquid waste

- Monitor liquid waste leaked or discharged to the soil column and gaseous radiological and chemical effluents

- Maintain and upgrade existing facilities and equipment, as required, to meet new commitments or requirements.

The activities identified previously relate to facilities or process-related activities discussed in this chapter. The following activities, which rely on the operations identified previously or the systems and facilities discussed in this chapter, are discussed in subsequent chapters of this FSAR:

- Criticality prevention (Chapter 6.0)

- Radiation protection (Chapter 7.0)

- Liquid, solid, and gaseous effluent monitoring and handling (Chapters 8.0, 9.0, and 10.0)

- Fire protection (Chapter 11.0)

- Emergency planning or preparedness (Chapter 15.0)

- Decontamination and decommissioning (Chapter 16.0).

Supplemental project-specific facility descriptions are included in the designated addenda. A description of the waste retrieval sluicing system (WRSS) is provided in Addendum 1, "Tank 241-C-106 Sluicing Safety Analysis." A description of the replacement cross-site transfer system is provided in Addendum 2, "Safety Analysis for the Replacement Cross-Site Transfer System." A description of the 241-AZ-702 ventilation system is provided in Addendum 3, "702-AZ Ventilation System (241-AZ-702) Safety Analysis." A description of the 241-AZ-101 mixer pump test is provided in Addendum 4, "Mixer Pump Test (241-AZ-101) Safety Analysis."

Several TWRS facilities and projects are not included in the TWRS FSAR for various reasons, including the following:

- An acceptable Authorization Basis that is revised annually already exists.

- The project is in a conceptual phase and is not expected to be finalized during FSAR preparation or is not expected to be operational during FSAR review.

- The facility or project is associated with retrieval or decontamination and decommissioning.

The specific facilities, activities, and projects not included in this FSAR are listed in Tables 2-1 and 2-2. Facilities, activities, and projects currently excluded will be incorporated into the FSAR during future annual revisions, using the process described in HNF-IP-0842, *TWRS*

Administration. In addition, modifications to the TWRS Basis for Interim Operation, HNF-SD-WM-BIO-001, *Tank Waste Remediation System Basis for Interim Operation*, approved by the U.S. Department of Energy, Richland Operations Office, that are not included in the FSAR, will be evaluated during FSAR Phase 1 implementation and incorporated into the FSAR, as necessary, before the transistion from the Basis for Interim Operation to the FSAR.

Section 2.3 includes an overview of the facilities and operations discussed in this chapter, and more detail on the structures is given in Section 2.4. Requirements that are relevant to this chapter are listed in Section 2.2. Sections 2.5 through 2.9 contain details of the operations, support systems, and equipment at each of these facilities, including the following:

- **Current TWRS Operations**—tank waste storage, waste receipt, and waste transfers between tanks

- **Safety Support Systems**—fire protection, radiation and toxicological monitoring, and effluent monitoring

- **Utility Distribution Systems**—electrical supply systems, process and sanitary water, and compressed air.

The figures provided in this chapter have been included to aid the reader in visualizing information that is presented in the text. These sketches should not be considered design drawings, and they must not be used to make engineering modifications to any systems, structures, or components depicted. Facility modifications are approved in accordance with detailed design information found in established procedures, configuration-controlled drawings, and vendor information.

Throughout Chapters 2.0 and 3.0, the terms "inactive," "out of service," and "abandoned" are used when describing various facilities and SSCs that are the responsibility of TWRS. These terms have been used as a matter of convenience to describe the status of each of these items and their relationship to the current mission. The following examples are provided to demonstrate the use of each term and are intended, in general, to clarify the use of each term:

- Inactive. This term has been used to describe cribs, ditches, and ponds and miscellaneous underground storage tanks. These facilities were used in various prior Hanford Site missions that since have been completed. These facilities no longer are considered to play an "active" role in the mission of the Hanford Site.

  Note the term "inactive" is also used to support the discussion of safety SSCs presented in Chapter 4.0. In Chapter 4.0, the term has been appropriately redefined.

- Out of service. This term has been used in the description of the SSTs. The SSTs were administratively removed as acceptable and approved receivers of waste in November 1980. Administratively the tanks are considered "out of service," but

they still maintain an important environmental protection role by containing the wastes currently inside. Efforts are underway to remove the drainable liquids that remain in the tanks.

- Abandoned. This term has been used to describe portions of the waste transfer system that are contained within the scope of this safety analysis report. Numerous sections of the transfer system have been modified by severing the piping in a way such that the transfer piping can no longer be used to transfer waste. Because the piping has not been removed from the ground and can no longer be used to transfer waste it is considered to be "abandoned."

2.2 REQUIREMENTS

The design codes, standards, regulations, and U.S. Department of Energy orders relevant to this chapter and required for establishing the safety basis for TWRS facilities are as follows:

- 10 CFR 830.120, "Quality Assurance," *Code of Federal Regulations*
- DOE 5400.5, *Radiation Protection of the Public and the Environment*, Change 2 (1993)
- DOE 5480.7A, *Fire Protection*, Change 0 (1993)[1]
- DOE 5480.11, *Radiation Protection for Occupational Workers*, Change 3 (1992)
- DOE 5480.28, *Natural Phenomena Hazards Mitigation*, Change 0 (1993)[1]
- DOE 5700.6C, *Quality Assurance*, Change 1 (1996)[1]
- DOE 5820.2A, *Radioactive Waste Management*, Change 0 (1988)
- DOE 6430.1A, *General Design Criteria*, Change 0 (1989)[1]
- DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, Change 1 (1994)
- DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, Change 1 (1993)

[1]Although these orders have been rescinded recently, the contractor is obligated by the existing contract to meet the requirements stated in these orders.

- DOE-STD-1022-94, *Natural Phenomena Hazards Characterization Criteria*, Change 1 (1994)

- DOE-STD-1023-95, *Natural Phenomena Hazards Assessment Criteria*, Change 1 (1995).

Before the current design requirements were issued, facilities were designed and constructed in accordance with the functional and safety requirements documented in project functional design criteria, specifications, and drawings (see WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*).

2.3 FACILITY OVERVIEW

The TWRS tank farm facilities provide the physical means for storing and moving radioactive liquid wastes between processing and storage facilities. In this section, an overview of tank farm facilities configuration is given (Figures 2-4 and 2-5), the current mission of the TWRS facilities is defined, and the operations performed in the facilities are briefly described.

2.3.1 Current Mission of Tank Waste Remediation System Facilities and Operations Supporting that Mission

The TWRS mission as described in WHC-SD-WM-MAR-008 includes waste storage management, retrieval, pretreatment, immobilization, interim storage and disposal, and tank closure operations. This FSAR addresses the tank farm facilities and operations that support the "manage tank waste" function. Tank farm facilities necessary for managing the tank waste are the SST and DST farms and the tank farm supporting facilities (e.g., catch tanks, DCRTs, and transfer lines). Necessary operations are in-tank waste storage, SST interim stabilization, waste receipt, tank-to-tank transfers, waste characterization, and waste concentration.

2.3.2 Brief History of Tank Waste Remediation System Operations

The TWRS project was established in 1991 to integrate all aspects of the treatment and management of the high-level radioactive wastes in 177 underground storage tanks in the 200 East and 200 West Areas.

2.3.2.1 Development of SST and DST Farms. The production of defense-related materials at the Hanford Site generated large quantities of solid and liquid radioactive mixed waste. Chemical processing of irradiated uranium fuels generated alkaline slurries containing heavy metals, organic solvents, inorganic salts, uranium, plutonium, and mixed fission products. High-level wastes were placed in the large, steel-lined, underground SSTs for temporary storage. Over time, the design of the high-level waste tanks has gradually improved and been modified, and more tanks have

been built to store an increasing volume of waste. Low-level cooling water, condensates, and other wastes from processing operations were discharged to the ground (i.e., cribs, ditches, or percolation ponds).

The underground waste storage tanks are grouped into "farms" and are buried approximately 3 m (10 ft) belowground near the center of the Hanford Site in the 200 East and 200 West Areas. The tanks were buried at this depth to shield facility workers and the public from the radioactive wastes and to prevent or mitigate the consequences of releases of radioactive materials.

Many of the tank farm facilities, used beyond their intended design life, have been upgraded and are continuously maintained and surveyed to ensure safe operations. These comprehensive maintenance and surveillance programs and other programmatic features that support TWRS operations are discussed in Chapters 6.0 through 17.0.

Certain tanks within the tank farms present unique safety hazards because of past in-facility or in-tank operations. These "watch list" tanks are categorized on the basis of the unique safety hazard presented by the content of the waste in the tank. Currently, transfers into or out of a "watch list" tank are not permitted. For example, "watch list" tanks are identified in HNF-EP-0182, *Tank Farm Surveillance and Waste Status Summary Report for Month Ending March 31, 1997*. The "watch list" tank categories are as follows:

- **Hydrogen/Flammable Gas Tanks**—Suspected of having a significant potential for hydrogen/flammable gas generation, entrapment, and episodic release. The presence of a flammable gas mixture and an ignition source would increase the risk of a release of radioactive material to the environment.

- **Organic Salt Tanks**—Contain organic carbon. High concentrations of organic compounds/chemicals could support an exothermic reaction at elevated temperatures (WHC-EP-0681, *Interim Criteria for Organic Watch List Tanks at the Hanford Site*). Under certain scenarios involving overheating of the tank, such a mixture of organic solids could react rapidly, possibly damaging the tank and allowing a release of radioactive material.

- **High Heat Tank**—Contain heat-generating cesium- and strontium-rich sludge and require the maintenance of drainable liquid in the tank to promote cooling. Water is added periodically to the tank to maintain liquid levels. The tank is cooled by evaporation in conjunction with active ventilation.

The underground waste storage tanks are described briefly in the following paragraphs. The latest tank summary data for the SSTs and DSTs, as of March 31, 1997, is provided in Table 2-3. Table 2-3 includes descriptions of currently stored waste, tank "watch list" designations, and waste volumes by type of waste (i.e., supernate, interstitial liquids, sludge, and salt cake). For the SSTs, the status of interim stabilization and intrusion-prevention efforts is included. It is important to note that the data presented in Table 2-3 is representative of

conditions at the time of FSAR development. The cited report, HNF-EP-0182, is published every month and the latest version should be obtained by the reader seeking the most current information.

2.3.2.1.1 Single-Shell Tank Farms. Twelve SST farms containing 149 (133 storage tanks [100 Series] and 16 receiver tanks [200 Series]) tanks were constructed between 1943 and 1964 and grouped into farms consisting of 4 to 18 tanks. The farms were divided equally between the 200 East and the 200 West Areas and assigned letter identifiers consistent with the area designations. The original SST design was a reinforced concrete shell and dome with mild carbon steel lining the bottom and walls. Over time, while the basic design remained essentially the same, the depth of the steel liner within the concrete shell was increased with corresponding increases in operating depth and storage capacity. Minor design improvements were made in the tank bottoms.

The first tanks, built concurrently with the bismuth-phosphate processing plants (B Plant and T Plant), were designed with 5.5-m (18-ft) liners and operating volumes of 2 million L (530,000 gal).[2] The next tanks were built first with 7.3-m (24-ft) liners and operating volumes of 2.9 million L (758,000 gal) and finally with liner heights of 9.8 m (32 ft) and operating capacities of 3.8 million L (1 million gal).

No process wastes have been added to the 149 SSTs since November 1980; therefore, these tanks are considered out of service. Tank summary data is provided in Table 2-3, and the SST farms are described in detail in Section 2.4.

No tank leaks were reported at the Hanford Site before the early 1950s; however, some pipes and fittings made from materials other than stainless steel did leak as early as 1945 (WHC-MR-0293, *Legend and Legacy: Fifty Years of Defense Production at the Hanford Site*). The first large, confirmed tank leak, 208,000 L (55,000 gal), occurred in 1956 at Tank 241-U-104. The largest known leak from a Hanford Site SST occurred in 1973 when 435,000 L (115,000 gal) escaped from Tank 241-T-106. SSTs were originally designed to store dilute nonboiling waste; however, fuel reprocessing was improved with the advent of the Plutonium Uranium Extraction (PUREX) and Reduction Oxidation (REDOX) Facilities. The improved processes generated more concentrated waste streams that were self-boiling. This may have contributed to the failures in the tank liners and subsequent releases to the soil column.

In a November 1963 incident, Tank 241-A-105, which had received PUREX high-level waste for about 3 yr, underwent a steam pressurization event below the tank liner bottom. This event ripped the liner and formed an irregular bulge about 15 m (50 ft) in diameter by 2 m (6 ft) high in the tank liner bottom. Following this incident, the tank was immediately taken out of service; and was interim stabilized in July 1979 and finally interim isolated in October 1985. For 10 yr following the incident, the contents were kept cool by using an exhauster and by

[2]The tanks were built using English units. Most of the conversions in this chapter are from English to metric units.

sprinkling water on the sludge. Nothing could safely remove the sludge trapped under the ruptured liner, but the tank was substantially emptied in 1977, and a hole was chemically milled at the top of the bulge (in 1977) to allow potential radiolytic hydrogen to escape. Temperatures below the tank are monitored via probes in lateral wells.

Sixty-seven SSTs, identified in Table 2-3, are "assumed leakers" based on tank surveillance data that indicates a loss of liquid attributed to a breach of tank integrity (HNF-EP-0182).

Both active and passive ventilation systems are used to contain SST airborne particulates. Active ventilation systems (exhausters) are used in the SST farms when the heat load is greater than 11,700 W (40,000 Btu/h) or when studies predict a peak waste temperature greater than operating specifications. The only two SST farms that contain actively ventilated tanks are 241-C and 241-SX. All SST farms contain tanks that are passively vented to the atmosphere through breather filters.

2.3.2.1.2 Double-Shell Tanks. As a result of leakage at the SST farms, construction of DSTs started in the late 1960s. The primary walls in the DSTs were made of thicker steel and they had a steel shell or secondary tank and improved leak detection system. Between 1968 and 1986, 28 DSTs were built in six tank farms each with two to eight tanks. Five of the tank farms are located in the 200 East Area, and one tank farm is located in the 200 West Area. All DSTs are similar in design and each has a capacity of approximately 3.8 million L (1 million gal). Slight differences in the design of the tanks and ancillary equipment were made over the years because of design improvements and the need to accommodate variations in waste composition.

The DSTs were constructed to provide intermediate storage for high-level radioactive waste, including waste capable of boiling because of radioactive decay (aging waste) and waste not capable of boiling (nonaging waste). Waste requiring intermediate storage is from Hanford Site processing facilities.

Designed to minimize the potential for leakage of radioactive liquids to the environment, each DST consists of a carbon steel primary tank and a carbon steel secondary tank within a protective reinforced concrete shell. The protective concrete shell is designed to sustain soil loads and to tolerate the temperature gradients caused by the heat generated by the contained radioactive waste.

The primary tank contains waste, is freestanding, and stands on an insulated concrete pad. During construction, the insulated pad protected the structural concrete foundation from excessive temperatures during annealing or stress relief treatment of the primary tank. Annealing reduces high-stress points at metal joints to reduce joint susceptibility to corrosion and cracking. The insulating pad is also cast with air distribution and drain grids to provide for leak detection, maintain a uniform tank bottom temperature, facilitate heat removal, and eliminate pockets of water condensation.

The insulating pad rests on the secondary tank, which is 1.5 m (5 ft) larger in diameter than the primary tank, creating an air space, or annulus, separating the two steel tank walls. The secondary tank serves as a confinement barrier in case of primary tank leakage.

The DSTs are actively vented (with fan-driven ventilation systems) to the environment. The primary ventilation system removes vapors from the primary tank and cools the waste by convective heat transfer and by evaporation of moisture. The annulus ventilation system can be used to cool the primary tank, remove moisture accumulation in the annular space, and help detect radioactive leakage. The annular space of each DST is monitored for leaks. To date, none of the DSTs has leaked.

Tank summary data is given in Table 2-3. The DST farms are described in detail in Section 2.4.

2.3.2.1.3 Ancillary Systems, Facilities, and Equipment. The ancillary systems, facilities, and equipment supporting operations in the SST and DST farms include underground and aboveground waste transfer pipelines, valves, diversion boxes, jumper connectors, waste transfer pumps, DCRTs, catch tanks, process pits, the 204-AR Waste Unloading Facility, and the 244-AR Vault Facility. These ancillary systems, facilities, equipment, and other miscellaneous facilities under the control of TWRS are discussed in Section 2.4.

2.3.2.2 Waste Inventory Generation and Description. Most wastes stored in the Hanford Site underground waste tanks are radioactive slurries generated by reprocessing of irradiated uranium fuel by means of one of the following processes (WHC-MR-0132, *A History of the 200 Area Tank Farms*):

- Bismuth phosphate ($BiPO_4$)
- REDOX
- PUREX
- Uranium recovery
- Waste fractionation.

Typical chemical compounds in the wastes produced by each of the processes are listed in Table 2-4. Smaller volumes of wastes were generated by research and development programs, laboratory processes, the "hot semi-works" (pilot plant for REDOX process), the PUREX pilot, and Plutonium Finishing Plant operations (WHC-EP-0210, *Waste Characterization Plan for Hanford Site Single-Shell Tanks*).

Since 1944, more than 1,510 million L (400 million gal) of high-level radioactive waste have been generated by these operations and others. More than 1,140 million L (300 million gal) were directed to the SSTs and DSTs. The remainder of the liquids were discharged to the soil in percolation or evaporating ponds, or by decanting decontaminated (i.e., very low radioactivity) dilute liquid wastes to the ground. Waste volume in the tanks has been reduced to approximately 208 million L (55 million gal) by evaporation, concentration, or both (either in the tanks or externally in evaporators).

All the fuel processing methods generated acidic waste streams. To neutralize the acid and minimize tank corrosion, sodium hydroxide or calcium carbonate was added before the waste was transferred to the tanks. Thus, the tanks contain moderately to strongly alkaline solutions with pH values up to 14. Further post-processing of some of the wastes has resulted in the addition of ferrocyanide and organic compounds listed as hazardous (WHC-MR-0132), thereby creating some of the current safety concerns.

Waste stored in the tanks consists primarily of inorganic compounds, including sodium hydroxide; sodium salts of nitrate, nitrite, carbonate, aluminate, and phosphate; and hydrous oxides of aluminum, iron, and manganese. The radioactive components in the waste consist primarily of mixed long-lived fission product radionuclides and actinide elements.

Mixed waste in underground waste storage tanks may contain heavy metals such as lead, chromium, zirconium, potassium, and cadmium. Detectable amounts of organic compounds are present. The portion of waste that is organic (complexed waste) contains the chelating agents EDTA (ethylene diamine-tetracetic acid) and HEDTA (2-hydroxyethylethylenediaminetriacetic acid) or TBP (tributyl phosphate), which was used in fuel processing.

The tanks now contain a mixture of liquid, sludge, and salt cake waste types with both radioactive and chemically toxic hazardous constituents. Liquids exist as supernate (liquid above solids) and interstitial liquid (liquid filling the void between solids) in the tanks. Sludge consists primarily of solids (hydrous metal oxides) precipitated by the neutralization of acid wastes. Salt cake, generally between the supernate and sludge, consists of the various salts formed by the evaporation of water from the waste. These waste types do not necessarily exist as distinct layers but rather are intermingled to differing degrees. Some sludges and salt cake contain interstitial liquids and are relatively soft; others are drier and harder. Table 2-3 contains the current volumes of each of these waste types for each waste tank.

2.3.3 Interfacing Facilities

As discussed in Section 2.1 and identified in Figures 2-1 and 2-2, other facilities within the Hanford Site interface with TWRS facilities. These interfaces are controlled to ensure that these other facilities do not impact TWRS operations (e.g., radionuclide controls are placed on 242-A Evaporator slurry being transferred to 241-AW Tank Farm or TWRS solid waste being transferred to solid waste). Major facilities that interface with the TWRS facilities addressed in this FSAR are identified in Table 2-5.

Typical facility interfaces for both liquid and solid waste transfers are shown in Figures 2-6 and 2-7. Specifically, these figures show facility or system physical boundaries: systems or structures belonging to the facility of origin (facility that generates the waste), the waste transfer system, and the facility destination (or facility that receives the waste). Although Figures 2-6 and 2-7 represent facility interfaces among TWRS facilities and other Hanford Site facilities, interfaces among TWRS facilities are similar.

The physical boundaries that are the TWRS interfaces for liquid waste transfers to a TWRS facility are shown in Figure 2-6 and identified in Table 2-5. For example, when PUREX was operational and transferring waste from the PUREX Facility (facility of origin) to the 241-AW Tank Farm (receiving facility), the PUREX Facility managed the transfer line to the 241-A-151 diversion box (junction); the waste transfer system managed the internals of diversion box 241-A-151 and the transfer line to valve pit 241-AW-A or 241-AW-B (junction); and the 241-AW Tank Farm managed the internals of valve pit 241-AW-A or 241-AW-B and the transfer line to the receiving tank.

The physical boundaries and the TWRS interfaces for liquid and solid waste transfers are shown in Figure 2-7 and identified in Table 2-5. The receiving facility can be another TWRS facility or another Hanford Site facility. For example, during transfers from a TWRS facility (facility of origin) to solid waste facilities (receiving facility), TWRS is responsible for the waste packaging; a truck transport system is responsible for transportation; and solid waste facilities in the 200 West Area are responsible for waste handling and disposal. Liquid waste transfers among TWRS facilities are depicted in Figure 2-7.

2.4 FACILITY STRUCTURES

TWRS includes a complex of tank farm facilities primarily located in the 200 East and 200 West Areas (Figures 2-1 and 2-2); however, other TWRS facilities, including administrative buildings, retention basins, and transfer lines, are located in areas adjacent to the 200 East and 200 West Areas. In addition, some administrative TWRS offices are located in the nearby city of Richland.

This chapter provides a description of the SSCs as they were designed and constructed and the intended function of each SSC. The SSCs identified in this chapter provide the hazard and accident analysts a "laundry list" of potential mitigative or preventive barriers for selecting Safety-Class, Safety-Significant and Defense-in-Depth items. The operability, as defined in the Technical Safety Requirements (TSRs), of many of the active systems within the TWRS facilities and described in the following has not been formally verified using operability tests. However, the TSRs provide the assurance that the selected Safety-Class and Safety-Significant SSCs are and remain operable in accordance with the TSRs. The configuration management program including the maintenance program assure operability of the Defense-in-Depth SSCs.

Field walkdowns were performed at the facility level (i.e., tank farm, building, or miscellaneous facility) to identify which structures currently exist and appear operable. The field walkdowns included an initial document review before the walkdown and a visual inspection of accessible portions of the operating systems. The members of the field walkdown team included system and/or facility cognizant engineers, design authorities, and operations personnel. The field walkdown activity independently verified all TWRS-owned structures or systems and the operability of the structures or systems. The procedure and results of the field walkdowns are documented in WHC-SD-WM-HIE-007, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report*.

The initial document review involved the latest drawings, databases, supporting design documents, procedures, roundsheets, condition assessment reports, and operations specifications or requirements. The design data collected during the document review was visually verified during the walkdown for aboveground structures or systems. Verification of inaccessible portions of a facility or structure (e.g., contents within a valve pit or diversion box) was based on the document review.

System operability was evaluated during the walkdown. This evaluation was qualitative (yes or no) and did not assess system condition. Operability of systems that could not be verified visually were marked "assumed operable," "inoperable," or "unknown," based on the document review and the information provided by members of the field walkdown team.

The data collected during the facility walkdowns is provided in the facility, structure, or systems descriptions, which are described in this chapter and in Chapter 4.0.

The following discussion begins with a description of the common structures and systems of SSTs, followed by a description of the specific structures and systems associated with these SSTs. This SST discussion is followed by a comparable discussion of DSTs. The next sections describe other underground storage tanks, including catch tanks and DCRTs; the 204-AR Waste Unloading Facility; the 244-AR Vault; cribs, ditches, and ponds; and storage and handling areas for contaminated solid waste materials. Completing the facility description are sections on the waste transfer systems, instrumentation and monitoring systems, cathodic protection systems, interlock systems, and mixer pumps.

2.4.1 Common Structures and Systems of Single-Shell Tanks

The primary function of an SST is to contain radioactive liquid waste over its lifetime. SSTs were designed to contain waste within a reinforced concrete shell with an internal liner (structurally independent from the reinforced concrete tank) of mild carbon steel covering the bottom and sidewalls (Figures 2-8 and 2-9). Of the 149 SSTs, 133 are 23 m (75 ft) in diameter with operating volumes of 2, 2.9, and 3.8 million L (530,000, 758,000, and 1 million gal). These tanks are collectively referred to as 100 Series tanks. Sixteen smaller tanks or receiver tanks share the same design as the larger tanks, but are only 6.1 m (20 ft) in diameter and can hold 208,000 L (55,000 gal) each. These tanks are collectively referred to as 200 Series tanks. Table 2-6 provides more details on SST design. Earth cover over each tank provides shielding. Heat generated by radioactive decay is dissipated through the walls and bottom to the surrounding soil.

Most of the 100 Series tanks (2- and 2.9-million L [530,000- and 758,000-gal]) are arranged in "cascades" of three or four tanks in a farm; when the first tank was filled, waste was allowed to overflow into successive tanks through piping in the sidewalls. Each successive tank in the cascade is lower than the previous tank. Therefore, solids settled out in the first or higher tank, and the supernate was stored in the last tank of the cascade or allowed to overflow to an adjacent crib. Much of the overflow piping between tanks in the various cascades has been

removed or blanked. Currently, the cascade lines provide an air flow path between connected tanks, which may be actively or passively ventilated (see 241-C Tank Farm description in Section 2.4.1.5.1).

The design of the common SST elements is discussed in more detail in the following sections. WHC-SD-TWR-RPT-002 provides the limited information available regarding standards or specifications followed during the design and construction of the SSTs.

2.4.1.1 Concrete Shell. The concrete shell maintains the structural integrity of the steel liner by protecting it from soil loads and provides secondary confinement of the waste material. Each SST shell has a 0.3-m- (1-ft-) thick concrete base slab, a 0.3- to 0.38-m- (1- to 1.25-ft-) dome and a 0.3-m- (1-ft-) thick cylindrical wall that rests on a circular footing integral with the tank and base slab. The reinforced concrete shells of the 100 Series tanks are cylindrical with domed roofs. The reinforced concrete walls, dome, and base of the shell support the tank surface live loads, static and dynamic soil loads, and hydrostatic and hydrodynamic loads.

The reinforced concrete shells of the 200 Series SSTs are vertical cylinders constructed of reinforced concrete. Each receiver SST shell has a 178-mm- (7-in.-) thick concrete base slab, a 0.3-m- (1-ft-) thick dome, and a 0.3-m- (1-ft-) thick cylindrical wall integral with the dome and base slab. The tanks are buried underground to provide radiation shielding.

2.4.1.2 Steel Liner. All SSTs are constructed of American Society for Testing and Materials A283 Grade C mild steel (except those in the 241-AX Tank Farm, which are American Society for Testing and Materials A201 Grade C). The thickness of each liner varies from 6.4 mm (0.25 in.) to 9.53 mm (0.375 in.). For the 100 Series tanks, the steel liners extend up the tank wall to a height of 5.5, 7.3, and 9.8 m (18, 24, and 32 ft) for the 2, 2.9, and 3.8 million L (530,000; 758,000; and 1 million gal) tanks, respectively. For the smaller 200 Series tanks, the steel liner extends 7.6 m (25 ft) up the tank wall. Waste levels were managed at approximately 0.3 m (1 ft) below the top edge of the liner.

2.4.1.3 Risers. Each SST has numerous dome risers, which are vertical pipes that penetrate the tank domes to various depths. Almost all the risers are 102, 305, and 1,070 mm (4, 12, and 42 in.) in diameter. The risers are located either in covered pits at or below ground level; dome risers primarily provide access to the tank interior for a variety of operating and monitoring equipment. This equipment can include periscopes; still and television cameras; ventilation air supply and exhaust ducts; and instruments used to measure or monitor temperature, pressure, specific gravity, liquid levels, dome-space gas concentrations, and sludge (solid) levels. Some risers are reserved as spares. Dome risers are normally capped or covered to prevent uncontrolled intrusion (e.g., rain and personnel) and to prevent releases of radioactive materials. Additional details regarding SST risers can be found in WHC-SD-RE-TI-053, *Riser Configuration Document for Single-Shell Waste Tanks.*

2.4.1.4 Process and Service Pits. Pumps, monitoring equipment, and transfer systems are typically contained in belowgrade concrete enclosures with removable reinforced concrete cover blocks (i.e., pits, caissons, diversion boxes). The type and number of pits associated with SSTs

depend on the type of waste stored and the function of the SST. Therefore, not all pits listed here are present at each tank. Leak detection is provided in the process, and service pits are used during transfers.

Process pits of the following types handle process solutions:

- **Central pump pit**—located at the center of the SST dome. Waste is normally pumped out of the SST through this pit.
- **Sluice pits**—located over off-center tank risers. A sluice pit is used to route high-pressure liquids to the sluicer assembly.
- **Condenser pit**—located off-center. A condenser pit contains a condenser used to condense tank vapors.
- **Heel pit**—located off center. A heel pit can be used for equipment installation.
- **Salt well pit**—located off center. A salt well pit is used for installing salt well pumps and piping.
- **Valve pit**—allows waste or process solution to be diverted to pipelines by means of valves, jumpers (temporary piping systems), or both.

Other pits located adjacent to the SSTs in the tank farms do not handle process solutions and therefore are not considered process pits. These pits are as follows:

- **Flush pit**—provides piping through which water is supplied to flush pipelines after a waste transfer.
- **Leak detection pit** (241-AX Tank Farm only)—provides primary tank leak detection capability.

2.4.1.5 Ventilation Systems. Both active ventilation and passive ventilation systems are used for tank venting.

2.4.1.5.1 Active Ventilation Systems. Air is drawn through a tank and its ventilation system, which may include permanent and temporarily installed systems, by a centrifugal exhaust fan.

Exhaust duct work vents air through high-efficiency particulate air (HEPA) filters and the exhaust blower, and then out the stack where the air is sampled for radioactive materials by a continuous air monitor (CAM) and record sampler. Both the inlet and exhaust filters will function as passive ventilation systems upon loss of the exhauster fans.

Each currently active ventilation system in use at the SST farms is described in the following paragraphs. An active ventilation system was initially installed on Tank 241-A-105; however, this system is currently inactive (i.e., not operating) and will not be restarted. Active ventilation is installed on specific tanks within two SST farms (241-C and 241-SX). At these two farms, a centrifugal exhaust fan draws air through the underground tanks, primarily to minimize accumulation of flammable gas. Additionally, an active ventilation system provides a cooling function as a Defense-in-Depth measure. System specifications are given in Table 2-7.

241-C Tank Farm. A skid-mounted, portable exhauster with a centrifugal exhaust fan has been installed for permanent use at Tanks 241-C-105 and 241-C-106 (Figure 2-10). Because of the cascade effect, the blower also indirectly serves Tank 241-C-104 which has a breather filter. Tanks 241-C-105 and 241-C-106 have air inlet filters. The exhauster draws air from the underground tanks, primarily to cool the tank contents either by convective heat transfer from the waste or by evaporation of moisture. A dedicated system will be used during Tank 241-C-106 sluicing (refer to Addendum 1).

In the 241-C Tank Farm, air is drawn through a deentrainer and enters 0.5-m (1.5-ft) ports in the exhauster plenum and is drawn past an electric heater and through HEPA filters. The air is then discharged to the atmosphere via a short stack. The discharged air is continuously sampled and monitored for radioactive materials.

241-SX Tank Farm. The 241-SX Primary Ventilation System removes air from the headspace in 13 of the 15 tanks using a stationary, pad-mounted exhauster (Figure 2-11). SSTs 241-SX-101 through 241-SX-112 and 241-SX-114 are ventilated by the exhaust system. Ducting from SSTs 241-SX-101 through 241-SX-106 is connected and routed underground to SST 241-SX-109. SSTs 241-SX-107 through 241-SX-112 and 241-SX-114 are actively ventilated primarily for minimizing flammable gas accumulation and are equipped with inlet air filters that include balancing dampers. Air inlet filters in tanks 241-SX-101 through 241-SX-106 are the same type of breather filter assemblies used for passively ventilated SSTs.

Filtered air is discharged to the atmosphere through exhaust blowers and a short stack. A sampling facility in the stack monitors the air being discharged for radioactive materials. SSTs 241-SX-113 and 241-SX-115 are passively ventilated through HEPA filters to the environment.

2.4.1.5.2 Passive Ventilation Systems. Passive ventilation systems serve all SSTs except specific tanks in the 241-C and 241-SX Tank Farms, which are currently actively ventilated. Passive ventilation means that airflow through the tanks is dictated by differences in atmospheric conditions (e.g., temperature and atmospheric pressure) in and out of the tank.

The typical breather filter system used on all passively ventilated tanks with little or no operations or cooling requirements is shown in Figure 2-12. Each breather filter consists of a housing that contains a roughing filter, HEPA filter, an outlet screen, and a small seal loop. Other breather filters mount on a single spool piece attached to the tank riser and do not have seal loops.

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An isolation valve is normally open to permit airflow between the tank vapor space and outside atmosphere through the filter. Air flowing to and from the tank passes through the filter.

Seal loops installed in the exhaust lines are designed to maintain tank pressures near atmospheric and are provided to relieve slight tank overpressurizations when the HEPA filter is plugged or isolated for maintenance. The seal loops are inspected weekly and refilled with oil if required.

2.4.2 Specific Structures and Systems of Single-Shell Tanks

In the following sections, each SST farm is discussed first for the 200 East Area and then for the 200 West Area. The tank farms within each area are discussed in order of construction from earliest to latest dates. Major systems, facilities, or structures within each tank farm are identified in WHC-SD-WM-HIE-007. In addition, this report provides an assessment of system status and operability.

2.4.2.1 200 East Area Single-Shell Tanks. The following sections describe the six SST farms located in the 200 East Area.

2.4.2.1.1 241-B Tank Farm. The 241-B Tank Farm, located north of B Plant on Baltimore Avenue, was built during 1943 and 1944 and was one of the first four tank farms at the Hanford Site. The tank farm includes twelve 100 Series tanks, each of which can hold 2 million L (530,000 gal). This volume corresponds to a liner height of 5.5 m (18 ft). The 241-B Tank Farm also has four 200 Series tanks. The tanks are arranged in a cascade of four tanks, three 100 Series tanks and one 200 Series tank. All 16 SSTs are passively ventilated through HEPA filters to the environment.

Originally, these tanks received waste from B Plant. Later, Tanks 241-B-102, 241-B-103, 241-B-106, 241-B-108, 241-B-109, and 241-B-112 were modified for use as receiver tanks for the In-Tank Solidification and Evaporator Program. Modifications included construction of pump pits, insulation and heat-tracing of transfer lines, and installation of profile temperature equipment. Systems, facilities, and structures associated with the 241-B Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.1.2 241-C Tank Farm. The 241-C Tank Farm, located north of the PUREX Facility and just northwest of the 241-AN Tank Farm, was constructed during 1943 and 1944. The 241-C Tank Farm has twelve 100 Series tanks [2 million-L (530,000-gal)] (241-C-101 to 241-C-112) measuring 23 m (75 ft) in diameter and four 200 Series tanks (241-C-201 to 241-C-204) measuring 6.1 m (20 ft) in diameter. The tanks are arranged in four cascades of three 100 Series tanks and one 200 Series tank each. These tanks received waste from B Plant. SSTs 241-C-105 and 241-C-106 (and indirectly 241-C-104) are actively ventilated; these tanks are connected to a common operating exhaust system (Section 2.4.1.5.1). In addition to the HEPA filters, Tank 241-C-103 has a vapor mixing system designed to mix outside air with head space gases. All other tanks within the 241-C Tank Farm are passively ventilated through HEPA

filters to the environment. Systems, related facilities, or structures associated with the 241-C Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.1.3 241-BX Tank Farm. SSTs in the 241-BX Tank Farm, located north of B Plant, were constructed during 1946 and 1947 according to the original tank design for 241-B Tank Farm. The twelve 100 Series tanks (2 million-L [530,000-gal]) SSTs are arranged in four cascades of three tanks each. These tanks received waste from B Plant. None of the SSTs in the 241-BX Tank Farm is connected to an operating exhaust system. All are passively ventilated through HEPA filters to the environment. Systems, facilities, and structures associated with the 241-BX Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.1.4 241-BY Tank Farm. The 241-BY Tank Farm, located north of B Plant, was built from 1948 to 1949 according to a modified 241-B Tank Farm design. Each of the twelve 100 Series tanks can hold 2.9 million L (758,000 gal). This corresponds to a 7.3-m (24-ft) liner height, versus 5.5 m (18 ft) for the original design. These tanks received waste from B Plant and are passively ventilated through HEPA filters to the environment. As part of the In-Tank Solidification System, 57,220 kg (126,000 lb) of Portland cement were added to Tank 241-BY-105 in November 1965. This cement was not removed from the tank and is still in place today. No unique hazards associated with the presence of the Portland cement in Tank 241-BY-105 were identified in the hazard analysis documented in Chapter 3.0. Systems, facilities, and structures associated with the 241-BY Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.1.5 241-A Tank Farm. The 241-A Tank Farm, located directly north of the 242-A Evaporator, was constructed during 1954 and 1955. Each of the six 100 Series tanks can hold 3.8 million L (1 million gal). Originally, these tanks received boiling waste from the PUREX Facility. All tanks within the 241-A Tank Farm are passively ventilated through HEPA filters to the environment (Section 2.4.1.5.2). Systems, related facilities, or structures associated with the 241-A Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.1.6 241-AX Tank Farm. The 241-AX Tank Farm, located north of the 241-A Tank Farm and east of the 241-AY Tank Farm, was constructed during 1963 and 1964. This tank farm contains four 100 Series tanks, each with a capacity of 3.8 million L (1 million gal), and similar in basic construction to SSTs in the 241-A Tank Farm. These four tanks are 23 m (75 ft) in diameter with 9.8-m- (32-ft-) high liners. In these tanks, a grid of drainage slots was added beneath the steel-lined bottoms. Any leakage through the tank liner enters drainage slots in the concrete pads and then flows to an adjacent leak-detection pit. These tanks received boiling waste from the PUREX Facility and are passively ventilated through HEPA filters to the environment. Systems, related facilities, and structures associated with the 241-AX Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.2 200 West Area Single-Shell Tanks. The following sections describe the six SST farms located in the 200 West Area.

2.4.2.2.1 241-T Tank Farm. The 241-T Tank Farm is located directly west of the T Plant. The 241-T Tank Farm was constructed from 1943 to 1944 and contains 16 SSTs.

The twelve 100 Series are 23 m (75 ft) in diameter, have 5.5-m- (18-ft-) high liners, and can hold 2 million L (530,000 gal). The four 200 Series tanks can hold 208,000 L (55,000 gal). The tanks are arranged in a cascade of four tanks, three 100 Series and one 200 Series tank. The 241-T Tank Farm received bismuth phosphate wastes from T Plant. All the SSTs at this tank farm are passively ventilated through HEPA filters to the environment. Systems, facilities, and structures associated with the 241-T Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.2.2 241-U Tank Farm. The 241-U Tank Farm, located directly west of U Plant, was constructed from 1943 to 1944. The 241-U Tank Farm contains 16 SSTs. Twelve of the SSTs (100 Series tanks) can hold 2 million L (530,000 gal) and are 23 m (75 ft) in diameter with 5.5-m- (18-ft-) high liners. There are four 200 Series tanks. SSTs in the 241-U Tank Farm received slurry from the 242-S Evaporator. The tanks are arranged in a cascade of four tanks, three 100 Series and one 200 Series tank. These tanks are passively ventilated through HEPA filters to the environment. Systems, facilities, and structures associated with the 241-U Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.2.3 241-TX Tank Farm. The 241-TX Tank Farm, located south of the 241-T Tank Farm, was constructed from 1947 to 1948 according to a modified 241-B Tank Farm design. The 18 SSTs (100 Series tanks) in the 241-TX Tank Farm are essentially the same as the original 241-B Tank Farm design except for increased capacity (from 2 million to 2.9 million L [530,000 to 758,000 gal]) achieved by increasing the liner height from 5.5 to 7.3 m (18 to 24 ft). The 241-TX Tank Farm received slurry from the 242-T Evaporator. The SSTs in the 241-TX Tank Farm are passively ventilated through HEPA filters to the environment. Systems, facilities, and structures associated with the 241-TX Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.2.4 241-S Tank Farm. The 241-S Tank Farm located on 13th Street, northwest of S Plant (the REDOX Plant), was constructed during 1950 and 1951 and consists of twelve 100 Series [2.9 million-L (758,000-gal)] SSTs. The SSTs were constructed according to the same design as the original 23-m- (75-ft-) dia SSTs, but with an increased liner height (from 5.5 to 7.3 m [18 to 24 ft]). The 241-S Tank Farm received waste from the 242-S Evaporator and several types of REDOX Plant wastes in all four cascades. These SSTs are passively ventilated through HEPA filters to the environment. Systems, related facilities, or structures associated with the 241-S Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.2.5 241-TY Tank Farm. The 241-TY Tank Farm is located north of the 241-TX Tank Farm and was constructed during 1951 and 1952. All six 100 Series tanks can hold 2.9 million L (758,000 gal) and are of the same design as the tanks in the 241-TX Tank Farm. The 241-TY Tank Farm SSTs were used to settle and decant low-level wastes from T Plant and to store the 242-T Evaporator feed. The 241-TY Tank Farm SSTs are passively ventilated through HEPA filters to the environment. Systems, facilities, and structures associated with the 241-TY Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.2.2.6 241-SX Tank Farm. The 241-SX Tank Farm is located south of the 241-S Tank Farm and was constructed during 1953 and 1954. Each of the fifteen 100 Series

tanks in this tank farm can hold 3.8 million L (1 million gal). These were the first tanks designed to contain self-boiling waste. Only SSTs 241-SX-113 and 241-SX-115 are passively ventilated through HEPA filters to the environment. All other tanks within the 241-SX Tank Farm are actively ventilated to the environment as described in Section 2.4.1.5.1. Systems, related facilities, and structures associated with the 241-SX Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.3 Common Structures and Systems of Double-Shell Tanks

Twenty-eight DSTs are located in six tank farms, five farms in 200 East Area and one farm in 200 West Area. As shown in Figures 2-13 and 2-14, DSTs consist of a carbon steel primary tank and a carbon steel secondary tank encased by a protective reinforced concrete shell. Dimensions for the tanks located in each of the six farms are given in Table 2-8.

The primary safety function of DSTs is to confine radioactive liquid and solid waste over the lifetime of the facility. These confinement features are discussed in the following sections. The design codes and standards followed during construction of the tanks are provided in WHC-SD-TWR-RPT-002. Table 2-9 summarizes common DST design parameters.

2.4.3.1 Primary Tank. The carbon steel primary tank is a free-standing, completely enclosed structure that contains and confines the waste. The primary tank measures 23 m (75 ft) in diameter and is 14.25 m (46.75 ft) high at the dome center. The nominal storage capacity is 3.8 million L (1 million gal) at a liquid level of 9.20 m (30.2 ft). The maximum storage capacity is 4.4 million L (1.16 million gal) at a liquid level of 10.7 m (35.2 ft), with the exception of four DSTs called "aging waste" tanks. The "aging waste" tanks have maximum operating levels of 9.20 m (30.2 ft).

A 25-mm- (1-in.-) thick steel plate 1.2 m (4 ft) in diameter is located at the center of the tank bottom. The plate thins to 13 mm (0.5 in.) at the interfacing weld and extends to a curved, or formed, piece of the steel plate called the "knuckle" (where the tank bottom joins the tank wall). The knuckle plate is 22.2 mm (0.875 in.) thick.

The wall plates at the interfacing weld thin from 22.2 mm (0.875 in.) at the knuckle to 19 mm (0.75 in.) to 15.9 mm (0.625 in.) to 13 mm (0.5 in.) and finally to 9.53 mm (0.375 in.). The wall meets the tank dome at the "haunch" junction. The haunch and most of the dome are formed of 9.53-mm- (0.375-in.-) thick steel plate. The exact dome center is a 13-mm- (0.5-in.-) thick circular plate 3.7 m (12 ft) in diameter.

All welded joints were radiographed; however, because high-stress points at weld joints are susceptible to corrosion and cracking, the primary tank was subjected in place to post-fabrication stress relief treatment.

2.4.3.2 Concrete Support Pad. The primary tank sits on a 203-mm- (8-in.-) thick insulating concrete support pad located between the primary and secondary tank floors. During

construction, the pad protected the external structural concrete foundation from excessive temperatures during the thermal stress relief of the primary shell. The pad was cast with air distribution and drain slots in a grid pattern. During regular tank operation, the pad will contribute to a uniform tank bottom temperature, provide a means of heat removal, provide a means of leak detection, and help eliminate pockets of water condensation.

To provide cooling, air is drawn through the drain slots via the annulus ventilation system (Section 2.4.3.7). The drain slots allow any leakage from the primary tank to drain into the annular space, where conductivity leak detection instrumentation is installed in annulus risers. Leak detection is also provided via the continuous air monitor in the annulus ventilation exhaust system.

2.4.3.3 Secondary Tank. The floor of the secondary tank (sometimes called a liner) lies beneath the insulating concrete pad and is built directly on top of the concrete foundation. This secondary tank is 1.5 m (5 ft) larger in diameter than the primary tank, which forms a 0.76-m- (2.5-ft-) wide annular space between the primary and secondary tanks. The secondary tank joins the primary tank dome at the upper haunch area, and these two tanks are enclosed in a reinforced concrete shell. The secondary tank provides a second confinement barrier for potential primary tank leaks, thus preventing uncontrolled releases of waste to the environment.

The secondary tank extends along the bottom, side, and upper haunch of the concrete shell. The secondary liner is roughly 12 m (40 ft) high and constructed of carbon steel plates varying in thickness from 9.53 mm (0.375 in.) to 13 mm (0.5 in.). The liner bottom is constructed of 9.53-mm (0.375-in.) steel plate. The secondary liner knuckle is made of a 13-mm (0.5-in.) steel plate that extends about 0.6 m (2 ft) from the floor and is welded to 9.53-mm (0.375-in.) wall plates. The secondary liner was not stress-relieved after construction and thus is not designed for long-term confinement of waste leaking from the primary tank.

Induced-draft ventilation of the annulus between the primary and secondary tank liners removes heat from the stored waste (i.e., decay heat). Radiation detectors in the annulus ventilation exhaust stream are provided to detect airborne radioactivity resulting from primary tank leakage.

2.4.3.4 Concrete Shell. The exterior concrete shell comprises a foundation, walls, and dome that completely encloses the secondary tank and primary tank dome. This shell is designed to support soil loading, dead loads, live loads (equipment, personnel), and seismic loads. The 27-m- (89-ft-) dia, steel-reinforced shell rests on a separate structural concrete foundation. The 0.46-m- (1.5-ft-) thick concrete shell walls rest on steel slide plates supported by the tank foundation. The 0.38-m- (1.25-ft-) thick concrete dome and the walls contain a lattice of reinforcement bars and embedded J-bolts. The J-bolts are threaded into nuts welded to the steel tank walls and dome.

The structural concrete foundation, which is 27.23 m (89.33 ft) in diameter, distributes all weight loads uniformly to the ground below. The circular center portion of the foundation is

1.8 m (6 ft) in diameter and 0.6 m (2 ft) thick. From the circular center portion, foundation thickness tapers to 0.3 m (1 ft) and expands again to 0.84 m (2.75 ft) at the outer edge.

The structural foundation contains drain lines and sumps called leak detection wells to collect leakage from the secondary liner. The top of the concrete foundation contains slots to drain any liquid that might leak from the secondary tank (actually, a tertiary leak detection and collection system). Any liquid that reached the foundation would drain through the slots to a leak detection well.

2.4.3.5 Risers. Each tank is equipped with riser pipes that penetrate the concrete dome and the top of the primary or secondary tank. The risers provide access to the primary tank and to the annulus space for waste transfer operations, equipment installation or use, and monitoring. Some risers are located in covered pits (e.g., central pump pits, annulus pump pits, and drain pits); others are located at specific predetermined locations at each tank.

Primary tank dome risers can be used to enable liquid, vapor, and sludge waste sampling and for instrument access to measure temperature and pressure, derive specific gravity, monitor liquid and sludge levels, and ventilate and pump the tank. Other riser uses in primary tanks include camera inspections, flammable gas sampling, and gamma/neutron measurement.

Annulus risers provide access for inspection and enable the introduction of liquid leak detection instruments, periscopes, still and television cameras, ventilation air supply and exhaust ducts, and temperature monitors. Additional details regarding DST risers can be found in WHC-SD-RE-TI-093, *Double-Shell Underground Waste Storage Tank-Riser Survey*.

2.4.3.6 Pits. Pits provide access from the surface to process piping and tank risers and are the points where jumpers (temporary piping systems), pumps, and other equipment are installed to establish waste transfer routings. Pump pits are constructed of reinforced concrete walls and floors located belowgrade and are provided with removable reinforced concrete cover blocks located approximately at grade elevation. Personnel are protected from radiation by the 508-mm-(20-in.-) thick cover blocks. The configuration of the piping in the pit is painted on the cover blocks to show the operator the routing of the liquid waste and the valve positions. Leak detection is provided in leak detection pits and used to shut down the transfer pump if a leak is detected during transfers. A shielding plug is provided that can be removed for observation purposes.

Permanently installed pumps are used to remove liquid waste from primary tanks, and temporary pumps are used to remove liquid waste from annuli and leak detection pits. Spare pumps can be used for either purpose. However, pumps that become contaminated during a transfer operation in a particular pit may remain permanently in that pit.

2.4.3.6.1 Central Pump Pits. Central pump pits, which are approximately centered on the tanks, have three purposes: (1) supernate filling or removal, (2) slurry distribution, and (3) mixer pump installation. Central pump pits typically measure approximately 2.1 m (7 ft) square by 3.0 m (10 ft) deep. The 241-AN central pump pit is 2.4 m (8 ft) x 4.2 m (14 ft) x 1.8 m

(6 ft) deep. A typical central pump pit is illustrated in Figure 2-15. A shielding plug is provided that can be removed for observation purposes.

Supernate filling is accomplished through piping or jumpers (temporary piping systems) connected to a riser. For supernate removal, central pump pits are designed to hold a deep-well turbine pump and piping or jumpers. In tanks without pumps, dummy pump heads are installed on the pump flange to support the supernate pump-out (and fill) jumper. Central pump pits for receiver tanks that store slurry are equipped with slurry distributors (Figure 2-16).

During filling operations, a slurry distributor (where available) disperses the slurry evenly within the tank. The pump pit cover block is marked with a distributor-indexing diagram so that the distributor may be set at any given position from an established zero-degree reference point. The zero-degree position for the distributor points directly at the level instrument assembly. "Do Not Slurry" zones appear on each slurry distributor indexing diagram. One zone, at the indicated zero-degree position, protects the automatic level instrument; another zone is identified to prevent slurry from being sprayed directly under the tank ventilation outlet; and additional zones are provided, as needed, to protect other in-tank instrumentation.

These pits have floor drains for returning leaked waste to the tank.

2.4.3.6.2 Annulus Pump Pits. Annulus pump pits, located over annulus risers, provide a means for pumping out any liquids that may accumulate in the annular space from a primary tank leak. A typical annulus pump pit is shown in Figure 2-17.

Annulus pump pits typically measure approximately 2.1 m (7 ft) square by 3.53 m (11.58 ft) deep [241-AN pits are 3.0 m (10 ft) deep] with 0.3-m- (1-ft-) thick concrete walls. Annulus pump pits are covered with a 0.51-m- (20-in.-) thick concrete cover block. A shielding plug on a small leak detector assembly access hole in the cover block may be removed for observation purposes. The entire cover block, however, must be removed to obtain access to the leak detector. These pits have floor drains for returning leaked waste to the tank.

In most instances, deep-well vertical turbine pumps will be installed as needed in annulus pump pits. The pump is lowered into position after a blind flange is removed. A rigid jumper assembly connects the pump outlet to a 51-mm (2-in.) process waste line enclosed in a 102-mm (4-in.) encasement. The encasement slopes to drain the encasement pipe toward the annulus pump or retrieval pit. The process waste line terminates at the central pump pit of the tank. The waste may then be pumped to a suitable tank through the existing transfer piping.

2.4.3.6.3 Feed Pump Pits. Feed pump pits are located off center on tanks 241-AW-102, 241-AP-102, and 241-SY-102 to provide another means of pumping the tank contents. A shielding plug is provided that can be removed for observation purposes. Feed pump pits typically measure approximately 2.1 m (7 ft) square x 2.51 m (8.25 ft) deep with 0.3-m- (1-ft-) thick reinforced concrete walls and 0.51-m- (20-in.-) thick concrete cover blocks. These pits have floor drains for returning leaked waste to the tank. A typical feed pump pit is shown in Figure 2-18.

2.4.3.6.4 Leak Detection Pits. Leak detection pits installed in all DST farms house level indicators and leak-monitoring instruments and collect liquid from the drainage grid at the top of the concrete foundation (upon which the secondary liner bottom rests). Each pit is fabricated as two parts: (1) a leak detection well and pump pit, and (2) a 152-mm- (6-in.-) dia radiation detection pit with dry well (Figure 2-19). A shielding plug is provided that can be removed for observation purposes. A leak detection pit is normally located adjacent to each tank annulus. The 241-AP Tank Farm, however, only has two pits; each pit collects drainage from four tanks.

The leak detection pit (including the adjacent radiation detection pit) may be ventilated through a 51-mm- (2-in.-) dia ventilation line connected to the tank annulus ventilation system by opening an in-line ball or gate valve with a T-handle. The T-handle extends about 0.9 m (3 ft) abovegrade, near the leak detection pump pit. Ventilation is unnecessary, however, unless the leak detection pits are contaminated.

Leak detection well and pump pits are 2.1 m (7 ft) square x 3.23 m (10.58 ft) deep with 0.3-m- (1-ft-) thick concrete floors and walls. A 0.51-m- (20-in.-) thick concrete cover block fits over the well and pump pit. The leak detection well floor is typically 19.15 m (62.83 ft) belowgrade. Below the top of the cover block at approximately 18 m (58 ft), a 152-mm (6-in.) encased drain pipe connects the leak detection well to the tank foundation for liquid collection. Depending on the tank farm, the liquid can be pumped back into the primary tank, which is approximately 3.7 m (12 ft) from the pit, or through process piping to a designated receiver tank.

The radiation dry well (through which radiation detection probes are inserted as part of the leak detection system) is 152 mm (6 in.) in diameter and terminates adjacent to the bottom of the leak detection well. The radiation monitoring systems have been deactivated in 200 East tank farms. The radiation dry well is accessed through a pit adjacent to the pump pit. This access pit is 1.17 m (3.83 ft) x 0.71 m (2.33 ft) x 0.69 m (2.25 ft) deep and is covered with a steel or sheet metal cover that is removed by using retractable lifting bails. The radiation well access pit drains into the leak detection pump pit, which then drains to the leak detection well.

2.4.3.6.5 Drain Pits. Drain pits are located over an off-center primary tank riser on tanks 241-AN-101, 241-AP-103, 241-AW-102 and 241-SY-102 to provide a means for returning fluids to the tank. Drain pits typically measure approximately 2.4 by 2.1 m (8 by 7 ft) by 3.53 m (11.58 ft) deep with 0.3-m- (1-ft-) thick walls and are covered with a 0.51-m- (20-in.-) thick concrete cover block. A shielding plug is provided that can be removed for observation purposes. A typical drain pit is shown in Figure 2-20.

2.4.3.6.6 Sluice Pits. A sluice pit is a reinforced concrete pit through which high-pressure liquids are routed to the sluicer assembly. Sluice pits are typically 4.3 m square x 3.84 m deep (14 ft square x 12.6 ft deep). These pits are located over off-center primary tank risers on DSTs 241-AY-101, 241-AY-102, 241-AZ-101, and 241-AZ-102. These pits have floor drains for returning leaked waste to the tank. The pits provide a means of injecting a high-pressure liquid stream directly into the sludge so that the sludge may be broken up, removed, and transferred to another tank.

In 241-AY Tank Farm, Tanks 241-AY-101 and 241-AY-102 have four sluice pits. 241-AZ Tank Farm is equipped with two sluice pits per tank and a central sluice transfer diversion box, 241-AZ-152, which can be used to return condensate to the tanks. A shielding plug is provided that can be removed for observation purposes.

2.4.3.7 Ventilation Systems. All permanent or temporarily installed DST ventilation systems consist of both a primary ventilation system and an annulus ventilation system. The combined annulus and primary tank ventilation systems for the 241-AN, 241-AP, 241-AW, and 241-SY tank farms can remove up to 29,000 W/tank (100,000 Btu/h/tank).
The 241-A-702 Ventilation System for the 241-AY and 241-AZ tank farms has three large condensers in the 241-A-401 Building, each designed for removing up to 2,600,000 W/condenser (9,000,000 Btu/h/condenser). The 241-AZ-702 Ventilation System is the new ventilation system for the AZ and AY tank farms and it replaces the 241-A-702 Ventilation System. See Addendum 3 for the facility description and system operation details for 241-AZ-702. The 241-A-702 Ventilation System has been isolated and it is currently being maintained in standby status. The following description of the 241-A-702 Ventilation System is retained in the FSAR for information and will be deleted when authorization is received from RL to remove the system from standby status. The main functions of primary ventilation are as follows:

- Remove radioactive decay heat from the primary tank by removing water vapors from the tank head space.
- Confine stored materials by maintaining vacuum conditions within the tank. The primary method of contamination control for the DSTs is confinement.
- Provide deentrainment of liquid droplets from condensed water vapor.
- Remove radioactive particulate materials from gaseous effluent.
- Control and monitor gaseous emissions.

The primary tank ventilation system filters and removes moisture from tank exhaust vapor before the vapor is discharged to the atmosphere. The primary tank ventilation system maintains a negative pressure on the tanks. The pressure may vary from tank to tank in a tank farm based on the waste characteristics and operational requirements. Confinement of airborne radioactive materials is thus ensured. The primary tank ventilation system can handle offgas with up to 100% humidity. A breakdown of the primary ventilation system airflow rates for DST farms is provided in Table 2-10.

The annulus ventilation system can be used for both cooling and leak detection.

Instrumentation for both primary and annulus ventilation systems is abovegrade and is located at the exhaust unit or in the instrument building. All primary ventilation, instrumentation, duct work drains, and seal pots are protected from freezing weather. Shielding is provided for the

demister, preheater, and, with the exception of 241-SY, filter assembly of each primary tank system.

2.4.3.7.1 241-AY and 241-AZ (Aging Waste Facility) Tank Farm Ventilation Systems. The 702-AZ Ventilation System is the new ventilation system for the AZ and AY tank farms and it replaces the 241-A-702 Ventilation System. See Addendum 3 for description of the 241-AZ-702 primary tank ventilation system. As noted in the preceding section the following description of the 241-A-702 system is retained in the FSAR for information. The 241-A-702 Primary Ventilation System (Figure 2-21) has been isolated. This system previously provided primary tank ventilation for the four aging waste facility (AWF) tanks (241-AY-101, 241-AY-102, 241-AZ-101, and 241-AZ-102) and for the 241-AX-152 diverter station. Several other miscellaneous structures (e.g., the 241-AZ-151 and 241-AZ-154 catch tanks) were ventilated indirectly through waste transfer lines. A backup ventilation system (Figure 2-21) was available when necessary. Table 2-10 provides summary information on the AWF ventilation systems.

The primary ventilation system was designed specifically for PUREX-generated aging waste (or boiling waste), which is characterized by elevated temperatures and significant radiological content.

The tank temperature determines the water vapor saturation in the head space. Air from operating air lift circulators, instrument air purges, and direct atmospheric inleakage through pit cover blocks, side fill lines, and risers determines the overall saturation in the ventilation system. Vapor can also be generated by radiolytic heat converting water to steam and by natural convection currents from thermal gradients. In addition to providing a confinement function, the ventilation systems help to control the temperature of the liquid in the tanks by removing heat released through such vaporization processes.

Primary Tank Ventilation Flow. Air is introduced into an AWF tank head space through air lift circulators and air purge instruments. Also, outside air is drawn into the tank through pit cover blocks and risers due to the vacuum created by the exhaust blower. Two 1,899-L/s (4,000-ft^3/min) exhausters (blowers) operate one at a time to draw the gases through an extensive particle and condensate removal system before discharging the gases to the atmosphere. Vapor is exhausted through a single 508-mm- (20-in.-) dia duct on each AWF tank and continues through individual tank-seal loops to a common 610-mm (24-in.) vent header.

The vapor stream proceeds through a section of 0.5-m- (1.5-ft-) dia steel pipe before passing through the 0.6-m- (2-ft-) dia seal loop to the K1-5-1 deentrainer. After passing through the K1-5-1 deentrainer, the vapor stream continues along the vent header through the vent header extension seal loop and enters the hot-pipe gallery of the 241-A-401 Surface Condenser Building. Three condensers (two in operation at a time) for removing moisture from the exhaust system are located in this building. The offgases from the three surface condensers are vented through a second deentrainer (K1-5-2A) before entering the 241-A-702 Ventilation Building.

A backup cooling water supply system, external to the condenser building, is available upon loss of raw water. This is a closed-loop supply system that must be manually activated and valved in. This system consists of the following:

- **Warm Water Sump**—receives used condenser cooling water and contains two electrical vertical turbine pumps (one in standby) to pump water from the sump to the cooling towers.

- **Forced Draft Wet Cooling Tower**—contains two wooden towers, each equipped with a variable speed electric fan that can be changed based on outside temperature.

- **Cold Water Sump**—receives cooled water from the cooling towers and contains two electrical vertical turbine pumps (one in standby) to pump water to the 241-A-401 condensers.

- **Deep Well and Pump**—a 20.3-cm- (8-in.-) dia, 83.5-m- (274-ft-) deep well equipped with a pump to supply makeup water to the cold water sump.

- **Backup power system (in the 241-A-701 Building)**—consists of a diesel generator that starts automatically upon loss of normal power. In addition, backup normal power is available using a manual switch at the 241-A-701 Building. The backup power system will run the entire backup cooling system; however, although both tower fans and the deep well pump can be run concurrently, only one warm sump pump and one cold sump pump can be run at a time.

The vapor stream then continues into the K1-3-1 steam heater housing (heater not in service) before reaching the filter banks. The ventilation ducts routed from the K1-3-1 steam heater housing extend through the floor of the filter side of 241-A-702 Building and exit through a wall on the blower side of 241-A-702 Building into a common 0.2-m^2 (2-ft^2) plenum that feeds one of the two 241-A-702 exhaust blowers. Twelve HEPA filters, in six banks, simultaneously filter the exhaust air flowing through the 241-A-702 Primary Ventilation System.

After filtration, the vapor stream from each set of filters enters a plenum and then passes through one of two 0.41-m- (1.33-ft-) dia stainless steel ducts, depending on which blower is operating. Vapor is discharged by the blower into the atmosphere by means of the 0.5-m- (1.5-ft-) dia stainless-steel exhaust stack. To control the volume of air being drawn off the tanks, a portion of the exhaust vapor is recirculated from the stack to the plenum through a manually controlled butterfly valve. This modification eliminated the need to replace (downsize) the blowers when two SST farms (241-A and 241-AX) were removed from the system. A CAM monitors effluent radioactivity levels, and a record sampler collects representative samples before the vapor stream is discharged to the atmosphere.

Two 203-mm (8-in.) cross-tie valves are located in a caisson near each tank. The primary purpose of these cross-ties is to allow the primary ventilation system to ventilate the annuli of the

tanks. The vent system transfer can be performed by opening the two manual cross-tie valves in the caisson located near the desired tank. These valves connect the primary ventilation piping to the associated annulus downstream of each primary tank.

The 241-A-702 Backup Ventilation System exhausts head space gases when the 241-A-702 Primary Ventilation System is shut down (i.e., when K1-1-1 and K1-1-2 exhaust fans are shut down).

Additionally, should both 241-A-702 primary blowers fail to provide the required 0.37-kPa (1.5-in. WG) vacuum (as measured by the K1-5-1 deentrainer inlet vacuum gauge) for the AWF tanks, the backup exhauster has a sequencing system designed to start automatically.

During backup exhauster operation, vapor is drawn through the butterfly valve and into the plenum of the exhauster system by a centrifugal exhaust blower. The vapor continues through a heater, which is capable of raising the temperature of saturated vapor. The heated vapor stream passes through two banks of four HEPA filters each and then out the stack, which is equipped with a CAM. The HEPA filters are aerosol tested annually. A CAM monitors effluent radioactivity levels, and a record sampler collects representative samples before the vapor stream is discharged to the atmosphere.

Annulus Ventilation System. Each of the 241-AY AWF tanks has its own annulus ventilation system. The 241-AZ Annulus Ventilation System is similar in function and design except that 241-AZ tanks are served by a common annulus ventilation system and share an annulus exhauster. To prevent contamination of the annulus should a leak path develop between the annulus and the primary tank head space, a lower vacuum in the annulus is maintained with respect to the primary tank head space pressure. The following paragraph describes the 241-AY/AZ Annulus Ventilation System, which is depicted in Figure 2-22.

The exhaust fan draws outside air into each ventilation unit through louver inlets. To prevent frost damage to the supply filters, radiant heaters are mounted inside each louver inlet. The air is then filtered through banks of HEPA filters. The filtered air continues through a supply air heater before entering the annulus. The air then passes through a manual butterfly valve and into the annular space via underground duct work. The air is distributed between the side of the annulus and a central air distribution chamber below the primary tank. An exception to this configuration is the system on Tank 241-AY-102, which has been modified to distribute air only to the central air distribution chamber below the tank (refer to Addendum 1). Exhaust air is then drawn out of the annulus through ducts that merge into a common underground duct, called the vent header. One vent header from each tank rises aboveground to a separate HEPA filter housing for each tank. As the air exits the header, a vacuum pump extracts an air sample and feeds it to a CAM. The exhaust air continues through an automatically controlled electric heater. The air then passes through another manual butterfly valve and through two filter housings, each containing four HEPA filters. The HEPA filters are aerosol tested annually. Filtered air exits the ventilation system through the exhaust blower and stack and is released to the environment.

2.4.3.7.2 241-AN, 241-AP, 241-AW, and 241-SY Tank Farm Ventilation Systems. The primary ventilation systems for DST farms 241-AN, 241-AP, and 241-AW are essentially identical (Figure 2-23). The only differences among these systems are in blower capacities and resulting tank airflow rates and in the efficiency rating of prefilters. The primary tank ventilation system filters and removes moisture from tank exhaust vapor before the vapor is discharged to the atmosphere. The primary ventilation system for 241-SY Tank Farm is slightly different from that of the other three tank farms and is addressed following the main ventilation discussion. In the discussion of the annulus ventilation system, the systems for 241-AN and 241-AW tank farms are discussed together because they are very similar; the annulus ventilation systems for the 241-AP and 241-SY tank farms are then discussed in turn.

Primary Tank Ventilation System. The primary ventilation system for all four tank farms is a dual system. Under normal operating conditions, only one of the dual systems operates at a time. The other unit provides backup support in case of equipment failure or HEPA filter changes.

Outside air is drawn into the tank through inlet filters, or pit cover blocks, or risers because of the vacuum created by the exhaust blower. Also, air is introduced into the tank head space through operating air lift circulators (241-AW-102) and air purge instruments. Air is drawn out of the tank through a 305-mm- (12-in.-) dia duct and into a belowgrade exhaust header. Primary tank exhaust ducts have air volume control butterfly valves located in vent pits. After leaving the ventilation pits, exhaust ducts combine into one 406-mm- (16-in.-) dia (except for 241-AN, 305 mm [12 in.]) duct. The exhaust header terminates at the primary K1 exhauster unit located on the primary ventilation pad.

At the primary ventilation pad, the air initially passes through a demister consisting of a wire-mesh pad that separates heavy moisture particles from the airstream and then through one of two motor-operated valves. Valve positions are controlled automatically by differential pressure switches that measure differential pressure across the blowers. The air then passes through an electric heater, which vaporizes the remaining moisture.

The dry, heated air is prefiltered to remove particulates. Next, two HEPA filters mounted in series remove particulates as small as 0.3 μ with at least 99.95% efficiency. Smaller particles can be trapped by the filter, but the filter is not rated for any particle smaller than 0.3 μ. A differential pressure indicator across each HEPA filter monitors operating conditions. Low differential pressure indicates low air flow or a failed filter. High differential pressure indicates blockage caused by accumulated solids or possibly ice formation on the filters. The 241-AN exhaust fans are shut down on high stack radiation and low differential pressure on the second HEPA filter.

After passing through the filters, the air is drawn through a K1 blower and exhausted from the K1 stack. A CAM monitors effluent radioactivity levels, and a record sampler collects representative samples before the air is discharged to the atmosphere. If an exhaust fan in the operating system fails, the backup ventilation system blower starts automatically. Under normal operating conditions, one of the K1 demisters is valved in and the opposite demister is valved out.

The 241-SY Ventilation System is entirely abovegrade. All 241-SY DSTs receive air through dual HEPA filter inlets and incidental leakage. The airflow exhausted from each tank to the primary ventilation system is combined into a 0.3-m- (1-ft-) dia duct and then routed to either the normal exhauster train or the backup portable exhauster train. The normal exhauster train consists of a demister, a prefilter, two HEPA filter housings, a fan, a flow meter, and an exhaust stack. The normal exhauster fan is designed to handle an airflow rate of 330 L/s (700 ft^3/min). The backup exhauster train also consists of a demister, a prefilter, two HEPA filter housings, a fan, and an exhaust stack. The backup exhauster is designed to handle an airflow rate of 472 L/s (1,000 ft^3/min) and must be started manually.

Annulus Ventilation System. The annulus ventilation systems for DST farms 241-AN and 241-AW are very similar (Figure 2-24). The air intake to the annulus of each tank is designed for 378 L/s (800 ft^3/min), and the air is routed through a 35%-efficiency prefilter and a testable, self-contained HEPA filter before being supplied to the annulus air distribution channels of each tank. The airflow exhausted from the annulus of each tank is combined and then routed through the two exhaust trains, each of which consists of a demister, an electric heater, two HEPA filter housings, and a fan, before being exhausted from a stack to the atmosphere. The annulus ventilation systems for DST farms 241-AN and 241-AW are designed to handle total airflow rates of approximately 3,000 L/s (6,125 ft^3/min) and 2,500 L/s (5,250 ft^3/min), respectively.

The 241-AP Annulus Ventilation System is similar to that of 241-AN with some differences (Figure 2-24). For example, the air intake to the annulus of each tank has a capacity of 507 L/s (1,075 ft^3/min) as compared with 401 L/s (850 ft^3/min) for the 241-AN system. To prevent ice formation on the filters, the 241-AP annulus air intake includes a heater to warm the incoming air. The air then passes through a 35%-efficiency prefilter and a HEPA filter before being supplied to the annulus air distribution channels of each tank. The airflow exhausted from the annulus of each tank is combined and then routed through one of two exhaust trains before being exhausted from a stack to the atmosphere. Each train consists of an electric heater, two HEPA filter housings, and a blower. The blower is designed to provide a total airflow rate of 4,060 L/s (8,600 ft^3/min) through the annulus system.

The entire annulus ventilation system for the 241-SY Tank Farm is abovegrade. Air intakes to the annulus of each tank are designed for a total of 94.4 L/s (200 ft^3/min). Intake air originates from four intake stations per tank. Each station consists of a cylindrical filter housing. These intakes are routed to the air distribution channels of each tank. Another intake, which has a single cylindrical filter housing, is routed directly into the annulus vent space. The airflow exhausted from the annulus of each tank is combined and then routed through a single exhaust train before being exhausted from a stack to the atmosphere. The exhaust train consists of a moisture eliminator, a prefilter, two HEPA filter housings, and a blower. The blower is designed to provide a total airflow rate of 354 L/s (750 ft^3/min) through the annulus system.

2.4.4 Specific Structures and Systems of Double-Shell Tanks

In the following sections, each of the DST farms is discussed in order of construction date from earliest to latest. All DSTs are actively ventilated, and tank design is summarized in Table 2-9. The codes and standards used to design and construct the DSTs are provided in WHC-SD-TWR-RPT-002. Major systems, facilities, or structures within the tank farm, as well as system status and operability, are identified in WHC-SD-WM-HIE-007.

2.4.4.1 200 East Area Double-Shell Tanks. The following sections describe the five tank farms located in 200 East Area.

2.4.4.1.1 241-AY and 241-AZ Tank Farms (Aging Waste Facility). The AWF, located northeast of the PUREX Facility, was constructed between 1968 and 1977. The AWF tank farms (241-AY and 241-AZ) consist of four tanks (241-AY-101, 241-AY-102, 241-AZ-101, and 241-AZ-102) each of which can hold 3.8 million L (1 million gal). The tanks, with the exception of 241-AY-102, received aging waste from the PUREX Facility. All tanks have received other process wastes.

The two 241-AY tanks are located southwest of the 241-AZ tanks on the western fringe of the 241-A Tank Farm. The two 241-AZ tanks are located in the northernmost fringe of the 241-A Tank Farm. Instrument buildings, located between the tanks of the 241-AY and 241-AZ Tank Farms, house process control piping and instrumentation. Various process pits and caissons contain the valves, meters, transmitters, and connectors required for waste transfer and tank control. Local exhausters (two in the 241-AY Tank Farm and one in the 241-AZ Tank Farm) maintain a negative pressure on the AWF tank annular spaces with respect to atmosphere. The systems and supporting structures within the AWF complex are listed in WHC-SD-WM-HIE-007.

The AWF tanks are the only DSTs in which process pipelines penetrate the sides of the tanks. Special temperature and radiation shielding is required because the tank farms received and handled PUREX process waste. A unique ventilation system capable of handling moist air is also required. Each 241-AY tank has its own annulus ventilation system. The 241-AZ tanks share a common annulus ventilation system.

The AWF tanks also differ from other DSTs, such as others in 200 East Area, by the addition of systems that allowed the tanks to receive and store high heat-generating wastes. These additional systems consist of air lift circulators, steam coils (currently inactive), and exhaust condensers. An AWF tank with air lift circulators and steam coils is depicted in Figure 2-25.

To prevent temperature excursions caused by excessive settling of heat-generating fission products, air lift circulators in each tank can be used to gently agitate the tank contents by forcing air into the liquid waste except for Tank 241-AY-102 for WRSS as described in Addendum 1. Each AWF tank is equipped with 22 air lift circulators. Circulator 1 is located at the tank center axis, circulators 2 through 8 are equally spaced around a radius of 4.4 m (14.5 ft), and circulators 9 through 22 are equally spaced around a radius of 8.2 m (27 ft). Air lift circulators 1,

9, 12, 16, and 19 are 5.2 m (17 ft) long and require a solution volume of about 2,460,000 L (650,000 gal) for total submergence. The remaining 17 circulators are 6.7 m (22 ft) long and require a solution volume of 3,220,000 L (850,000 gal) for total submergence. The air lift circulators installed in the AWF tanks are shown in Figure 2-25. In addition, two mixer pumps, similar to the mixer pumps installed in Tanks 241-AP-102 and 241-SY-101 (Section 2.4.15) have been installed in Tank 241-AZ-101.

Steam coils have been installed in each of the AWF tanks, but are currently not in use and steam has been blanked off. The coils were used initially to heat the tank contents and to either maintain a standby temperature or obtain a desired boil-off rate. The coils are constructed of Schedule 40 carbon steel tubing; the diameter of the outer coil is about 1.0 m (40 in.). The overall length of the coil assembly is 17 m (55 ft) in the 241-AY tanks and 16.56 m (54.33 ft) in the 241-AZ tanks. The coil portion of the assembly is approximately 7 m (23 ft) long. A steam coil is shown in Figure 2-25.

The exhaust condenser system is a subsystem of the tank primary ventilation system described in Section 2.4.3.7.1. The exhaust condenser system, which is part of the 241-AZ-702 Ventilation System, is described in Addendum 3.

2.4.4.1.2 241-AW Tank Farm. The 241-AW Tank Farm, located south of the 242-A Evaporator and constructed from 1978 to 1980, comprises six 4.4 million-L (1.16 million-gal) DSTs. The farm, which stores low-heat radioactive liquid waste that was generated by the PUREX Facility, is an integrated facility that has dedicated ventilation equipment (Section 2.4.3.7.2).

Tank 241-AW-102 is the feed tank for the 242-A Evaporator and is used for all waste concentration operations. Any waste designated for concentration is pumped to feed Tank 241-AW-102 for transfer to the 242-A Evaporator. Tank 241-AW-101 was constructed as an alternative feed tank to the 242-A Evaporator.

In addition to the central pump pit, annulus pump pit, and leak detection pit, which are common to all 241-AW tanks, Tank 241-AW-102 has a feed pump pit and drain pit. Tank 241-AW-102 also has two air lift circulators for mixing tank contents to provide a uniform feed to the 242-A Evaporator and a dip tube assembly installed to read specific gravity. Cladding removal waste was initially stored in Tanks 241-AW-103 and 241-AW-105. Solvent extraction wash waste from past operations and miscellaneous sump waste are stored in Tank 241-AW-104. The systems and supporting structures for the 241-AW Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.4.1.3 241-AN Tank Farm. The 241-AN Tank Farm, located north of the 241-AZ Tank Farm and constructed from 1980 to 1981, comprises seven 4.4 million-L (1.16 million-gal) DSTs. The tanks are essentially identical except that one tank (241-AN-101) has two additional concrete process pits, and another tank (241-AN-107) has 80 risers because of the 21 air lift circulator assemblies installed in the tank to gently agitate the waste. The tanks are designed to store double-shell slurry produced at the 242-A Evaporator. Tank 241-AN-107 is

equipped with a mixer pump, and a recent review of the design drawings for this tank farm has determined that this tank was constructed at an elevation of approximately 10.2 cm (4 in.) lower than other tanks in the 241-AN Tank Farm. The systems and supporting structures within the 241-AN Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.4.1.4 241-AP Tank Farm. The 241-AP Tank Farm is the most recently constructed (1983 to 1986) and comprises eight DSTs and associated facilities located southeast of the 242-A Evaporator. Each tank can hold 4.4 million L (1.16 million gal). The 241-AP Tank Farm is designed to operate similarly to the 241-AW Tank Farm. Low-heat radioactive liquid wastes are transferred to or from the 241-AP Tank Farm via 241-AW Tank Farm facilities. The systems and supporting structures within the 241-AP Tank Farm are listed in WHC-SD-WM-HIE-007. Tank 241-AP-102 was identified as the Grout Treatment Facility feed tank and contains a mixer pump (Section 2.4.15) originally installed to support grout operations. Tank 241-AP-107 is equipped with pits to accommodate three mixer pumps (not installed) simultaneously.

2.4.4.2 200 West Area Double-Shell Tanks. Only one DST farm, 241-SY, is located in the 200 West Area. This tank farm was constructed from 1973 to 1976 and consists of three tanks, each of which can hold 4.4 million L (1.16 million gal). These tanks have received various wastes from various operations and facilities in the 200 East and 200 West Areas. Tank 241-SY-101 was used as a double-shell slurry holding tank for the 242-S Evaporator. A central pump pit on Tank 241-SY-101 houses the mixer pump that mixes tank contents. Tank 241-SY-102 receives waste generated by 200 West Area SSTs and other 200 West Area facilities (e.g., Plutonium Finishing Plant and 222-S Laboratory). This tank was the feed tank for the 242-S Evaporator and serves as a cross-site tie for transfers between the 200 East and 200 West Areas.
Tank 241-SY-103 was used to store high-strontium concentrated liquor. The systems and supporting structures within the 241-SY Tank Farm are listed in WHC-SD-WM-HIE-007.

2.4.5 Other Underground Waste Storage Tanks

The following sections discuss the catch tanks, DCRTs, and associated ventilation systems, and inactive miscellaneous underground storage tanks.

2.4.5.1 Catch Tanks and Double-Contained Receiver Tanks. Catch tanks (discussed in Section 2.4.5.1.2) are underground storage tanks that collect small amounts of waste drained from waste transfer systems and DST equipment. A DCRT (discussed in Section 2.4.5.1.3), together with its related equipment, may function as an interim short-term storage facility for liquid wastes pumped from other storage sites or facilities or a valve pit to route wastes. A lift station may be a catch tank or DCRT located in a low point in a transfer line. Liquids collected in a lift station are pumped out.

2.4.5.1.1 Ventilation Systems. The three types of ventilation systems equipped with HEPA filters in use at TWRS are active permanent and temporary systems (i.e., with an exhaust fan), shared systems (i.e., connected in line with a common operating exhaust system), and passive systems (i.e., equipped with a breather filter assembly). The following active catch tanks

have no HEPA filtration systems and "vent" by means of the floor drains to their respective diversion boxes: 241-A-302A, 241-TX-302C, 241-U-301B, 241-UX-302A, and 241-ER-311.

Active Ventilation Systems. No active ventilation systems are associated with catch tanks. Thus, only those active systems associated with the DCRTs are discussed in the following paragraphs and summarized in Table 2-11.

- **244-A DCRT**—The ventilation system for the 244-A DCRT is installed in the filter pit. The fans and stack CAM are aboveground. Associated instrument readout and alarm panels are located in the 242-A Evaporator control room.

  The receiver tank, the pump and filter pits, and the tank vault annulus are vented through a single exhaust system. The filter pit contains tank and annulus air ventilation and filtering equipment. Outside air at 47.2 L/s (100 ft^3/min) enters the DCRT annulus through an air intake equipped with an electric heater, prefilter (roughing filter), and single-stage HEPA filter. Because no provision is made to provide filtered air to the tank, unfiltered air, in addition to dip tube purge air, normally seeps in through cover blocks.

  An exhaust fan provides ventilation airflow through the DCRT vault, receiver tank (or both vault and receiver tank), and filters. The vault and receiver air streams join into a single line, then split and flow through one of two parallel HEPA filter banks in the filter pit, then join back into a single line. After passing through the filters and fan, the air stream is exhausted out a short stack to the atmosphere. Detectors equipped with sample probes and located in the exhaust stack continuously monitor and sample the exhaust air. An alarm is sounded locally and at the 242-A Evaporator control room if alpha or beta-gamma monitoring capabilities are lost.

  A pressure gauge on the intake exhaust duct measures the annulus air pressure relative to ambient atmospheric pressure. Differential pressure indicators installed in the HEPA filter banks provide pressure-drop data. High differential pressure across the prefilter and the first of two HEPA filters in each bank causes an alarm to sound in the 242-A Evaporator control room. Low differential pressure across the final HEPA filter in each bank automatically shuts down the exhaust fan and sounds an alarm locally and at the 242-A Evaporator control room. A pressure indicator monitors airflow through the stack and stack sampler.

- **244-BX DCRT**—The ventilation system for 244-BX DCRT is similar (but not identical) to the 244-A Ventilation System. The ventilation system in 244-BX is installed in the filter pit with three banks of HEPA filters. Instrument readout and alarm panels are located in the 244-BX Instrument Building and the 241-BY-254 Building.

At 244-BX, the air from the receiver tank and the vault is vented through a single exhaust system. Outside air is drawn through an air heater, a prefilter, and a HEPA filter at a flow rate of 59 L/s (125 ft^3/min) into the annulus. Because no provision is made to provide filtered air to the tank, unfiltered air, in addition to dip tube purge air, normally seeps in through cover blocks.

An exhaust fan provides ventilation airflow through the DCRT vault, receiver tank (or both vault and receiver tank), and filters. The vault and receiver air streams flow through two of the three parallel HEPA filter banks in the filter pit, and then join into a single line. After passing through the filters and fan, the air stream is exhausted out a short stack to the atmosphere. Detectors equipped with sample probes and located in the exhaust stack continuously monitor and sample the exhaust air. An alarm is sounded locally if alpha or beta-gamma monitoring capabilities are lost.

A pressure gauge installed on the intake exhaust duct measures the annulus air pressure relative to ambient atmospheric pressure. Differential pressure indicators installed in the HEPA filter banks provide pressure drop data banks. High differential pressure across the prefilter and the first of two HEPA filters in each bank sound an alarm in the 244-BX Instrument Building and the 241-BY-254 Building. Low differential pressure across the final HEPA filter in each bank automatically shuts down the exhaust fan and sounds a local alarm and an alarm at the 242-A Evaporator. A pressure indicator monitors airflow through the stack and stack sampler.

- **244-CR DCRT**—The 244-CR Vault ventilation comprises an ambient air supply with air directed and controlled through the vault and tanks by operation of the 244-CR Vault ventilation. The 244-CR Vault ventilation system comprises air filtration system and active ventilation exhaust system. The 244-CR Vault is divided into upper and lower sections. The upper section is considered the pump pit and riser pit areas, and the lower or "vault" section houses the primary tanks, which are separated from the vault by annular spaces. The upper and lower vault sections are connected by exhaust ports and a floor drain which allows airflow between the two sections. Air is removed from the lower vault section at the floor level and routed into a filter plenum. The 244-CR Vault ventilation system also removes air directly from the tanks and routes it to this common filter plenum. The air is then treated by a double bank of HEPA filters prior to being discharged to the environment through the monitored 296-C-5 exhaust stack. Alarm panels are located in the 271-CR control room.

- **244-S DCRT**—The equipment configuration of the ventilation system for 244-S DCRT is identical to the ventilation system for 244-A DCRT with the exception that the 244-S DCRT instrument readout is located in the 244-S DCRT Instrument Building.

- **244-TX DCRT**—The ventilation system for 244-TX DCRT is identical to the ventilation system for 244-BX DCRT. Alarm panels associated with 244-TX DCRT are located in the 244-TX Building and 242-T Evaporator control room.

- **244-U DCRT**—The ventilation system in the 244-U DCRT is identical to 244-BX DCRT. The instrument readout and alarm panels associated with the 244-U DCRT are located in the 244-U Instrument Building and the 241-U-271 control room.

Shared Ventilation Systems. The following two catch tanks have shared ventilation systems:

- **241-AX-152 Catch Tank**—The 241-AX-152 catch tank is connected to the 241-A-702 Primary Ventilation System (Section 2.4.3.7.1) by means of a ventilation line.

Passive Ventilation Systems. The ventilation systems for the following catch tanks and DCRTs consist of a breather filter similar to the breather filter assemblies on SSTs (described in Section 2.4.1.5.2):

- 241-EW-151
- 241-S-304.

The following catch tanks have no ventilation system or breather filter and are indirectly ventilated through waste transfer lines:

- 241-AZ-151
- 241-AZ-154
- 241-A-350.

2.4.5.1.2 Specific Systems and Structures of Catch Tanks. Catch tanks are underground storage tanks used to collect waste drained from waste transfer systems and DST equipment. The four basic catch tank designs are (1) direct buried, concrete; (2) direct buried, steel; (3) steel tanks contained in a vault or pit; and (4) concrete vaults with steel liner. The first three designs are shown in Figures 2-26 and 2-27. The active catch tanks and their dimensions and other attributes are listed in Tables 2-12, 2-13, and 2-14.

Catch tanks can be pumped to a DST via a diversion box through an underground pump-out line. In most instances, a submersible pump is installed in the catch tank to remove liquid; however, in some instances, water jets are also used. When necessary, catch tanks are pumped out by using aboveground lines and a tank truck. With the exception of 241-U-301B, all catch tanks are connected to a diversion box via a permanent, underground pump-out line.

200 East Area Catch Tanks. The catch tanks located in the 200 East Area are described in the following paragraphs:

- **241-A-302A Catch Tank**—This 31,940-L (8,438-gal) catch tank is a horizontal cylindrical vessel. A pump pit is located above the tank, which is approximately 5.2 m (17 ft) belowgrade and rests on a sand bed.

- **241-A-350 Catch Tank**—The 241-A-350 lift station is located southeast of Tank 241-A-106 in the 241-A Tank Farm. The lift station has a pump pit over a caisson or vault that contains the catch tank 241-A-350 (Figure 2-28). The 2,940-L (776-gal) catch tank receives drainage from the 241-A-A and 241-A-B valve pits . A waste transfer pump is contained within Tank 241-A-350, providing the capability to pump the tank's contents through an encased line. The sump within this lift station also contains one pump that pumps sump liquid back to Tank 241-A-350.

- **241-A-417 Catch Tank**—This 167,315-L (44,200-gal) catch tank is a cylindrical concrete vault with an all-welded steel liner that extends to within 127 mm (5 in.) of the vault roof. Above the catch tank are a rectangular pump pit and a rectangular valve pit. The vault/catch tank is approximately 4.3 m (14 ft) belowgrade.

- **241-AX-152 Catch Tank**—This 41,640-L (11,000-gal) catch tank, which is constructed of reinforced concrete and stainless steel-lined walls, is approximately 5.2 m (17 ft) belowgrade. Above the catch tank are a rectangular pump pit and a rectangular diverter pit. This catch tank is connected to diverter station 241-AX-152 and equipped with a water jet for moving accumulated waste solutions to an underground storage tank.

- **241-AZ-151 Catch Tank**—This 45,046-L (11,900-gal) catch tank, which consists of a pump pit on top of a catch tank, is buried approximately 5.2 m (17 ft) belowgrade. The 241-AZ-151 catch tank is L-shaped. All inside surfaces of the catch tank are lined with American Society for Testing and Materials A569, 10-gauge steel. This catch tank is connected to diversion box 241-AZ-152.

- **241-AZ-154 Catch Tank (out of service)**—This 3,290-L (869-gal) catch tank consists of a pump pit equipped with a pump and located on top of a steel-lined, reinforced-concrete catch tank. The catch tank is 3.4 m (11 ft) belowgrade and is connected to 241-AZ-101 and 241-AZ-102.

- **241-ER-311 Catch Tank**—This 66,934-L (17,682-gal) catch tank consists of a horizontal, cylindrical carbon steel vessel; a steam jet box resting on the tank, and a pump pit above the tank. The catch tank is 6.1 m (20 ft) belowgrade and rests on a sand bed. The catch tank is connected to diversion boxes 241-ER-151 and 241-ER-152. Catch tank 241-ER-311 can be pumped out by means of an

unencased line buried directly in the soil (direct-buried line) to diversion box 241-ER-151.

200 West Area Catch Tanks. The catch tanks located in the 200 West Area are described in the following paragraphs:

- **241-S-304 Catch Tank**—This 23,850-L (6,300-gal) catch tank, which consists of a pump pit on top of a vertically positioned steel tank, is 7.9 m (26 ft) belowgrade. The catch tank is connected to diversion box 241-S-151.

- **241-TX-302C Catch Tank**—This 66,930-L (17,681-gal) catch tank, which consists of a horizontal cylindrical vessel, a steam jet box resting on the tank, and a pump pit above the tank, is approximately 8.8 m (29 ft) belowgrade and rests on a sand bed. This catch tank is connected to the 241-TX-154 diversion box. Catch tank 241-TX-302C can be pumped out via a direct-buried line to the diversion box.

- **241-U-301B Catch Tank**—The 241-U-301B structure consists of a 133,530-L (35,275-gal) catch tank and a pump pit directly above the catch tank, which is approximately 1.8 m (6 ft) belowgrade. The catch tank is an unlined, reinforced concrete tank connected to diversion boxes 241-U-151 and 241-U-152. This catch tank can be pumped out by means of a direct-buried line to the 244-U DCRT or through an aboveground line and tank truck.

- **241-UX-302A Catch Tank**—This 66,934-L (17,682-gal) catch tank is connected to diversion box 241-UX-154. A pump pit is located above the tank, which is approximately 6.1 m (20 ft) belowgrade and rests on a sand bed. Catch tank 241-UX-302A is located near the 241-UX-154 diversion box and can be pumped out via a direct-buried line to the diversion box.

600 Area Catch Tank. The catch tank located in the 600 Area is described in the following paragraph:

- **241-EW-151 Catch Tank**—A 2,940-L (776-gal) catch tank is provided to collect liquids that might enter the cross-site transfer vent lines. The catch tank and sump overflow to the cross-site transfer pipeline encasement and then drain to the catch tanks in 241-UX-154 and 241-ER-151. One transfer pump is provided in catch tank 241-EW-151 so that liquids can be transferred from the catch tank.

2.4.5.1.3 Specific Systems and Structures of Double-Contained Receiver Tanks. A DCRT, together with its related equipment, may function as an interim short-term storage facility for liquid wastes pumped from other storage sites or facilities or a valve pit to route wastes. A DCRT typically consists of an underground concrete structure that contains a filter pit, pump pit, instrument pit, flush pit, and vault in which a receiver tank is installed. The active DCRTs are depicted in Figure 2-29 and listed in Table 2-15.

200 East Area Double-Contained Receiver Tanks. The DCRTs located in the 200 East Area are described in the following paragraphs:

- **244-A DCRT**—The 244-A DCRT is located west of the 241-AN Tank Farm. The 244-A DCRT is similar in design to the 244-S DCRT. The DCRT consists of an underground concrete structure that contains a filter pit, a pump pit, and a vault. The vertically mounted carbon steel receiver tank is located in a steel-lined vault and has a total capacity of 61,627 L (16,280 gal).

  The 244-A DCRT is located at a low point in the transfer system. A transfer pump is used to "lift" the transferred liquids. One waste transfer pump is located inside the receiver tank (TK-244-A). This DCRT is an intermediate facility between diversion box 241-ER-153 and valve pits 241-A-A and 241-A-B.

- **244-BX DCRT**—The 244-BX DCRT is located east of Tank 241-BX-102 within the 241-BX Tank Farm. The rectangular 244-BX DCRT catch station is fabricated of reinforced concrete. The DCRT catch station consists of a tank vault, a pump pit, instrument pit, flush pit, and a filter pit (Figure 2-29). An instrument building is adjacent to the 244-BX DCRT. The top of the vault is closed with cover blocks that are removed to allow access to the pump and filter pits.

  The 117,350-L (31,000-gal) horizontal receiver tank (TK-244-BX) is located in the tank vault. A waste transfer pump is located inside the receiver tank, and a pump can be located in the vault sump. The 244-BX DCRT is connected to the 241-B, 241-BX, and 241-BY Tank Farms.

- **244-CR DCRT**—The 244-CR vault is located south of the 241-C Tank Farm. The 56,781-L (15,000-gal), 347-type stainless steel receiver tank (244-CR-003) is used for short-term storage of salt well waste from the 241-C Tank Farm. The 244-CR vault is a two-level, multicell structure constructed belowgrade. The lower cell contains the process tanks and the upper cells contain piping and equipment. The vault structure is covered by concrete cover blocks that are removed to permit access to the piping and equipment cells. One waste transfer pump is located inside Tank 244-CR-003. Tanks 244-CR-001 (151,400 L [40,000 gal]), 244-CR-002 (56,781 L [15,000 gal]), and 244-CR-011 (151,400 L [40,000 gal]), which are internal to the vault, are inactive.

200 West Area Double-Contained Receiver Tanks. The DCRTs located in the 200 West Area are described in the following paragraphs, and a summary list is provided in Table 2-15:

- **244-S DCRT**—The 244-S DCRT is located south of the 241-SY Tank Farm and east of 13th Street. The tank vault, which contains the 76,768-L (20,280-gal) 244-S receiver tank (mounted vertically), is lined and separated from the pump pit

above by a concrete slab perforated to permit piping and personnel access and supported on steel beams. Surface structures above the 244-S DCRT include a flush pit and building, an instrument building, an exhaust unit CAM enclosure, an annulus unit CAM enclosure, and an air intake structure.

Waste transfer pumps can be installed within the 244-S DCRT to remove waste from the receiver tank and vault sump. This tank is connected to the cross-site transfer system and to the 241-S, 241-SX, and 241-SY Tank Farms.

- **244-TX DCRT**—The 244-TX DCRT is located north of the single-shell 241-TX Tank Farm. The rectangular 117,350-L (31,000-gal) 244-TX DCRT facility is fabricated of reinforced concrete and consists of a tank vault, a pump pit, and filter pit. The top of the vault is closed with cover blocks that are removed to allow access to the pump, instrument, flush, and filter pits. The horizontally mounted 244-TX receiver tank is fabricated of carbon steel and is located in the tank vault.

  Unlike other DCRTs, the 244-TX receiver tank is equipped with high-pressure turbine pumps to sluice and agitate the waste. These pumps keep solids suspended in the tank when plutonium-bearing waste from the Plutonium Finishing Plant is handled. In addition, three neutron monitors located beneath the tank detect plutonium buildup.

  Waste transfer pumps can be installed within the 244-TX DCRT to remove waste from the receiver tank and vault sump. Waste can be transferred from the 244-TX DCRT to the 241-SY Tank Farm via the 244-S DCRT. Waste within the 244-TX DCRT is routed through the 241-TX-152 diversion box to the 241-U-152, 241-U-151, and 241-S-151 diversion boxes. Piping enables direct routing of the waste from the 241-U-151 diversion box to the 244-S DCRT.

- **244-U DCRT**—The 117,350-L (31,000-gal) 244-U DCRT is located southeast of Tank 241-U-110 in the 241-U Tank Farm. The 244-U DCRT was constructed in 1978 and is currently being put into service to receive salt well interstitial liquid from tanks at the 241-U Tank Farm and catch tank 241-U-301B. The 244-U DCRT is located in a tank vault.

  Waste transfer pumps are provided in the receiver tank and the vault sump. Contents of 244-U DCRT can be routed to any of the 241-SY tanks through supernatant lines and valve pit 241-SY-B.

2.4.5.2 Miscellaneous Inactive Storage Facilities. The miscellaneous inactive storage facilities may contain low- or high-level radioactive wastes or nonradioactive materials and may be located belowground or aboveground. The inactive miscellaneous underground storage facilities are typically tanks buried directly in the ground or within vaults. These tanks contain both radioactively contaminated (Section 2.4.5.2.1) and nonradioactively contaminated

(Section 2.4.5.2.2) waste. The miscellaneous inactive storage facilities include nonradioactively contaminated active underground storage tanks. These tanks, buried or within facilities, are clearly posted to identify the hazard present and to prevent intrusion. The inactive miscellaneous aboveground storage facilities are typically tanks located on the surface or contained within inactive TWRS facilities. These tanks include both radioactively contaminated and nonradioactively contaminated (Section 2.4.5.2.3) waste.

2.4.5.2.1 Radioactively Contaminated Inactive Miscellaneous Underground Storage Tanks. A group of 63 small, <189,270 L (<50,000 gal), radioactively contaminated, inactive, and abandoned underground storage tanks are collectively termed the inactive miscellaneous underground storage tanks. These tanks are located throughout the 200 East and 200 West Areas, as shown in Figures 2-30 and 2-31.

Many of these abandoned tanks are buried directly in the ground; others are installed in underground vaults. Many of the tanks contain sludge and process materials. These inactive miscellaneous underground storage tanks were not designed, nor are they used, for high-level waste storage.

The tanks have been administratively divided among TWRS (36 tanks), the U.S. Department of Energy Environmental Restoration Project (24 tanks), the Plutonium Finishing Plant (1 tank), and T Plant (2 tanks) (WHC-SD-WM-PD-046, *Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tanks Program Plan*, and WHC-EP-0861, *Status Report for Inactive Miscellaneous Underground Storage Tanks at Hanford Site 200 Areas*).

Of the inactive miscellaneous underground storage tanks under TWRS control, 14 are located in the 200 East Area and 23 in the 200 West Area. All 37 tanks are listed in Table 2-16.

2.4.5.2.2 Nonradioactively Contaminated Inactive/Active Miscellaneous Underground Storage Tanks. Waste in the nonradioactively contaminated inactive underground storage tanks is not fully characterized. The nonradioactively contaminated tanks include, for example, chemical addition, fuel storage tanks, and septic tanks. Table 2-17 identifies active nonradioactively contaminated underground storage tanks. These active tanks and the contents are representative of nonradioactively contaminated inactive underground storage tanks.

2.4.5.2.3 Radioactively and Nonradioactively Contaminated Inactive Miscellaneous Aboveground Storage Tanks. No radioactively contaminated inactive aboveground storage tanks have been identified (WHC-SD-WM-HIE-007). The inactive miscellaneous aboveground nonradioactive storage facilities are similar to tanks found in industry. Waste in the nonradioactively contaminated aboveground tanks is not fully characterized. As documented in WHC-SD-WM-HIE-007, the nonradioactive aboveground tanks were used for chemical addition, fuel storage, sodium storage, and air receivers. These tanks are located in or in close proximity to a tank farm or located within inactive TWRS facilities.

2.4.6 204-AR Waste Unloading Facility

The 204-AR Waste Unloading Facility, located south of the 244-AR Vault and west of the 241-AX Tank Farm, permits rail tank cars or tank trailers carrying liquid radioactive waste to be received into a fully enclosed, heated, and ventilated building. This versatile facility not only allows tank cars and tank trailers to be pumped out to a designated 200 East Area tank farm, but also allows chemical adjustment and sluicing of tank cars to remove sludge.

Completed in 1981, the 204-AR Waste Unloading Facility (Figure 2-32) is a reinforced concrete structure approximately 20 m (64 ft) long x 12 m (40 ft) wide x 7.77 m (25.5 ft) high. The facility is divided into three major areas:

- Rail tank car unloading canyon (located on the first floor) containing transfer pumps, process piping, remotely operated valves, and a catch tank (located belowgrade)
- Mechanical equipment room (located on the first floor) containing chemical storage and makeup tanks, motor control center, ventilation system, and fire system
- Control room and personnel facilities (located on the second floor).

The air compressor is located in a small prefabricated steel building (Building 209-A) near the northeast corner of the facility. The following sections provide more details on the major areas of the 204-AR Waste Unloading Facility.

2.4.6.1 First Floor. The first floor of the 204-AR Waste Unloading Facility is approximately 19 m (62 ft) long, 12 m (38 ft) wide, and 7.3 m (24 ft) high (Figure 2-33). The first floor is divided into two process areas: the railcar unloading canyon and the mechanical equipment room.

2.4.6.1.1 Rail Tank Car Unloading Canyon. The shielded rail tank car unloading canyon is approximately 19 m (62 ft) long, 5.5 m (18 ft) wide, and 7.3 m (24 ft) high. The concrete shielding walls are approximately 0.6 m (2 ft) thick at the base and 0.3 m (1 ft) thick at the top. An additional concrete wall, approximately 5.5 m (18 ft) long x 3.7 m (12 ft) high, at the east end of the canyon can shield personnel from the tank car. Three drains in the floor of the canyon are routed to the catch tank. Railcars or tank trailers enter the west end of the canyon through a roll-up door and a pair of hinged doors.

Portable CAMs are located in the tank car unloading area, one on the balcony, and the other on the main floor. These probes, which warn of high radiation fields, are single-channel gamma monitoring units with local readouts as well as audible and visual alarms.

Catch Tank. Tank TK-1 is a 5,678-L (1,500-gal), stainless steel catch tank for temporarily storing process solutions flowing through all drains in the system. The tank is located below floor level of the unloading area in a stainless steel-lined pit. The pit contains a sump and is

covered with a removable steel grating. The catch tank is equipped with liquid-level instrumentation, an overflow line that drains to the sump in the pit, inlet connections for the drain lines and decontamination solution, and a pump-out line. The bottom of the catch tank slopes toward the pump-out line.

The catch tank is vented to the ventilation exhaust plenum through a deentrainer/heater and a single-stage HEPA filter. A hydraulically driven sluicer removes solids from the interior of the catch tank, thereby minimizing the accumulation of radionuclides.

Liquids from the catch tank are periodically pumped to the tank farm on a batch basis by either pump P1-A or P1-B. Any liquid in excess of tank capacity overflows into the pit sump. The catch tank is equipped with a high-liquid-level alarm that annunciates in the control room. The alarm is wired to close motor-operated valves to prevent process liquid from flowing into the catch tank. The sump in the pit has a leak detector and a pump-out line to the 241-A-A Valve Pit.

Transfer Pumps P1-A and P1-B. Two identical, self-priming pumps are located at the east end of the rail tank car unloading canyon. Pump design allows either pump to transfer liquids or boost raw water pressure. The P1-A pump normally pumps radioactive liquids from tank cars, tank trailers, the catch tank, and the sump. The P1-B pump raises the raw water pressure to sluicing tank cars.

Either pump can be used to transfer waste from the 204-AR Waste Unloading Facility to a tank farm. A flow recorder/controller on the 204-AR control panel indicates, and permits adjustments to, the flow rate. An ultrasonic flowmeter measures the flow rate of the waste, and a diaphragm-operated valve in the transfer line controls the waste flow.

Raw Water System. A 15.2-cm (6-in.) raw water line and a 5.1-cm (2-in.) raw water line come off the 20.3 cm (8 in.) Hanford Site raw water system and enter the 204-AR Building on the north side. The 5.1-cm (2-in.) line supplies water to the chemical addition tanks for adjusting the composition of the waste before or during a transfer. This line is protected by a reduced pressure backflow preventer (RPB-1) which is located at the wall, north of the chemical addition tanks. The backflow preventer is installed to prevent cross contamination of the Hanford Site raw water system and to meet Washington State Code requirements.

The 15.2-cm (6-in.) line supplies the fire protection suppression system and a 7.6-cm (3-in.) line used for activities such as line flushing, pump priming and sealing, tank sluicing and rinsing, and Unloading Room washdowns. Two reduced pressure backflow preventers, in a series, protect this 7.6-cm (3-in.) line. The first backflow preventer (RPB-2) is located in the Mechanical Equipment Room just west of chemical addition tank #5. This backflow preventer is installed to prevent cross contamination of the Hanford Site raw water system and to meet Washington State Code requirements.

The second device is a Safety-Class, backflow preventer (RPB-3) located in the Waste Unloading Area. This reduced pressure backflow preventer is installed to further reduce the

chance of cross contamination of the raw water supply and to help prevent a spray leak or pool accident from occurring in the Mechanical Equipment Room during internal or external transfers. This Backflow preventer is not installed to meet Washington State Code requirements. A backflow prevention system or physically disconnecting raw water or other service systems precludes contamination of these systems and the potential for a spray source in the Mechanical Equipment Room. Any other system (e.g., chemical addition, sampling, or tanker sluicing system) that has a backflow potential must have a backflow prevention system installed or be physically disconnected during internal and external transfers.

To mitigate the consequences of a spray leak or pool accident in the Waste Unloading Area during a backflow condition, the west rollup and personnel access doors must be closed during internal and external transfers.

2.4.6.1.2 Mechanical Equipment Room. The mechanical equipment room, located on the north side of the unloading canyon, is approximately 18 m (58 ft) long, 6.1 m (20 ft) wide, and 3 m (10 ft) high and has two floor drains connected to the catch tank. The equipment located in this room includes the chemical makeup system; motor control center; heating, ventilation, and air conditioning (HVAC) equipment; and fire protection. Two doors on the north side of the Mechanical Equipment Room lead directly to the outside.

Chemical Makeup System. When the composition of waste in the tank car or the catch tank does not meet tank farm acceptance specifications, chemical adjustment solutions are prepared in the chemical makeup system. The required volume of adjustment solution is metered into the tank car pump-out line during transfer.

An inline mixer system enables the receipt of liquid waste with a solution pH as low as 7. Inline chemical adjustment is the only method used for adjusting the contents of tank trailers. The inline mixer system provides a means for pumping out the low pH waste and mixing it with a required nitrite or caustic solution in the pump-out line to reduce the problem of precipitating solids. Two positive displacement metering pumps, P5-A and P5-B (in parallel), feed the necessary nitrite or caustic additive to the mixing device.

The four storage/makeup tanks are used for various solutions:

- **Tank 2, Nitrite Solution (TK-2)**—This 1,893-L (500-gal) carbon steel tank is used to make up sodium nitrite solutions. TK-2 equipment includes drain and overflow lines to the catch tank, a steam heating coil (out of service), a weight factor liquid-level sensing system, a raw water supply line, a chemical addition port, and an agitator. Chemicals can be pumped into the tank car or catch tank by using pump P-3. Pumps P5-A and P5-B can pump chemicals from TK-2 into the 102-mm (4-in.) pump-out line.

- **Tank 3, Dilute Caustic Solution (TK-3)**—This 1,893-L (500-gal) stainless-steel tank is used to make up dilute caustic solutions. TK-3 equipment includes drain and overflow lines to the catch tank, a steam heating coil, a weight factor liquid-

level sensing system, a raw water supply line, a chemical addition port, and an agitator. Chemicals can be received from TK-5 by using pump P-4 and routed to the tank car or catch tank by using pump P-3. Pumps P5-A and P5-B can pump chemicals from TK-3 into the 102-mm (4-in.) pump-out line.

- **Tank 4, High pH Buffer Solution (TK-4) (out of service)**—This 757-L (200-gal) stainless steel tank was used to make up a high pH buffer solution for pH probe (out of service) calibration. TK-4 equipment includes drain and overflow lines to the catch tank, a weight factor liquid-level sensing system, a raw water supply line, a chemical addition port, and an agitator. Buffer solution was routed to the pH probe cavity by using either pump P5-A or pump P5-B.

- **Tank 5, 50% Caustic Solution (TK-5) (out of service)**—This 6,814-L (1,800-gal) carbon steel tank receives 50% sodium hydroxide solution delivered by tank truck. The fill pipe for TK-5 penetrates the 204-AR Waste Unloading Facility wall and terminates outside the building next to a platform provided for the tank truck. A pump mounted on the tank truck transfers the caustic solution to TK-5. From TK-5, chemicals can be transferred either (1) to TK-2 by using pump P-4 or (2) directly to the catch tank or tank car by using pump P-3. Pumps can also be used to transfer liquid from TK-5 to the 102-mm (4-in.) pump-out line. TK-5 equipment includes drain and overflow lines to the catch tank, a steam heating coil (out of service), and a weight factor liquid-level sensing system.

Chemicals are added to TK-2, TK-3, and TK-4 in the mechanical equipment room.

Motor Control Center. The motor control center is located at the west end of the mechanical equipment room. Agitator controls for the chemical makeup system, pump controls, and power controls are mounted on the control panels.

Heating, Ventilation, and Air Conditioning Equipment. The HVAC equipment located in the mechanical equipment room includes the main exhaust duct work, exhaust fan, and final stage of HEPA filters. The duct work also houses the demisters, heaters, and exhaust dampers.

Fire Protection. Heat and smoke detectors, as well as a sprinkler system, are installed throughout the 204-AR Waste Unloading Facility. A radio fire alarm master box, control panel, and supervisory annunciator panel are located at the building exit that is at the southeast end of the facility. One inlet line supplies raw water for use in the mechanical equipment room and other similar demands. Another inlet line supplies raw water for use in the fire protection system for the facility, in the sluicing system for the tank car unloading canyon, and in pump shaft seals for the P-1A and P-1B pumps. A backflow preventer in each raw water supply line prevents accidental contamination of the raw water system.

Raw Water System. The raw water system is routed into the Mechanical Equipment room via two separate water lines. One line supplies water to the chemical addition tanks for adjusting the

composition of the waste before or during a transfer. The second raw water line supplies water for the fire protection system and is used to support activities such as line flushes, pump priming and sealing, tank sluicing and rinsing, and Unloading Room washdowns.

The non-safety related backflow prevention system, located in the Mechanical Equipment Room, is used to prevent accidental chemical contamination of the raw water systems. The Safety-Class backflow prevention system, located in the Unloading Room, is used to prevent a potential spray leak or pool from occurring in the Mechanical Equipment Room during internal or external transfers.

2.4.6.2 Second Floor. The second floor contains the control room and administrative areas. The administrative areas include a soiled clothes room and its airlock, toilets, and a locker room (Figure 2-33).

The control room, located on the east end of the second floor, is shielded from the rail tank car unloading canyon by approximately 0.3-m- (1-ft-) thick concrete shield walls that contain a lead glass window for viewing tank unloading operations. The control room contains a main control panel and an auxiliary panel. The main control panel contains instrumentation to monitor pump pressures, drain valve operations, leak detection, and radiation levels (204-AR stack, soiled clothes room, and railcar unloading canyon).

The auxiliary panel contains audible and visible alarms for the following process and monitoring variables:

- Radiation monitors—High radiation or monitor failure
- Catch tank level—High and low
- Leak detection—Catch tank sump level, transfer line
- Flow rates—Low flow to tank farms
- Door position—Outer and inner doors to canyon
- HEPA filter differential pressures.

2.4.6.3 Ventilation Systems. Three ventilation systems within the 204-AR Waste Unloading Facility service the personnel area, the radiation zone, and the mechanical equipment room. The personnel area ventilation system operates at positive pressure. This system provides air to the control room, locker room, toilet, and soiled clothes room. Most of the air supplied to the control room is recirculated. The air not recirculated is exhausted through the soiled clothes room or the toilet exhaust systems.

The radiation zone exhaust system operates at a negative air pressure and draws air from the canyon area, soiled clothes room, and catch tank. The fan is located in the mechanical equipment room and discharges air through the roof ventilator. The canyon area exhaust air is filtered through parallel roughing and HEPA filter banks (Table 2-18), through a second or final HEPA filter bank located in the mechanical equipment room, and then through the main duct work before being exhausted to the environment through a stack. Record air samplers collect particulate matter on filter paper at the exhaust stack.

The catch tank exhaust system consists of a moisture separator, heater, and HEPA filter and associated duct work. The catch tank duct work is connected to the main duct work just upstream of the final HEPA filter bank. The soiled clothes exhaust system duct work is also connected to the main exhaust duct work just upstream of the final HEPA filter bank. A water spray fire protection system suppresses fires upstream of the HEPA filters.

The mechanical equipment room is not connected to the radiation zone exhaust system. The mechanical equipment room exhaust system consists of a wall-mounted exhaust fan operated on a demand basis and only when the radiation zone exhaust system is operable.

2.4.6.4 Radiation Monitoring Systems. The 204-AR Waste Unloading Facility is equipped with radiation monitoring systems in accordance with the requirements of the Radiological Protection Program described in Chapter 7.0. The personnel sampling and monitoring equipment is as required in WHC-SD-SQA-TA-20011, *Technical Assessment of Workplace Air Sampling Requirements at the Tank Farm Facilities*. These systems may include record air samplers and CAMs.

Record air samplers collect particulate matter on filter paper at three 204-AR Waste Unloading Facility locations: the tank car unloading room balcony, control room, and exhaust stack.

CAMs monitor and record beta-gamma activity in the airflow through the tank car/tank trailer unloading area, mechanical equipment room, control room, and exhaust stack. Audible and visual alarms annunciate at the CAMs and in the 204-AR Control Room. A multipen recorder on the auxiliary panel in the 204-AR Control Room records CAM levels for the exhaust stack and unloading area.

The exhaust stack monitoring system consists of a fixed record air sampler in addition to a CAM. The CAM measures particulate emissions from the stack through isokinetic probes mounted in the stack.

2.4.7 244-AR Vault

The 244-AR Vault, located north and west of 241-A Tank Farm in the 200 East Area, was constructed in 1966. The vault was designed to receive, treat, and transfer PUREX Facility tank farm sludges to 221-B Plant for fission product removal; provide interim storage for PUREX Facility acid waste feed to 221-B Plant; and receive and distribute the neutralized high-level waste of 221-B Plant. The 244-AR Vault is being cleaned and readied for decontamination and decommissioning. Therefore, this facility description addresses only the following major structures and components:

- Canyon building and process cells
- Ventilation systems
- Control rooms.

2.4.7.1 Canyon Building and Process Cells. The canyon building is a reinforced concrete structure with 0.5-m- (1.5-ft-) thick walls. The canyon building measures 29 m (94 ft) by 5.5 m (18 ft) internally and is 11 m (36 ft) high above the process cell concrete cover blocks on the canyon floor. The cover blocks, which separate the process cells from the canyon, are 1.5 m (5 ft) thick and have recessed lifting bails. The process cells house the process vessels and associated equipment. The canyon building also contains two shielded personnel access doors and a large, shielded motor-driven equipment access door that slides on a monorail. A metal wind-reduction facility is attached to the east end of the building for weather protection when the equipment-access doors are open.

Three process cells and a failed equipment storage cell are located below the canyon (Figures 2-34 and 2-35). Each of the three process cells contains sumps with an intercell sump overflow. Cells 1 and 2 have identical inside dimensions, 6.4 m (21 ft) square x 9.98 m (32.75 ft) deep. Cell 3 is 9.8 m (32 ft) long x 3.7 m (12 ft) wide x 6.4 m (21 ft) deep. The concrete cell walls are 0.6 m (2 ft) thick.

Cell 1 (Figure 2-35) is located between cell 2 and the failed equipment storage area at the east end of the vault. Each of the concrete cell walls is 0.6 m (2 ft) thick. Cell 1 contains Tank 244-AR TK-001, a sump jet, wall nozzles, permanent piping, instrumentation, and a cell spray system.

Tank 244-AR TK-001, the primary storage tank for neutralized current acid waste (high-level first-cycle solvent extraction waste from the PUREX Facility), is located in cell 1 of the 244-AR Vault and is constructed of 9.53-mm- (0.375-in.-) thick, Type 304L stainless steel plate. The flat-bottomed, 163,333-L (43,148-gal) tank is 6.1 m (20 ft) in diameter and 6.02 m (19.75 ft) high. The tank is equipped with upper and lower cooling coils, a transfer pump, a transfer jet, an agitator, spray rings, a purge air system, a sampler, vessel vent and chemical addition lines, instrumentation, and three spare tank nozzles.

Cell 2 (Figure 2-35) is located between cells 1 and 3 of the canyon building. Cell 2 contains Tank 244-AR TK-002, a sump jet, wall nozzles, permanent piping, instrumentation, a cell spray system, and radiation monitoring equipment.

Tank 244-AR TK-002 is constructed of 9.53-mm- (0.375-in.-) thick, Type 304L stainless steel plate. The flat-bottomed, 164,431-L (43,438-gal) tank is 6.1 m (20 ft) in diameter and 6.02 m (19.75 ft) high. The tank is equipped with upper and lower dual service (heating and cooling) coils, a transfer pump, a sluice pump, a transfer jet, an agitator, spray rings, a purge air system, a sampler, vessel vent and chemical addition lines, a radiation monitoring dry well, instrumentation, three spare tank nozzles, and a spare permanent piping line.

Cell 3 (Figure 2-35) is located on the west end of the canyon building and contains Tanks 244-AR TK-003 and 244-AR TK-004, a sump jet, wall nozzles, permanent piping, instrumentation, a cell spray system, and radiation monitoring equipment.

Tanks 244-AR TK-003 and 244-AR TK-004 are constructed of 13-mm- (0.5-in.-) thick, Type 18-8Cb, stainless steel plate. The slope-bottomed, 18,143-L (4,793-gal) tanks are 2.9 m (9.5 ft) in diameter and 2.7 m (9 ft) high. Each tank is equipped with a cooling coil, two transfer jets, a transfer pump, an agitator, a spray ring, a purge air system, a sampler, vessel ventilation and chemical addition lines, instrumentation, and three spare tank nozzles.

The failed equipment storage area is located next to cell 1 in the east end of the canyon building. This storage area contains three storage tubes, each constructed of 1.4-m- (4.5-ft-) dia, 12-gauge, corrugated, galvanized pipe, that extend 11 m (35 ft) below the failed equipment storage area cover blocks. Each of the storage tubes discharges to the cell 1 floor. The storage tubes are vented to cell 1 through 152-mm- (6-in.-) dia vent pipes located 6.7 m (22 ft) above the storage tube bottom. The storage tubes are covered with a 0.6-m- (2-ft-) thick reinforced concrete block.

2.4.7.2 Ventilation Systems. Four ventilation systems service the 244-AR Vault:

- Control room ventilation system, K-1
- Canyon intake ventilation system, K-2
- Canyon exhaust ventilation system, K-3
- Tank ventilation system, K-4.

These systems are not currently operable, and significant modifications or upgrades would be required to return these systems to service. The facility process area is passively ventilated to the building. A summary of the 244-AR Vault ventilation systems, as designed, is provided in Table 2-19.

2.4.7.3 Control Rooms. The control room contains controls or instrumentation required to operate the 244-AR Vault. The room is 10 m (34 ft) long, 6.86 m (22.5 ft) wide, and is divided into several localized equipment areas. These areas are the jet gang valve stations, steam control station, HVAC instrument panel, transmitter and converter racks, process instrument panels, hydrogen purge air control station, switch gear and motor control centers, and crane control room. (Steam lines to the steam control station are valved out; therefore, the station is out of service.)

2.4.8 Cribs, Ditches, and Ponds

Those cribs currently owned or operated by TWRS are shown in Table 2-20. All cribs, ditches, and ponds used or operated by TWRS are identified graphically in Figure 2-3 and are discussed in the following sections. These areas are posted as radiation or contamination areas (see Section 7.6.2.3 for area definitions) to prevent intrusion.

2.4.8.1 Cribs. A crib is defined as a subsurface liquid distribution system. The primary function of a crib at TWRS was to dispose of liquid effluents so that low-level radionuclides (if any) were absorbed and held in the soil beneath the crib.

Crib designs vary widely but the function of all designs is the same. A typical crib design is shown in Figure 2-36. Most cribs consist of gravel-filled trenches, 3.0 to 4.6 m (10 to 15 ft) deep, approximately 3 m (10 ft) wide at the bottom, with the sides sloping out toward the top. The bottom third to half of the crib is filled with coarse gravel to provide a large volume of pore space between the individual rocks.

For many cribs a vapor barrier (typically plastic) on top of the gravel is covered by original soil material. Liquid-level risers are constructed into the gravel to allow measurement of effluent levels in the crib. Level readings are taken by using an insulated calibrated wire (zip cord) and a direct current meter, a sonic ullage gauge, or a liquid-level gauge.

2.4.8.2 Ditches and Ponds. Wastewater generated from operating facilities within the exclusion areas of the 200 East and 200 West Areas can be discharged to B Pond, which consists of the following lobes: 216-B-3, 216-B-3A, and 216-B-3B, which are currently inactive, and 216-B-3C, which is currently active. A contingency pond (216-E-28) is located northwest of B Pond and east of 200 East Area and consists of three lobes. Each 216-E-28 lobe is equipped with liquid-level stakes, a flow control structure, and a flowmeter. Ditches (which are gravel lined) and pipelines (used for transporting water to the ponds) may be equipped with valves for regulating or adjusting the flow.

2.4.9 Storage and Handling Areas for Contaminated Equipment and Materials

TWRS facilities or areas for storage or handling of contaminated equipment and materials include the 209-E Complex, vertical storage units, the 213-W Building, and the 2727-W Sodium Storage Facility. These facilities and areas are discussed in the following sections.

2.4.9.1 209-E Complex. The 209-E Complex is located north of the PUREX Facility in the 200 East Area. What is referred to in this FSAR as the 209-E Storage Area consists of a less than 90-day waste storage pad for hazardous and mixed wastes and an Intermediate Holding Area for low-level radioactive wastes. The 209-E Complex also contains the inactive Critical Mass Laboratory which is not included in this FSAR. Offices that are part of the Critical Mass Laboratory house administrative support personnel who operate the less than 90-day waste storage pad and the Intermediate Holding Area.

The less than 90-day waste storage pad is a 12- x 18-m (40- x 60-ft) covered and fenced concrete pad used for the temporary accumulation of solid and liquid hazardous waste and contact-handled low-level mixed wastes. Curbs are used on the periphery of the pad to segregate hazardous and mixed waste areas and to provide for spill containment. This area is compliant with the *Resource Conservation and Recovery Act of 1976*.

A variety of wastes and waste forms are stored temporarily at the less than 90-day waste storage pad until they can be transported to a treatment, storage, and disposal facility. Potential hazardous wastes include household-grade and vehicle batteries; transformers containing

polychlorinated biphenyl; ballasts from light fixtures; asbestos; and a variety of solvents, oils, paints, and cleaning materials used in non-radiologically contaminated areas. Mixed wastes include solvents, oils, paints, and cleaning materials used on jobs within radiation zones. Other contributors are equipment and material that have come into contact with tank waste.

The Intermediate Holding Area, which is a staging area for low-level radioactive waste, is west of, and separated from, the less than 90-day waste storage pad. A chain-link fence encloses this open-air storage area of about 233- x 67-m (765- x 220-ft). Low-level radioactive waste at the Intermediate Holding Area includes containerized rags, paper, wood, and metal products that have come into contact with contamination other than tank wastes.

Low-level radioactive wastes from TWRS operations are collected and transported to the Intermediate Holding Area for characterization (weighing, radiation monitoring, assaying). After characterization, most waste containers are staged for transportation to an offsite waste compaction facility. From there, the compacted waste normally is transported to a disposal site but could also be returned to the Intermediate Holding Area for disposal staging. Some waste containers at the Intermediate Holding Area are staged for transport to disposal sites without compaction.

2.4.9.2 Vertical Storage Units. The vertical storage units (most of which are located in the 200 West Area SST farms) were used in the past to store dry, radiologically contaminated equipment or soil. These facilities are now inactive. The vertical storage units are constructed of steel pipes, range from 0.3 to 0.6 m (1 to 2 ft) in diameter, and are approximately 1.8 to 2.1 m (6 to 7 ft) deep; however, some of the vertical storage units may be up to 7.3 m (24 ft) deep. The number and diameter of each vertical storage unit, identified by SST farm, are presented in Table 2-21.

2.4.9.3 213-W Building. The 213-W Building was designed to compact low-level wastes and is referred to as the Dry Waste Compactor Facility. Compaction activities have ceased and will not be resumed. Activities such as contaminated instrument repair take advantage of the controlled environment in the 213-W Building, which is unoccupied except during such activities.

The 213-W Building is a preengineered, self-framing metal structure located near the west boundary of the 200 West Area. The 213-W Building has three rooms with a combined floor space of approximately 79 m^2 (850 ft^2). The rooms, arranged in series, include a personnel entry room separated by an airlock from a work room and a package inspection room with a roll-up garage door. The work room can be maintained at a slight vacuum and ventilated through two HEPA filters to an external, dedicated 8.8-m (29-ft) monitored exhaust stack. (The exhauster has not been operated since 1997.) All rooms are protected by a dry pipe fire suppression system and have personnel doors that open to the outside. Floor drains are connected to an inactive, underground retention tank with a pit access. The 213-W Building is adjacent to 272-WA Building, which contains offices, change rooms, support shops, a garage, and a lunchroom.

2.4.9.4 2727-W Sodium Storage Facility. The 2727-W Sodium Storage Facility houses five horizontally mounted sodium storage tanks in a preengineered, self-framing metal structure located in the south-central part of the 200 West Area approximately 11 m (35 ft) west of a north–south rail spur. Although TWRS owns the facility, it is managed by Solid Waste, which provides oversight, safety surveillance, and maintenance. The insulated tanks have an outside diameter of approximately 4.3 m (14 ft) and a length of 7.16 m (23.5 ft).

The head space of each sodium storage tank contains pressurized nitrogen gas 14 kPa to 69 kPa (2 to 10 lb/in^2 gauge) to preclude oxidation of the sodium. A nitrogen gas pressure monitoring system is connected to each tank through an externally mounted, common weatherproof control panel. The common control panel includes an audible horn, indicating lights, and a strobe light. The 8.5- by 26-m (28- by 84-ft) building encloses one large room with a floor space of approximately 214 m^2 (2,300 ft^2). Features of the building include the following:

- Four gravity-type roof ventilators are located on the ridge line of the roof approximately 6.7 m (22 ft) abovegrade. Personnel doors on each end of the building are louvered for ventilation.

- The metal building is grounded by interconnected, 2.4-m (8-ft) grounding rods in six locations to form a grounding grid. Each internal sodium tank is grounded to the building grounding grid. The external sodium tank pressure control panel and the externally mounted master fire alarm cabinet are independently connected to the building grounding grid.

- No water or steam service is provided and external signs clearly indicate water should not be used to fight fires. No weeds or other combustibles are allowed near the building.

External resistance heaters wrapped around the tanks to melt the sodium are disconnected (i.e., the sodium is solid). An insulating layer of refractory brick held in place by a wire mesh covered with an aluminum sheath surrounds the heaters and tanks.

2.4.10 Waste Transfer Systems

Liquid wastes are transferred to and from tank farm storage and related operational units (e.g., tanks within receiver vaults and evaporators) through a network of buried transfer pipelines, operating equipment, and control or transfer structures (diversion boxes, valve pits, DCRTs, and diverter stations). Liquid wastes are also received from operational facilities (e.g., Plutonium Finishing Plant).

The purpose of transfers is to move liquid waste from one location to another over a planned, established route in response to (1) a loss of tank integrity, (2) processing requirements, and (3) changing storage needs. Liquid waste generated in the 200 East and 200 West Areas is

transferred through the network of pipelines both to and from the underground storage tanks, vaults, and the 242-A Evaporator. Types of internal transfers are as follows:

- From tank farms to 242-A Evaporator
- Cross-site
- Between process facilities and tank farms
- Farm to farm
- Within a farm
- Catch tank to storage tank
- Condensate collection tank to storage tank.

Transfers are made over both dedicated and nondedicated routes. Dedicated routes are not interconnected to tanks or facilities and as such have no potential for misroutings, and do not require valving or jumper changes. Therefore, repetitive transfers are often made through a dedicated route so that jumper placement and valve alignment do not need to be changed. For example, dedicated routes were used in the past for transfers into the 241-AW Tank Farm from the PUREX Facility. Nondedicated waste transfer routes require repositioning of jumpers or realignment of valves. In addition to the underground piping network, the routing equipment at tank farms consists of pumps, valves, rigid piping, and rigid and flexible jumpers. Leak detection instrumentation is located in diversion boxes and process pits.

The components of the active sitewide waste transfer and routing systems related to SST and DST farms are described in this section. The inactive and abandoned systems (including identified and unidentified systems) will be evaluated when found or during decontamination and decommissioning activities.

2.4.10.1 Transfer Pipelines and Jumpers. Waste is transferred from a sending facility or tank to a receiving tank through existing underground piping or temporary overground piping. Transfer pipelines are identified and categorized on the basis of the material transferred. The categories are as follows:

- **Process Lines**—Pipelines that return waste from the leak detection pit or annulus pump pit to a central pump pit. (Process piping is also a general term used for pipelines between processing facilities and a tank farm.)

- **Supernatant Lines**—Pipelines that transfer liquid waste between tanks or processing facilities.

- **Slurry Lines**—Pipelines that transfer liquid-solid slurries between tanks or processing facilities.

- **Sluice Lines**—To support WRSS (Addendum 1).

All active transfer lines in the 200 East and 200 West Areas, including the cross-site transfer line, are identified in Table 2-22. The known inactive transfer lines are identified in Table 2-23.

Jumpers are rigid or flexible sections of piping used to connect transfer lines during transfers using nondedicated routes. Jumpers are removed and installed in diversion boxes or other pits.

2.4.10.1.1 Waste Transfer Lines. The primary pipe used in waste transfer lines is carbon or stainless steel, as detailed in WHC-SD-TWR-RPT-002. Waste transfer lines used at the Hanford Site are of three general types:

- Encased piping
- Direct-buried piping
- Overground piping.

The term "encased piping" indicates that the primary transfer line is completely enclosed within a secondary confinement barrier. The secondary confinement barrier is usually a larger pipe (newer designs), concrete jacket (older designs), or a pipe trench. The term "direct-buried piping" indicates that the piping is not encased and is buried directly in the soil. The term "overground piping" refers to piping that is not buried.

Encased Piping. To provide secondary confinement, primary encased pipes are encased either in concrete or in a larger, outer pipe (Figure 2-37). Encasements collect liquid leaks from a failed process line and deliver the liquid to a detection point.

The concrete encasement used as secondary confinement consists of a reinforced concrete trough and cover block. The width of the trough depends on the number of primary pipes the trough contains. The cover blocks are either precast and placed on top of the trough or the trough is covered with a steel plate and the concrete is poured in place. The concrete joints are sealed with asphalt and tar.

Features associated with the concrete-encased lines include an earth cover and a series of either test or swab risers or leak detectors. At various locations along the encasement, 51-mm (2-in.) test risers have been provided as shown in Figure 2-37. The test risers consist of 51-mm (2-in.) pipes extending from within the encasement to 1 m (3 ft) above ground level. These test risers are monitored for contamination and moisture using swabs or video cameras. Any leaks inside the primary line collect in the concrete void. An approximate location of a leak can be determined with an absorbent leak detection pad inserted into a test riser.

In the pipe-in-pipe design, a second, larger pipe surrounds the primary pipe or waste transfer line. This pipe-in-pipe design provides better leak confinement than concrete, and the encasement can be pressure tested to ensure its integrity. To prevent settling in the primary pipe resulting from elevation changes, each encasement is equipped with an encasement hydro test riser and a leak detection riser. The pipe-in-pipe encasement drains to a leak detector that alarms if a leak into the encasement occurs. Air purge leak detectors are used in some encased transfer

lines. These systems bleed air through the encasement and detect a leak when the pressure in the encasement increases.

A section of pipe-in-pipe encasement is shown in Figure 2-37. Inside an encasement, one method of supporting the primary pipe is to rest the pipe on a flat bar. This bar is welded to the encasement and primary pipe. In a second method of supporting the primary pipe, two bars are welded axially to the primary pipe only and rest on the inside surface of the encasement pipe. This design allows the primary pipe to expand relative to its encasement. The primary axial supports of the pipe are spaced to eliminate sagging of the primary pipeline.

Some of the underground piping systems are provided with cathodic protection and heat tracing capabilities. The heat tracing system was intended to prevent liquid waste gelling, crystallization, or precipitation in process lines. Unless determined by analysis, the transfer systems are operated without the heat tracing system. New supernatant lines are constructed without a heat tracing system. Some salt well transfer lines, including the jumpers leading to the receiver tank, are heat traced to prevent a temperature drop in the salt well liquor to prevent crystallization.

When buried, the outside of the steel on the secondary or encasement piping is subject to external galvanic corrosion resulting from bacterial and chemical activity in the soil and to galvanic corrosion from dissimilar metals. To minimize and control corrosion, most encasement piping associated with the DSTs in the 200 East Area are currently protected by an impressed-current cathodic protection system.

Associated with each type of encased piping designs are other engineered features to ensure primary line integrity and prevent line blockage. The other engineered features include risers at encased piping end points and cleanout boxes. Risers, which include encasement hydro test risers, leak detection risers, and test risers, are associated with both types of encased lines. Cleanout boxes are associated with only the pipe-in-pipe encasements. In the following paragraphs, the types of risers are discussed and a cleanout box is described:

- **Encasement Hydro Test Risers**—The capped, 13-mm- (0.5-in.-) dia encasement hydro test risers, which are located at the high ends of encasements, allow air to escape from an encasement that is being filled with water for pressure testing. After the pressure check, test water is allowed to flow into a process pit drain.

- **Leak Detection Risers**—The leak detection risers are located at the low end of encased lines entering the tank farms and are designed to contain conductivity probe leak detectors (Section 2.4.11.3). These risers are 38 mm (1.5 in.) in diameter and are divided into a capped riser and a probe riser.

  The capped riser is used to add water during both pressure testing and testing of the leak detection alarm system. The probe riser contains an electrode connected to a leak detection station and alarm system. Leakage into an encasement pipe

flows to the leak detection riser to be contained at the seal loop inside the pit. Opening the seal loop valve allows liquid to flow to the pit floor drain.

The leak detection risers are not used on short, in-farm lines (between pits) where leakage into encasement drains is detected by leak detectors mounted on pit floors (Section 2.4.11.3). These risers, however, are used on lines entering the tank farms from outside pits.

- **Test Risers**—The test risers are located on the low end of encased lines not equipped with leak detection risers. The test risers also are located intermittently along the length of especially long lines (e.g., SL-160 and SN-260). The test risers are fabricated from capped, 51-mm- (2-in.-) dia Schedule 40 pipe. The test risers are used as filling points for hydro testing and can be used as entry points for contamination swab testing or inserting video cameras.

- **Cleanout Boxes**—Slurry transfer lines are subject to plugging from settling solids. The cleanout boxes, shown in Figures 2-38 and 2-39, were installed so that transfer lines could be cleaned if plugs develop. The boxes are positioned approximately every 30.5 m (100 ft) along the slurry transfer lines between evaporator facilities, valve pits, and storage tanks.

Direct-Buried Piping. Direct-buried transfer lines are made of carbon steel, typically 25- to 76-mm- (1- to 3-in.-) dia welded pipe and buried approximately 1 m (3 ft) underground. Direct-buried lines are pressure tested annually. In the past, direct-buried lines were used to transfer process solutions. The use of direct-buried lines in normal transfer service is being discontinued except for occasional use as drain lines or for temporary pumping operations. These lines are insulated to keep dissolved substances from precipitating out and plugging the lines.

Overground Piping. Some of the tanks that require waste transfer do not have any piping or the tank transfer systems have failed (leaked). A temporary overground transfer system has been developed to transfer waste for these tanks. The temporary overground transfer system uses jet or submersible pumps and overground piping with either earth or earth and concrete block pipe protection systems.

The overground system consists of a primary pipe inside a secondary confinement pipe and a pipe protection system (concrete barrier). The primary pipe is a 25-mm- (1-in.-) dia stainless steel-wrapped flexible hose lined with ethylene-propylene-diene monomer. The secondary confinement is a 51-mm- (2-in.-) dia welded, stainless steel pipe. The stainless steel braided tube wrapped around the primary pipe provides abrasion resistance during assembly of the system, and provides reinforcement to minimize the chance of bursting the ethylene-propylene-diene monomer hose. The overground systems are carefully sloped to prevent low spots and to facilitate flushing.

Confinement piping slopes to drain by gravity to each tank pit from approximately the center point of the piping run. Sandbags or other weights are applied to the legs of pipe supports.

When necessary for radiation shielding or to prevent impacts to the overground transfer line, concrete blocks cover all the exposed pipe between tank pit connections. The temporary piping is connected to a waste transfer pump or to existing tank transfer piping.

2.4.10.1.2 Jumper Assemblies. Jumpers are rigid or flexible sections of pipeline used to connect separate nozzles located inside diversion boxes and various types of pits. Nozzles are the termination of waste transfer lines going into diversion boxes and pits. Jumper installation or removal requires removal and replacement of the cover block.

Two types of jumpers (Figure 2-40) are used at the Hanford Site:

- **Rigid jumpers**—stainless or carbon steel pipe is fitted to specific wall nozzle configurations.

- **Flexible jumpers**—braided, stainless or carbon steel, flexible hose permits multiple connections.

The function and design are essentially the same. A flexible jumper can be shaped to fit various configurations, whereas a rigid jumper is designed to fit a specific configuration. The type of head (i.e., connector at end of jumper) used depends on the nozzle design. The following two types (one larger than the other) are used at TWRS:

- The larger connector (Hanford Site head) has a flat-nozzle flange gasket.

- The smaller connector (PUREX head) has a radius-faced beveled flange gasket.

Both types of jumper head connectors are shown in Figure 2-41 together with a crane-supported impact wrench used to tighten the connectors to the nozzles. New construction uses the PUREX head design.

Valves are fabricated in rigid jumpers so that waste routes can be changed by opening and closing the valves. The valve handles are located above the top of the valve or other pit cover blocks, and the valve stems extend downward through penetrations in the cover blocks. A flow diagram painted on the cover blocks assists the operator in valving to the correct pipeline and avoiding misrouting of the waste.

A diversion box jumper generally connects only two nozzles, and a valve pit jumper can connect to several wall nozzles, each leading to a different waste transfer line. The valve pit jumper uses built-in two- and three-way valves to divert the flow where needed.

Diverting liquid flow from one tank to another through valve pits usually does not require major changes to the jumper or alignment. Multivalve, multiconnector jumpers as well as flexible jumpers are used to reduce radiation exposure and field time because of the less frequent jumper changes.

2.4.10.2 Miscellaneous Transfer Equipment. In addition to the equipment identified in the transfer line systems description, other structures or facilities in the transfer line are used to control or direct waste transfers.

2.4.10.2.1 Valve Pits. Valve pits (Figure 2-42) are located belowground and are reinforced concrete structures that contain valves and jumper assemblies to route the liquid waste through the connected pipelines within a tank farm. Valve pits have 0.3-m- (1-ft-) thick walls and heavy, 0.51-m- (20-in.-) thick grade-level cover blocks. When several tanks are pumped to a single receiver tank, the flow is routed to a valve pit. In the valve pit, the transfer lines of the sending tank are connected to the receiver tank line by means of a series of valves and jumper connections. Two- and three-way valves are built into each rigid jumper assembly to divert the flow in the required direction. Each valve pit is equipped with leak detection. Some of the leak detection systems are interlocked (Section 2.4.14) to shut down the transfer pumps. Each valve pit also has a flush line connected to a flush pit and a drain line connected to an underground storage tank.

2.4.10.2.2 Diversion Boxes. Diversion boxes (Figure 2-43) are belowgrade, reinforced concrete structures that provide a flexible method of directing liquid waste from a given point to any other given point. The top of the diversion box is a concrete cover block that usually extends abovegrade. The cover blocks vary in thickness from box to box. Some diversion boxes are lined with steel.

Diversion boxes are normally connected to a specific tank farm and are used to establish waste transfer routes between tank farms. The waste transfer route between selected facilities can be established by selecting a combination of lines that are connected by diversion boxes, diverter stations, pump and valve pits, and associated valving and equipment.

Diversion boxes also provide confinement for leaks in waste transfer lines (which drain back to the boxes through the encasement) and leaks at jumper nozzle connections. Waste transfer lines are connected inside the diversion box by installing a jumper between the connecting nozzles. Jumpers may be either rigid or flexible, but rigid jumpers are required when valves are used.

The basic diversion box was designed to operate without valves. However, some transfer operations are better served by using valves (e.g., when wastes are transferred from multiple facilities to a common storage tank). In this type of transfer, rigid jumpers and valves are required.

After a waste transfer is completed, the transfer lines are flushed to the receiving tank and toward the sending tank.

All diversion boxes drain to a catch tank or nearby underground storage tank, and all boxes contain a leak detector probe that alarms if a leak occurs that causes waste to accumulate in the diversion box. The operating connections for a typical diversion box are illustrated in Figure 2-44.

2.4.10.2.3 Diverter Stations. Diverter stations can accommodate only gravity fluid flow. The 241-AX-152 diverter station is currently the only active diverter station in the 200 Areas.

A diverter station allows routing changes without removing cover blocks or changing jumpers. Several incoming waste transfer lines are routed into a 189-L (50-gal) receiver tank. A moveable spout on the bottom of the receiver tank directs the flow of waste to any one of several exit pipe funnels located within the diverter station. Each routing funnel represents a direct transfer line to a specific receiver tank, as shown in Figure 2-45.

A catch tank located in the bottom cell of the diverter station collects any spillage or leakage. The catch tank is equipped with a water jet so that accumulated waste solutions can be transferred to a waste storage tank.

2.4.10.2.4 Catch Tanks. Catch tanks (Section 2.4.5.1) are underground storage tanks that collect small amounts of waste drained from diversion boxes, valve pits, diverter stations, and other DST equipment.

2.4.10.2.5 Double-Contained Receiver Tanks. A DCRT (Section 2.4.5.1) is a short-term waste storage facility that is also used as a valve pit for waste transfer operations. The DCRT consists of an underground concrete structure that contains a filter pit, pump pit, instrument pit, flush pit, and a vault in which a tank is installed.

2.4.10.2.6 Supplemental Covers. A supplemental cover is an engineered secondary barrier to knock down spray leaks from transfer-associated structures smaller than 15 m^3 (530 ft^3), including cleanout boxes, that are physically connected to waste transfer lines with an active transfer pump not under administrative lock. A supplemental cover is designed to meet the following criteria: (1) knock down spray leaks of up to 125 psig; (2) construction material is compatible with tank waste; (3) it allows for maintenance and surveillance activities on the transfer-associated structure; (4) it allows a waste leak of 20 gpm to be released at the bottom of the supplemental cover; (5) it is able to withstand a maximum wind speed of 90 mph; (6) it is able to withstand snow or ash load of 45 psf; and (7) it extends to the ground. The requirements for cover operability are defined in HNF-2296, *Justification for Continued Operation of Transfer Lines Having Structures with Less Volume Than the 241-A-A Valve Pit*.

The supplemental covers for COBs have two basic configurations. One configuration has a one piece solid top. The basic design consists of 1 ½ in. x 1 ½ in. x ¼ in. stainless steel angle frame on two 6 in. x 3/4 in. stainless steel plate footings with 16 gauge stainless steel side panels and ⅜ in. clear plexiglass (acrylic) top. There is a ½ in. space between the lower edge of side panels and the top of the footings. Figure 2-69 illustrates a standard supplemental COB enclosure. Refer to HNF-2329, *Calculation For Supplemental Covers On Structures Smaller Than 241-A-A*, for details concerning design of supplemental covers installed on COBs.

The second configuration for supplemental covers are constructed of a 30 mm. thick geomembrane, which is resistant to corrosive ingredients in the tank waste. The cover dimensions allow ½ in. clearance on all sides and top. The covers completely enclose the transfer structure.

The cover extends to within 1 in. of the ground. The seams and edges have 1- to 2-in. overlap for added strength. The pit structure is adequate to support weight of the cover. Refer to HNF-2329 for details concerning design of supplemental covers installed on valve pits.

2.4.10.3 Pumps. The three types of pumps used at TWRS to move liquids or solids from facility to facility are (1) jet pumps in combination with centrifugal pumps, (2) submersible pumps, and (3) transfer pumps. A fourth type of pump mixes in-tank waste to suspend solids or to prevent the buildup of flammable gases.

2.4.10.3.1 Jet Pumps. The components of a jet pump system (Figure 2-46) located within a pump pit are a centrifugal pump, flexible or rigid jumpers, a flush line, and a flow totalizer. The centrifugal pump supplies motive fluid to the submerged jet pump system. The jumpers contain piping, valves, and pressure and limit switches. Typically, up to four jet pumps are manifolded to a common waste transfer line.

A centrifugal pump (Figure 2-47) and jet pump are needed to raise the liquid waste approximately 12 to 15 m (40 to 50 ft) to the pump pit. Raw water fills the jet pump system loop and primes the centrifugal pump for operation. A recirculation loop permits the prime to be maintained on the centrifugal pump while pumping at very low rates.

The centrifugal pump located in the pump pit pressurizes power fluid to the jet assembly. The power fluid passes through a nozzle within the jet assembly and converts fluid pressure head to velocity head, thereby reducing the pressure within the jet assembly chamber. The reduction in pressure allows the interstitial liquid (i.e., liquid within salt cake) to enter the jet assembly chamber and mix with the power fluid. Conversion of velocity head to pressure head above the nozzle lifts power fluid and interstitial liquid to the pump pit.

Jet pump systems are used for Salt Well Pumping (SWP). The complete salt well system consists of a jet pump and a 254-mm- (10-in.-) dia salt well casing with a stainless steel salt well screen welded to a Schedule 40 carbon steel pipe. The screen is inserted into the 0.3-m (1-ft) tank riser located in the pump pit. The stainless steel screen portion of the system extends through the tank waste to near the tank bottom. The salt well screen portion of the casing is an approximately 3.0-m (10-ft) length of 254-mm (10-in.-) dia, 300 series, stainless steel pipe with screen openings (slots) of 1.27 mm (0.050 in.). A flow totalizer (a magnetic element) is attached to the discharge line to measure the quantity of liquid transferred.

2.4.10.3.2 Submersible Pumps. A submersible pump can be used to raise large volumes of supernate. The pump motor itself is above the pump intake and is submersed in the liquid being pumped. The pump motor is cooled by the liquid being pumped. A flow director (shroud) installed in the pump helps move the flow past the motor. A sensor shuts off the submersible pump if the submersible pump motor temperature increases.

2.4.10.3.3 Transfer Pumps. Transfer pumps are installed in a pump pit, with the motor located in the pit and the intake located in the tank waste. Typically, transfer pumps are deep-well, vertical turbine pumps, where the pump intake is a rigid pipe that extends to a fixed depth in

the tank waste. Some transfer pumps have a floating intake, which is a flexible jumper connected to rigid pipe that does not extend into the waste. The intake, or flexible jumper, floats on the surface and collects only surface liquids until the jumper is fully extended.

2.4.10.4 200 East Area Transfer Lines. The active and known inactive transfer lines, line origins, intermediate junctions, and line terminations within the 200 East Area are listed in Tables 2-22 and 2-23, respectively.

2.4.10.5 200 West Area Transfer Lines. Active transfer lines, line origins, intermediate junctions, and line terminations in the 200 West Area are listed in Table 2-22. The known inactive lines within the 200 West Area are identified in Table 2-23.

2.4.10.6 Cross-Site Transfer System. The cross-site waste transfer system transports mixed-waste solutions from the 200 West Area to the 200 East Area. The system consists of diversion boxes located in the 200 East and 200 West Areas (241-ER-151 and 241-UX-154, respectively), a vent station, and a reinforced-concrete-encased stainless steel pipeline system approximately 3.7 km (2.3 mi) long.

Four of the six transfer lines placed within the concrete encasement are not usable (i.e., have failed pressure tests). Leak detectors for the cross-site transfer line are located at the diversion boxes. Additionally, 58 encasement test risers are spaced regularly along the concrete encasement between the 241-UX-154 and 241-ER-151 diversion boxes. The test risers provide access to the encasement void space for leak detection purposes. The encasement slopes in both directions from the 241-EW-151 vent station.

The 241-EW-151 vent station is located south of and between the 200 East and 200 West Areas. The elevation of the top of the vent station or cover blocks is 231.8 m (760.5 ft) above sea level. Because the vent station is 15 m (50 ft) higher than the diversion boxes in the 200 East and 200 West Areas, venting the transfer line following a transfer allows liquids to flow from the vent station back through the transfer system diversion boxes to the sending and receiving tanks.

Salt well and miscellaneous 200 West Area plant wastes are collected and stored in Tank 241-SY-102. The waste is transferred from Tank 241-SY-102 through the 244-S DCRT, valve pit, diversion boxes, and cross-site system structures to the 200 East Area. The waste is then routed through the 244-A DCRT to the 241-A-A valve pit for transfer to the 200 East Area DSTs, where the waste is held for later processing at the 242-A Evaporator. The specific routing of waste through the 200 East Area and the waste destination depends on the type of waste, the availability of tanks for storage, and approved procedures controlling waste transfers.

Another cross-site transfer system known as the replacement cross-site transfer system has been constructed and is described in Addendum 2.

2.4.11 Common Sitewide Instrumentation and Surveillance Monitoring Systems

The instrumentation and other supporting systems and equipment used in TWRS are common to most facilities on the Hanford Site. The following systems are discussed in this section and the following section:

- Computerized surveillance systems
- Liquid- and sludge-level monitoring system
- Leak detection and monitoring systems
- Waste sampling equipment and methods
- Temperature monitoring
- Dome-space gas monitoring
- In-tank surveillance cameras
- Criticality detection systems.

2.4.11.1 Computerized Surveillance Systems. The primary computerized surveillance system within TWRS is the Tank Monitoring and Control System (TMACS). The formerly used Computerized-Automated Surveillance System (CASS) has been replaced by TMACS. CASS (historical overview only) and TMACS are discussed in the following subsections.

2.4.11.1.1 Computerized-Automated Surveillance System. The central CASS Facility was located in the 2750-E building in the 200 East Area. TMACS has replaced the CASS and the CASS has been physically removed from service.

2.4.11.1.2 Tank Monitoring and Control System. TMACS was originally designed to monitor waste tank temperatures but has since been expanded for monitoring of other parameters and has replaced the CASS. The system continuously monitors temperatures, liquid levels, tank pressures, ventilation flows, and hydrogen gas concentrations. The data inputs to TMACS originate within the tank farms and associated facilities, which communicate by means of dedicated telephone lines with the TMACS main computer system located in the 2750-E Building.

TMACS provides real-time dynamic graphics depicting the status of all parameters associated with the monitoring tank. Features include alarm management, data storage, data trending, reporting, event logging, failure status, and graphical presentation using a hierarchy of displays that allows progression from the general to the specific. TMACS receives two major data inputs: PANALARM and ACROMAG.

PANALARM is the existing tank farms alarm and annunciator system. The inputs to TMACS include all tank farm alarms, tank pressure, radiation levels, and leak detection signals. TMACS samples the PANALARM system data points at a rate of approximately 100 points per second.

ACROMAG is a data processor that currently collects liquid level data from the ENRAFs (Section 2.4.11.2) vapor space gas sample data directly from the standard hydrogen monitoring

system, tank vapor space pressure data, tank waste and vapor space temperature data, and the ventilation system exhaust flow rates. TMACS samples most of the SST temperature data every 10 minutes and most of the DST temperature data every 60 seconds. Sample rates for other data (e.g., ENRAF data, standard hydrogen monitoring system data, pressure data, and ventilation flow rates) are based on user needs or requirements.

The user can select a single tank from a graphic display of the tank farms. The tank level is displayed as a horizontal line above the tank bottom (the position of this line changes dynamically as the liquid level in the tank changes). Temperature values are displayed on the basis of the height of the temperature sensor. Tank pressure values (both low and high ranges), as well as the percentage hydrogen (for tanks with a standard hydrogen monitoring system installed), sample flow, and discrete alarm signals are provided on the graphic display. Dynamic trend graphs can be obtained by selecting the parameter of interest from the graphic display. For example, the user can select a temperature sensor and the period of interest (e.g., 1 h, 8 h). The current, low, and high numeric values over the selected period are displayed next to the sensor number.

2.4.11.2 Liquid- and Sludge-Level Monitoring System. The following describes liquid- and sludge-level monitoring in the waste tanks.

2.4.11.2.1 Liquid-Level Monitoring. Liquid-level monitoring is a primary tool for maintaining strict accountability of radioactive and chemical waste solutions. Surveillance of the liquid level in an isolated tank gives the first indication that liquid may be leaking from the tank or (an unlikely possibility) that liquid is intruding into the tank. Liquid levels in all waste storage tanks are monitored and recorded.

Three devices are used to monitor the liquid level in the primary tanks:

- A level-indicating transmitter assembly provides continual automatic monitoring. The level-indicating transmitter may include Food Instrument Corporation (FIC) gauges and ENRAFs.

- For some tanks, a level indicator assembly or manual tape provides a manual backup for the level-indicating transmitter.

- A high-level detector provides the alarm input for a high liquid level. (The high-level detectors are disconnected in flammable/hydrogen gas "watch list" tanks.)

In addition, liquid observation wells have been installed in SSTs to measure liquid levels within the tank solids.

Food Instrument Corporation Gauges. Many underground storage tank liquid levels in the 200 East and 200 West Area tank farms are measured by automatic FIC gauges (and read by TMACS). An automatic FIC gauge (Figure 2-48) consists of the following:

- Plummet suspended on a tape
- Tape reel
- Rotameter
- Sight glass
- Control box
- Air supply
- Flush spray attachments.

FIC gauges are mounted on selected risers. The plummet of an FIC gauge is suspended to rest at the liquid surface in the tank and is raised and lowered to contact the liquid surface. The reading is accomplished either automatically or manually, depending on the FIC. An FIC can operate in one of three distinct modes: automatic, Sintrusion, and manual.

The FIC gauges can be read automatically or manually in the field. Automatic liquid-level measurement devices are installed in many of the waste tanks and catch tanks in the tank farms in the 200 East and 200 West Areas. The gauges are mounted on selected risers. The controls automatically raise and lower (bob) the plummet position at the air-liquid interface at 1- to 1.5-min intervals. When the plummet contacts liquid, an electrical circuit to ground is completed, thus indicating the liquid level. Level readouts are also displayed locally at the tank gauge.

When the liquid in a tank has been processed and a sludge or salt cake layer has been left in the tank, the automatic FICs are placed in the intrusion mode. At this point, the main concern is detection of incoming liquids (intrusion). In this method of monitoring surface levels, the plummet in the FIC gauge stays suspended above the salt cake surface. This method is used only to monitor tanks with solid surfaces. An automatic FIC that fails must be read manually.

ENRAFs. An ENRAF (Figure 2-49) consists of a sight glass, control box, and flush spray attachments. ENRAF Series 854 level gauges are certified by Factory Mutual for the National Fire Protection Association (NFPA 70, *The National Electric Code*) hazardous Class I, Division 1, Groups B, C, and D Locations. The measuring principle for these gauges is based on the detection of variations in the weight of a displacer suspended in the process fluid. The displacer is connected to a wire wound on a precision measuring drum. A level change causes a change in the weight of the displacer, which is detected by the gauge force transducer. Electronics within the gauge cause a servo motor to adjust the position of the displacer and compute the tank level on the basis of the new position of the displacer drum. The gauge displays the level in decimal inches. A digital output signal (analog optional) transmits the level data for remote data processing.

Manual Tapes. Three types of manual tapes are used in TWRS. The flake-box type, described here, is of a more recent design. The older types include a vertically mounted exposed tape reel and a horizontally mounted encased tape reel. Despite their differences, both operate in

essentially the same manner. The reel is permanently attached to the tank riser, and the measuring tape is attached to the reel. The measuring tape is inserted through the hole in the riser flange. Readings are obtained by attaching a portable direct current meter to the terminals provided at the riser. The zero position on the manual tape represents the bottom of the tank or sump.

Flake-box housings are located on primary tank risers (on all DSTs and most DCRTs) and on some annulus risers (241-AN, 241-AP, 241-SY and 241-AW Tank Farms). A flake box consists of a steel housing containing a reel that is wound with a premeasured stainless steel tape. A probe is attached to the end of the measuring tape, which extends down through the tank riser. Flake boxes serve different purposes in different locations. Installed on a primary tank, they provide a means of determining waste liquid level within the tank. On a tank annulus, flake boxes can detect leakage from the primary tank into the annulus.

The elevation of the probe adjusts by turning a hand crank on the side of the housing to wind or unwind the steel tape. A portable direct current ammeter is connected to the tape and ground (riser flange) to determine when the electrical circuit to ground is completed. The plummet is lowered until the electrical circuit is completed, and the liquid level at the point of contact is read manually from the tape housing. The liquid level in the tank (height in feet from the bottom of the tank or sump) is determined from graduations on the steel tape as measured relative to the tank riser flange, the cross bar or fixed index point on those reels with plexiglass housings, or the edge of the access hole. The zero position on the steel tape represents the bottom of the tank or sump. For most manual tapes, a 13-mm (0.5-in.) line from an instrument air header continually purges the level indicator housing into the primary tank. The annulus flake box tapes are set at predetermined levels in the annulus and will sound an alarm if liquid is detected.

On the tanks lacking level instrument systems, liquid-level readings can be obtained either with the manual tape or by means of a calibrated, insulated wire (zip cord). Electrodes are attached to the premeasured, insulated wires. In each instance, readings are obtained by attaching a portable direct current meter to the terminals provided at the riser and lowering the electrodes until deflection of the direct current meter indicates contact with the liquid surface.

High-Level Detectors. The high-level detector assembly consists of an electrode (two electrodes in the 241-AP Tank Farm) suspended from the riser. Although the detectors are currently in place, electrical power to these systems has been disconnected due to the potential for flammable gas within the monitored tanks. When these detectors were operational, high liquid level was detected when liquid contacted the electrodes and completed the electrical circuit across the electrodes. Readings in excess of tank high-level limits were designed to engage the associated area pump interlock (shutdown) or alarm system and provide audible and visual alarms at CASS.

Weight Factor and Specific Gravity Monitoring. The weight factor and specific gravity monitoring systems (241-AW-102, DST leak detection pits, DCRTs with the exception of 244-CR TK-003, and SSTs with operable salt well pumps) consist of three small pipes (known as dip tubes) inserted into a tank through a riser. During operation, compressed air purges are

supplied to the dip tubes at a controlled rate, the differential pressure is measured, converted to liquid level or specific gravity, and can be read locally or are electrically transmitted to indicators at a remote location (Figure 2-50).

2.4.11.2.2 Sludge Level Monitoring. A solid or sludge layer is commonly formed in the bottom of waste storage tanks as the contents concentrate and solids precipitate. The sludge level must be monitored because changes in the sludge level indicate a change in tank solution makeup and, in some instances, could explain apparent changes in liquid levels.

Two methods are used for measuring sludge levels: (1) a steel doughnut attached to the bottom of a calibrated tape (Figure 2-51) and (2) the ENRAF described in Section 2.4.11.2.1.

- A calibrated tape is attached to the doughnut cable and lowered until the tape becomes slack. The tape reading indicates the sludge level.

- An ENRAF calibrated to a different density (higher density than supernate) is used to detect the sludge level in a tank.

2.4.11.2.3 Single-Shell Tank Farm Liquid and Sludge Level Monitoring. The surface levels of tanks are monitored by using a manual tape or an automatic level-indicating transmitter. Manual tape readings and manual surface-level readings, taken with the manual-mode level-indicating transmitter gauges, are input to the Surveillance Analysis Computer System (SACS) and readings from ENRAF gauges are connected to TMACS. The TMACS alarm sounds if the readings are outside set limits. Data from level-indicating transmitter gauges connected to TMACS are transferred to the SACS.

Liquid observation wells have been installed in many tanks to determine interstitial liquid levels within the tanks. Gamma or neutron probes are lowered into the wells to measure the levels. The data from the fully automatic measurements are sent to SACS for processing and storage.

2.4.11.2.4 Double-Shell Tank Farm Liquid and Sludge Level Monitoring. Several methods are used to measure the surface level in a tank. In all instances, the measurement represents the amount of liquid (in inches) from the bottom of the tank. This figure is multiplied by a conversion factor to calculate the volume (in gallons). In all 23-m- (75-ft-) dia tanks, a 25 mm (1 in.) depth of liquid represents a volume of 10,410 L (2,750 gal).

Sludge-level cables are found at each DST farm. The sludge-level assemblies are bolted on risers.

2.4.11.3 Leak Detection and Monitoring Systems. In addition to the liquid level monitors used for leak detection (Section 2.4.11.2), dry wells and laterals monitor liquid intrusion to the soils surrounding and supporting the underground tanks as a method of leak detection. Dry wells are vertical next to the tank, and laterals are below the tank. A number of wells are randomly situated inside a tank farm or located adjacent to specific tanks about 2 to 3 m (6 to 10 ft) from

outer walls of a tank. In Hanford Site soils, liquids spread horizontally, as well as vertically, and a waste tank leak is indicated by increased levels of radiation in these wells. The term "dry" is used because the wells were initially located above the groundwater table.

Dry wells are made from mild steel casings, most of which are open at the bottom end to allow any subsurface liquid to enter and rise in the pipe. Their depths range from 23 to 76.2 m (75 to 250 ft). All new dry wells are grouted around the top to reduce surface water penetration into deeper soil. Presently, approximately 750 monitoring wells are located in the 200 East and 200 West Area SST farms.

Instruments for detecting and confirming leaks in underground storage tanks are inserted through various types and diameters of access channels located beside and underneath the tanks. The instruments are lowered to a predetermined depth to monitor radiation levels.

The probes used to detect radiation within the dry well area are scintillation or Geiger-Mueller probes. A scintillation probe is used in wells with a history of low-level radiation. A Geiger-Mueller probe is used in wells that have higher radiation levels. This type of probe measures the radiation-induced ionization occurring in the gas-filled tube of the instrument.

The probes have been recently upgraded to differentiate between various isotopes. The upgraded system is a spectral gamma logging system. This system uses a high-purity intrinsic germanium detection device to provide assays of gamma-emitting radionuclides near the drywells. Thus, previously characterized gross gamma contamination is now specifically linked to several radioisotopes. The most prevalent radioisotope detected was ^{137}Cs, while other gamma-emitting radionuclides such as ^{60}Co, ^{152}Eu, and ^{154}Eu were generally found near the surface and are believed to be the result of spills (DOE/EIS-0189, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington*).

2.4.11.3.1 Single-Shell Tank Farm Leak Monitoring. Internal tank instrumentation and external dry wells detect leaks in the SSTs. The dry wells are located around the circumference of most tanks and throughout the tank farms. Drywells with the exception of those located by Tanks 241-C-105 and 241-C-106 are no longer monitored for leaks. The 241-A Tank Farm and parts of the 241-SX Tank Farm are also provided with lateral (horizontal) dry wells. The lateral dry wells are not currently used to monitor leakage to the soil.

The dry wells are open-bottomed, mild steel casings of either 152- or 203-mm (6- or 8-in.) dia and depths ranging from 23 to 45.7 m (75 to 150 ft). Radiation probes determine the radiation profile in the dry well.

2.4.11.3.2 Double-Shell Tank Farm Leak Monitoring. In a typical DST, three conductivity probes are spaced in the annulus around the tank center at 120° intervals. This method of leak detection is redundant to the annulus exhaust CAMs. However, in the 241-SY Tank Farm, only one conductivity probe is mounted in each tank annulus. An illustration of a leak detection system for a DST including transfer line showing the inter-relationship of the system is provided in Figure 2-52.

For the concrete shell portion of a DST, the leak detection system is known as a "leak detection pit weight factor" system (Figures 2-19, 2-53, and 2-54). This system monitors liquid level in leak detection pit sumps. A small amount of water is kept in the leak detection pit sump so that the operability of the dip tubes may be constantly verified. Detections of higher-than-normal liquid levels are investigated. Two annunciators, one at the instrument building and the other at the evaporator control room, alarm upon detection of a leak by either leak detector.

Leak detection pit instrumentation consists of a liquid level detector and a thermocouple.

- **Liquid Level Measurement System**—Each leak detection pit has a specific gravity unit used for liquid-level measurement. The specific gravity monitoring instrumentation converts the pneumatic specific gravity signal to an electrical signal for transmission to a monitoring station.

  Two of the three specific gravity dip tubes in leak detection pits are below a maintained water level. One of these dip tubes is located near the pit floor; a second dip tube is located 254 mm (10 in.) above the floor. The third dip tube is located near the top of the well, above the water level. The differential pressure between the two pipes below the water measures the specific gravity; the differential pressure between the top and the lowest dip tubes measures the weight factor (Figure 2-54).

- **Temperature Measurement System**—Temperature measurement elements (thermocouple assemblies), which are installed at the bottom of each of the leak detection pits, are used in the event of a leak from the annulus tank that drains to the leak detection pit. A dual thermocouple assembly is mounted below the water level in each leak detection well. Temperature measurements may be read in the respective instrument buildings.

Transmitter enclosures are provided for leak detection pits in the DST farms. A typical enclosure, shown in Figure 2-55, contains the following transmitters:

- Specific gravity transmitter

- Weight factor transmitter (provides a signal to the leak detection pit weight factor gauge) and alarm switch (provides a signal to the leak detection pit weight factor alarm switch)

- Pressure transmitter (transmits primary tank pressure to high/low pressure alarm, annunciators, and narrow-range -1 to +0.2 kPa [-4 in. to +1 in. WG] pressure recorder)

- Pressure transmitter (transmits primary tank pressure signal to the wide-range -2.5 to +20 kPa [-10 in. to +80 in. WG] pressure recorder).

Transmitters for pressure, weight factor, and specific gravity convert hydrostatic pressure differences (across dip tubes) into pneumatic signals. The pneumatic signals are transmitted to the pressure switch rack in the instrument building and activate the respective weight factor alarm switches. These alarm switches convert the pneumatic signals to electrical signals that energize annunciators on instrument building panel boards.

2.4.11.3.3 Pit/Box and Transfer System Leak Detection System. Part of this leak detection system encompasses the leak detection equipment associated with the pump pits, sluice pits, valve pits, cleanout boxes, diversion boxes, transfer boxes, and some encased transfer lines. This part of the system includes dual probe electrodes, induction-type relays, fail-safe relays, transmitters, and reset switches. The other part of this system monitors some transfer lines in which 51-mm (2-in.) test risers are installed to provide radiation monitoring and leak detection capability.

Leak detection conductivity probes are located in central pump, tank, annulus, leak detection, valve, flush, and service pits and in cleanout boxes. Identical control stations (each near the serviced tank) hold single-mounted detection monitors for the central pump, annulus pump, and leak detection pits.

Encasement leak detectors are installed on tank farm piping encasements, normally on the transfer lines that leave or enter the tank farm. Transfer lines within the tank farms generally do not have leak detectors, as they rely on pit leak detectors. The leak detectors are installed in the transfer lines to monitor the integrity of the primary confinement barrier and to detect challenges to the encasement pipe or secondary confinement barrier. The leak detectors also are used to assist in identifying the source of a leak when a pit leak detector alarms.

The installation and operability of a leak detector system are tested during the installation of the leak detector system. A channel functional test is performed during normal operations to verify the operability of the leak detection system. This test ensures that all alarm and status indicators are operable; however, it does not functionally test the operability of the leak detection element.

A failure of the leak detector up to the leak detection element would be annunciated because the leak detector systems are designed to be "failsafe"; that is, the systems contain an internal circuit that alarms upon loss of power. Additionally, the internal circuitry also will alarm if any of the wires to the leak detection element are broken. A failure of the leak detection element itself would not be known. For leak detection elements to fail, they would require an insulating layer to form around them. All of the chemistry, soil, and corrosion products are expected to be sufficiently conductive when wetted by a leak to activate the leak detection element.

2.4.11.4 Temperature Monitoring Systems. Temperature monitoring in the waste tanks is required to maintain tank operating conditions. The temperature data provides information about the waste temperature within a tank and identifies an accumulation of solids, or "hot spots." In addition, during transfers temperatures are recorded for the receiving tanks.

2.4.11.4.1 Single-Shell Tank Farm Temperature Monitoring. Internal tank temperatures are measured with profile thermocouple trees that consist of steel pipes with 4 to 18 thermocouples per tree, usually starting 102 mm (4 in.) from the bottom and placed at 0.6-m (2-ft) intervals up the tree. For tanks lacking a thermocouple tree, a single thermocouple is inserted in the liquid observation well. Temperatures may either be read and recorded manually or transferred automatically to TMACS.

2.4.11.4.2 Double-Shell Tank Farm Temperature Monitoring. The temperature of each DST and its contents is monitored by using thermocouple elements and digital temperature equipment located in the associated instrument building.

Thermocouple elements are installed during construction of each tank in the following locations (Figure 2-56):

- Insulating concrete (all dual thermocouple elements)
- Primary tank lower walls
- Concrete foundation
- Concrete walls and haunch
- Concrete dome.

The thermocouple system, shown in Figure 2-56, provides access to thermocouple elements located in the liquid in leak detection pits and at 18 different depths in the primary tank contents.

Thermocouples, either individual or installed on thermocouple trees, extend through the tank risers into the tank contents. Temperature data from these thermocouples can be used to chart a temperature progression from the bottom to the top of the tank over time (a "profile"). In tank farms equipped with stationary temperature display systems, no provisions exist for taking temperature readings at the tank risers. The thermocouple signals are sent directly to the instrument buildings.

A probe with thermocouple elements is suspended in each primary DST. The end of the probe is approximately 152 mm (6 in.) above the bottom of the tank, and the first thermocouple element is 102 mm (4 in.) above the end of the probe and approximately 254 mm (10 in.) above the tank floor. A typical probe design is shown in Figure 2-57.

Thermocouples are also installed a few inches above the bottom of the tanks at different locations from the center. These thermocouples are specially designed to measure sludge temperatures. A typical thermocouple arrangement for a tank from 241-AP Tank Farm is shown in Figure 2-58.

Dome Thermocouples. These thermocouples monitor temperatures in the tank dome.

Tank Knuckle Thermocouples. These thermocouples measure the temperatures in the tank knuckles.

Air Lift Circulator Thermocouples. These temperature-monitoring devices are used primarily in AWF tanks. Each air lift circulator is equipped with several temperature elements that can detect hot spots. The 22 air lift circulators have attached thermocouples that extend 76 mm (3 in.) above the liner bottom.

Sludge Thermocouples. Sludge thermocouples detect accumulations of heat-generating solids and are located near the tank bottom.

Sensor Locations. Thermocouples are located throughout the insulating concrete, foundation, and concrete shell.

- **Insulating Concrete**—Thermocouples are embedded in the concrete layer directly under the primary tank and the foundation to monitor temperatures throughout the tank. The thermocouples are close to the underside of the primary tank liner bottom and are equally spaced in a circular arrangement. Additional thermocouples contact the outer surface of the primary tank shell.

  Twenty-four thermocouples are embedded in the insulating concrete pad between the primary and secondary tank (Figure 2-56). The thermocouple spacing varies slightly to avoid interference with the insulating concrete drain slots. Thermocouple elements attached to the primary tank wall in the annulus monitor the temperature of the tank wall just above the lower knuckle.

- **Foundation**—The foundation thermocouples lie between the bottom of the concrete shell and the earth below. These thermocouples, arranged in pairs, measure temperature gradients in the concrete base.

  Maximum heat transfer between the temperature element and the conduit is achieved by loosely packing aluminum foil into the conduit cap. Foil is epoxied into place before the conduit end is capped.

- **Concrete Shell**—Thermocouple probes measure temperatures near the inner and outer surfaces of the concrete shell, as shown in Figure 2-56. The thermocouple elements are assembled and installed in pairs. One thermocouple element of a pair is located near the inner surface of the shell (on the annulus wall or annulus/ primary tank dome), and the other element is located close to the soil on the outer surface of the shell. Twenty-four thermocouple probe units are embedded in the concrete shell wall and another 24 in the haunch and dome.

Portable Potentiometer. The portable potentiometer provides profile temperature data, which is manually read at the tank riser.

The profile temperature thermowells (from which the readings are taken) have been placed inside the tank and bolted onto an existing riser. On top of the riser is a housing box that consists

of a plug receptacle and an indicator dial (also called a "Christmas Tree"). To obtain a temperature reading, the portable potentiometer must be plugged into the receptacle.

Heat Trace Sensing System. Three thermocouple probes are attached to the underside of the tank farm process piping. The conduit and probes are held in place with stainless steel straps.

Thermocouple Terminal Boxes. Six terminal boxes equally spaced around the perimeter of the tank are junction boxes for the thermocouple leads. A seventh terminal box, near riser 4, transmits primary tank thermocouple signals. Thermocouple element locations and corresponding instrument building selector switches are shown in Figure 2-59.

Tank Temperature Retrieval. For selected tank farms, the temperature thermocouples have been connected to selector switches located on panel boards in the farm instrument building. The selector switches are labeled to identify the tank and thermocouple numbers. To obtain a temperature reading, the appropriate selector switch is connected to the readout unit with the plug-in cord provided.

Data Acquisition and Signal Conditioning System. For the 241-AY and 241-AZ tank farms, the thermocouples are routed to an instrument building, where data from the thermocouples is received by the data acquisition and signal conditioning system. Equipment in this system scans the thermocouples on command and converts the thermocouple inputs for direct readout in degrees Fahrenheit at the data acquisition and signal conditioning system building.

The 241-AP Tank Farm has a temperature display system used for monitoring tank temperature data. The system has an alarm and historical tracking features.

2.4.12 Waste Sampling Equipment and Methods

Sampling methods depend on the type of waste in each tank. The methods used in support of various TWRS activities include core sampling, grab sampling, auger sampling, and various types of vapor space or gas sampling. As shown in Table 2-1, with the exception of the flammable gas hazards addressed in this FSAR, rotary mode core sampling is outside of the scope of this FSAR.

2.4.12.1 Core Sampling. Core sampling remotely obtains samples of solid or semisolid material stored in the tank farm waste storage tanks. Core sampling consists of boring a hole into the solid-sludge mixture in the tank with a hollow, tubular drill string; capturing a portion of the solid-sludge mixture inside the drill string with a sampling assembly; and retrieving the sampling assembly to the surface.

Push mode core sampling is used to obtain solid or supernatant liquid samples of the high-level waste materials in the underground waste tanks. Specially designed core-sampling trucks and sampling devices are used to obtain samples from the tanks. A cylindrical cross-section of the

tank contents below the riser used for sampling is obtained by pushing a sampler bit into the waste (Figure 2-60). During a sampling task, the sampler is lowered into the waste by a hydraulically powered drill string. Drill ram hydrostatic pressure is monitored during the sampling operation to measure waste resistance. A series of core samples is taken repeatedly until the bottom of the tank is reached.

A rotary platform is mounted on the sampling truck. The shielded receiver is mounted at one end of the rotary platform; the drill unit is mounted at the other end of the platform. Liquid or nitrogen gas is used as a hydrostatic head fluid. There is a down force limiter, which shuts down push operations when excessive down forces are encountered. A cylindrically shaped, shielded receiver houses the full sampler once it has been withdrawn from the tank. Also mounted on the sampling truck is an electrically operated winch. The winch unit raises and lowers the drill string and additional equipment that connects the riser of the tank being sampled with the drill rig. The system confines the waste sample throughout the operation.

2.4.12.2 Auger Sampling. Auger sampling obtains samples of the surface layer of "watch list" tanks that may generate flammable gases or may contain organic solvents. Auger sampling may also be used to obtain core samples in tanks containing 200 to 300 mm (8 to 12 in.) of waste. Auger samples are obtained by using a stainless steel, hand-turned auger bit contained in a sleeve. The method is similar to wood boring or ice augering. This method cannot be used to sample low viscosity wastes because the sample cannot be properly captured in the sampler.

2.4.12.3 Supernatant Liquid and Soft Slurry Grab Samples. A special sampling bottle contained in a cage can obtain liquid or soft slurry samples of the waste. The bottle is capped and lowered to the desired level. The bottle is then opened so that it fills with liquid, is retrieved from the tank, and is restopped. This "bottle-on-a-string" sampling procedure conforms to ASTM E-300-73, *Weighted Bottle Sample Method.*

2.4.12.4 Vapor or Gas Sampling. Vapor space or gas samples are required to determine the composition of hazardous, explosive, or flammable gas mixtures containing hydrogen (H_2), ammonia (NH_3), and nitrogen oxides (NO_x). Gas samples are obtained by three methods: (1) a sample may be drawn, by fan, through a device that traps or concentrates certain gas constituents; (2) a sample may be collected in a container; or (3) the gas may be analyzed in situ using portable monitors. The various methods are described in WHC-SD-WM-PLN-101, *Fiscal Year 1996 Tank Waste Remediation System Tank Waste Analysis Plan.*

The standard hydrogen monitoring system was developed to operate in a Class 1, Division 1, Group B (hydrogen) atmosphere. Where necessary, system components are designed to meet NFPA 70 requirements for operating in a hydrogen environment. The standard hydrogen monitoring system can be installed in four different configurations: (1) on the ventilation exhaust duct, (2) on a gas probe assembly, (3) on a multifunction instrument tree assembly, or (4) on a modified riser flange. After the system has been leak tested and calibrated, the valving is configured to sample the tank vapor space.

The standard hydrogen monitoring system provides online monitoring of gas samples for hydrogen content and enables more detailed laboratory analyses of grab samples. The system is designed for use on any tank. Details are provided in the design documentation in WHC-SD-WM-SDD-001, *System Description Standard Hydrogen Monitoring Systems*. The system schematic is shown in Figure 2-61. The main components of the sampling system are the main flow loop, the auxiliary flow loop, the grab sample loop, and the calibration system.

The sample enters the stainless steel tubing at the sample probe location and is routed to an environmentally controlled enclosure (i.e., the cabinet housing the instrumentation). The stainless steel tubing is heat traced to prevent condensation. The sample then passes through a series of particulate filters with a differential pressure indicator to determine filter performance. A vacuum pump is used to pull the sample through the system. The system upstream of the vacuum pump is below atmospheric pressure so that the gas cannot leak out of the system. The portion of the system downstream from the vacuum pump is outside the enclosure. Thus, any gas that might leak in the downstream leg of the system cannot accumulate (with the potential for fire or explosion), but rather is released to the atmosphere.

The main flow loop provides the primary means of monitoring for hydrogen. The hydrogen sensor is an electrochemical cell that provides an electrical signal proportional to the hydrogen partial pressure in the gas sample. The sensor range is 0% to 50% hydrogen. An in-line flow-measuring element is provided so that the flow rate can be measured and adjusted with the flow control valve.

The grab sampling loop permits gas specimens to be collected for later analysis. Gas sample cylinders are inserted in the assembly by using vacuum tube fittings with ring seals. The cylinders are evacuated by opening the valves downstream of the cylinders. The local isolation valve upstream of the cylinder is opened, and the flow through the cylinder is controlled with the flow control valve on the basis of the flow indicator. After the desired flow is maintained for a specified amount of time, the isolation valve upstream and the cylinder valve downstream are closed in sequence to trap the gas sample.

A calibration gas supply is used to periodically calibrate the hydrogen sensors. The calibration standards are nominally 0.5%, 3.0%, and 100 ppm by volume of hydrogen in air. The calibration system has a flow indicator and controller specially designed for low volumetric flows.

An alarm and annunciator system is provided on the hydrogen monitoring system. Both the electrochemical and solid-state hydrogen sensors are alarmed for hydrogen concentrations. The alarms include a red strobe light beacon, an audible wavering horn, and a local panel light. In addition, low sample flow rate, sample gas low temperature, calibration gas low temperature, or cabinet high/low temperature will activate an amber strobe light, an audible wavering horn, a local panel lamp, and a remote trouble alarm. These alarms indicate that the system needs to be maintained or that the hydrogen level in the tank exceeds a specified percentage of the lower flammability limit.

2.4.12.5 Dome-Space Gas Monitoring. In addition to the standard hydrogen monitoring system that is limited to hydrogen gas, various sampling techniques and equipment are used to monitor the gases (not limited to hydrogen gas) contained in the dome space. Typically, the dome space gas samples or vapor samples are obtained by using a gas-sample probe (unique to the gas sampling and analysis equipment used) installed in the vapor space above the tank contents. A gas-sample probe may also be part of another tank monitoring system, as is the multifunction instrument tree. The multifunction instrument tree, which is inserted into the tank waste and connected to TMACS, contains 27 thermocouples and several probe chambers for gas samples.

2.4.12.6 Pressure Monitoring Systems. For DSTs, the pressures within the primary tank (i.e., vapor space) are continuously monitored. The primary tank pressure (i.e., tank pressure/ vacuum systems) is monitored locally at the instrument buildings and remotely at TMACS. The primary tank pressure/vacuum monitoring system is required to monitor pressure within the vapor space with respect to atmospheric pressure.

Primary tank pressure is monitored by measuring the differential pressure between the tank vapor space and the atmosphere. The primary tanks are equipped with differential pressure monitoring systems to detect excessive vacuum levels (low-pressure conditions) and insufficient vacuum (high-pressure conditions). Backup pressure monitoring is provided by magnetic gauges that are located on tank risers or in local instrument buildings. Pressure switches will activate when tank vacuum is lost (e.g., high pressure) as a result of a loss of ventilation or a pressurized release. The switches will also activate when vacuum is excessive (i.e., loss of ventilation system control). The switches will activate local audible alarms and alarms at TMACS.

2.4.12.7 In-Tank Surveillance Cameras. In-tank video systems may be either portable (i.e., installed temporarily for a few hours or days) or permanently installed in a tank dome space. Other cameras are designed to be mounted on top of a tank riser for riser inspection. Cameras used in flammable gas tanks are purged, and some are also designed to prevent sparking. Most cameras are equipped with pan, tilt, and zoom features that are operated from a van or control console located on top of or near the tank. All camera systems normally consist of a camera, lights, associated cabling, and a van containing control and recording electronics.

2.4.12.8 Criticality Detection Systems. There are no criticality detection systems in TWRS (Chapter 6.0). Neutron detection is provided at 244-TX DCRT (Section 2.4.5.1.3).

2.4.13 Cathodic Protection Systems

Underground carbon steel and stainless steel pipelines transfer mixed waste in the 200 East and 200 West Areas (Section 2.4.10.1.1). These pipelines form a network connecting process plants, underground tanks, and an evaporator. The steel of the buried pipe-in-pipe (not concrete encased) is subject to external galvanic corrosion resulting from bacterial and chemical activity in the soil. Cathodic protection systems are provided to minimize waste line failures. The cathodic protection systems protect only the underground piping and not the underground tanks.

The NEMA-U, oil-cooled, and silicon-dioxide rectifiers of the cathodic protection system are supplied with three-phase alternating current, are insulated with high-density polyethylene, are completely enclosed for protection from the environment, and are located outside tank farm boundaries. Rectifier output voltages are adjustable. Cathodically protected lines are identified in Table 2-22.

2.4.14 Interlock Systems

Certain tank farm equipment (e.g., process pumps and HVAC fans) is interlocked to detect abnormal conditions and to protect personnel, equipment, and the environment. For example, the tank farm transfer pumps, interlocked to the leak detection system, are designed to shut down when a leak is detected in a process pit or in a transfer line encasement. As discussed in Section 2.4, the operability of the interlocks has not been verified using operability tests; however, the operability of Safety-Class and Safety-Significant interlocks are assured by means of the surveillance requirements in the TSR controls.

Pump shutdown interlock sequences are related to various sources, including leak detectors, flush line limit, and pressure switches. In addition, pumps are equipped with their own internal circuitry to shut down the pump upon detection of abnormal operations (e.g., when the pump motors draw unusually high or low amperage).

Most transfer pumps in the 200 Area DSTs are interlocked to shut down together if any of the following occur:

- Any one of the master shutdown switches in the 242-A Evaporator control room is activated
- A leak is detected in any tank farm valve pit or pump pit.

If any one of the process pit leak detector relays is activated because of a leak or circuit failure, the interlock relay will activate and send a "fail" signal to three locations. The first signal activates the leak detection alarm for the process pits in the control room. The second signal is sent to the leak detector transmitter in the instrument building. The third signal is designed to activate the master shutdown relay if a leak is detected or a detector fails and trips other interlocks stopping the pumps.

2.4.14.1 Pump Interlocks. Pump motor shutdown interlocks are linked to various devices, including leak detectors, flush line limit switches, and pressure switches. In addition, pump motor electrical power supplies are interlocked with the internal protective circuitry of the pump motor to avoid pump damage when the pump motors draw unusually high or low current. Pump control, interlock circuitry, and master pump shutdown system devices are designed to prevent contamination of the environment, equipment, and facilities if a leak occurs during waste transfer operations. However, in TWRS, an operator is relied upon to terminate a transfer, thus preventing contamination of the environment, equipment, and facilities. A pump motor power

loss of more than 10 to 15 seconds shuts down pumping operations and requires operator action to restart. As discussed in Section 2.4, the operability of the interlocks has not been verified using operability tests; however, the operability of Safety-Class and Safety-Significant interlocks are assured by means of the surveillance requirements in the TSR controls.

All central pump pit pumps in the 241-A, 241-AN, 241-AP, 241-AW, 241-AX, 241-AY, and 241-AZ Tank Farms are designed to shut down together when any one of the master shutdown switches in the 242-A Evaporator control room is tripped or if a leak is detected in any "A Complex" area valve or pump pit.

2.4.14.2 Pressure and Limit Switches. Pressure switches are used in flush pits where steam or raw water is supplied for tank farm use. Pressure switches are mounted at strategic locations within the flush pit to sense line pressure fluctuations. In most instances, when the line pressure exceeds a set point, the pressure switch causes the associated pump to shut down.

The pressure switches are valved into the raw water/transfer line piping only when the raw water is required for flushing the transfer line. Excessive pressure at the switch may indicate backflow of radioactive waste into the raw water supply. The switch prevents contamination of the raw water system by de-energizing the associated waste transfer pumps. Operation of waste transfer pumps is not allowed during line flushing operations.

A limit switch installed on a valve is a device that opens or closes a pair of contacts when the transfer line valve stem is rotated. Typically, a small lever extending from the limit switch moves as the valve position is changed. If a limit switch is tripped during a transfer, an interlock will shut down any associated waste transfers. As with the interlocks, the operability of the limit switches has not been verified using operability tests.

2.4.14.3 Heating, Ventilation, and Air Conditioning Interlocks. HVAC fans are interlocked to shut down if the exhaust stack CAM units detect high levels of radioactive particulate in the primary exhaust stream. The interlock circuitry for HVAC equipment shuts down the ventilation systems if CAMs detect high levels of radioactive particulate in 241-SY and 241-SX Tank Farms.

2.4.15 Mixer Pumps

Submersible mixer pumps blend the waste layers in a tank. The bottom layer of waste in the tank is a nonconvective layer that traps hydrogen. The upper layer is a thinner convective layer that freely releases hydrogen. The mixing thereby releases hydrogen in a controlled manner.

The type of mixer pump located in Tanks 241-SY-101 and 241-AP-102 is a submersible pump 17 m (56 ft) long (Figure 2-62) (LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*). A similar pump is installed in Tank 241-AN-107. The pump intake is submerged to a waste depth of 3.7 m (12 ft) in the thinner, convective waste layer; the pump discharge is in the bottom, nonconvective layer. Although mixer pumps installed in

Tank 241-AZ-101 are similar in design to those in Tank 241-AP-102, they differ in the size of the pump (i.e., the pumps in Tank 241-AZ-101 are larger).

Electrical power is supplied to the pump assembly through conduits inside the support column. These conduits are rated for use in an explosive hydrogen environment, and the support column is filled with inert nitrogen. All motor connections, cable, wire, and conduit connections are located below the waste surface in a nonhazardous location within the tank. The pump is equipped with vibration monitors, flowmeters, and pump discharge pressure meters to detect abnormal conditions resulting from a plugged nozzle, frozen jet, or other malfunction.

The data acquisition and control system has been designed to control the Tank 241-SY-101 mixer pump and ancillary systems and equipment. This system consists primarily of a computer-based system that collects, interprets, and displays data and annunciates alarms. Data from this system is used as an evaluation input for mixer pump operation. This system also monitors the liquid level in 241-SY-101.

Because of the size and operating environment of the mixer pump, a special waste packaging system is used during pump removal. This system consists of a flexible receiver, similar to a sleeve, into which the mixer pump is drawn as it is raised from the riser and decontaminated with high-pressure water jets. The sealed flexible receiver confines liquids as the pump is removed from the tank. The flexible receiver containing the mixer pump is loaded into a shipping container for disposal.

2.4.16 Light-Duty Utility Arm

The light duty utility arm (LDUA) system provides the capability to reach locations within the waste tank surface that are not directly under the access risers (HNF-SD-WM-HIE-010, *Hazard Identification and Evaluation for Deploying the Light Duty Utility Arm in Flammable Gas Facility Group 3 Tanks*). The LDUA system deploys a family of tools and sensors, called end effectors, into the underground waste tanks by means of a robotic arm on the end of a telescoping mast. The system collects and manages the data retrieved and generated. Access into the tanks is through existing risers. A mobile deployment subsystem transports the mast and arm between tanks and positions them over a 30.5-cm (12-in) tank riser. Ancillary subsystems support the main deployment equipment, performing such functions as maintaining confinement of the tank atmosphere; decontamination of the mast, arm, and end effectors; power distribution; and observation of in-tank operations. The system is operated from the remote Operations Control Trailer located outside the tank farm perimeter fence, up to 275 m (900 ft) from the LDUA deployment vehicle.

End effectors are the tools that perform the specific in-tank tasks of the LDUA system. End effectors (and their storage and transporation containers) are available to provide a basic capability to perform visual surveys and inspections of the tanks, to perform in-tank object manipulation, and to collect small waste samples. The gripper end effector has the ability to grasp and manipulate objects in the tank or to manipulate other tools, including waste probes that

provide information on the consistency of tank waste. The high-resolution stereo video system provides the ability to obtain detailed observational data of the waste and tank structures in areas not visible from the other in-tank surveillance cameras (Section 2.4.12.7, "In-Tank Surveillance Camera"). The extended reach end effector provides additional capability by extending the LDUA reach by 2.08 m (6.83 ft) (HNF-2174, *Hazard Evaluation for Deploying the Extended Reach End Effector (EREE) on the Light Duty Utility Arm (LDUA) in Flammable Gas Facility Group 3 Tanks*). It also provides the ability to sample using a pair of pneumatically operated scoops to collect waste samples. The extended reach end effector incorporates two video cameras (one black and white and one color) plus a lighting system mounted for optimum viewing of the sampling.

2.4.17 Cone Penetrometer

The cone penetrometer soil sampling technique uses a portable platform to deploy small-diameter push rods (piping segments approximately 1 m [39 in.] long with screwed connections), or rods, to depths of up to 70 m (230 ft) for vadose zone characterization (HNF-SD-WM-HIE-012, *Hazard Identification and Evaluation for Deploying the Cone Penetrometer in the Tank Farm for Vadose Zone Characterization*). Soil sensor and soil sampling probes are mounted on the front end of cone penetrometer push rods. The conical-tipped sensors are pushed slowly to target depth(s) by hydraulic cylinders on the cone penetrometer platform. Hydraulic cylinders can provide as much as 15, 900 kg (35,000 lb) of pushing force. Set up is limited to areas not directly over tanks, transfer lines, or buried utilities. The cone penetrometer is not intended for in situ characterization of tank waste. A trailer-mounted support module is located near the platform, providing electrical power and hydraulic support through power cables and hoses.

2.5 PROCESS DESCRIPTION

The activities and operations performed within the TWRS facilities are described in this section. Typical activities and operations required to support the current mission are presented in Table 2-24. These activities and operations provide the means to safely manage tank farm wastes and, in conjunction with the institutional and safety programs discussed in Chapters 6.0 through 17.0, provide Defense-in-Depth to prevent or mitigate unwanted releases of radioactive or hazardous materials. Those operations that are directly relied upon to protect the facility worker, the onsite worker, or offsite individuals are identified in Chapter 3.0 and reflected in the TSR controls.

2.5.1 Waste Storage

The objectives of tank waste storage are to isolate the waste from the environment and to avoid human exposure until final disposition of the waste and associated facilities. Tank waste is stored as outlined here:

- Tanks that may receive and store waste from either processing activities or other tanks are considered in-service tanks, and those that cannot or do not receive waste are considered out of service tanks. None of the 149 underground SSTs received additional waste after November 1980. The 28 underground DSTs are all considered in-service tanks and those not on the "watch list" may receive liquid waste from processing activities or other tanks.

- In-service tanks such as DCRTs and catch tanks also receive liquid waste from normal tank farm transfer operations and serve as temporary storage locations.

- The 36 inactive miscellaneous underground storage tanks administered by TWRS may store some uncharacterized hazardous and radioactive waste. The capacities of these tanks are presented in Section 2.4.

- Although the 204-AR Waste Unloading Facility directly transfers newly generated liquid waste to the underground DSTs, amounts less than 5,680 L (1,500 gal) of dilute waste may be temporarily stored in the catch tank at this facility.

- The 244-AR Vault is out of service, but each of the four storage tanks and the cell sumps contain some quantities of uncharacterized hazardous and radioactive waste. The tanks in this facility are discussed in Section 2.4.

2.5.1.1 Waste Control. During storage activities, water or caustic solution (NaOH in water) may have to be added to waste tanks. Caustic solutions are added to tanks when the hydroxyl ion concentration of the waste is lower than the minimum level required to control corrosion of the primary tank wall and precipitation of fissile material. The caustic solution can be added to the tank by one of the following methods:

- A vendor-owned tank truck carrying caustic solution is connected to a skid-mounted metering pump. A flexible hose is connected between the metering pump and the tank mixer pump, and the caustic solution is transferred to the metering pump. The caustic solution is then pumped into the tank and distributed throughout the waste until the specific amount of solution has been added. This method is used when the hydroxyl ion concentration in the waste is low enough to potentially cause serious corrosion.

- Drums (208-L [55-gal]) containing caustic solution are connected to a skid-mounted metering pump by means of a flexible hose. The caustic solution is then pumped into the tank through an available tank riser. This method can be used for both high- and low-hydroxyl ion concentration in the waste.

- A vendor-owned tanker truck carrying caustic solution is connected to a spare tank riser, and a predetermined quantity of solution is added directly to the tank. This method can be used when the hydroxyl ion concentration in the waste is low enough to potentially cause serious corrosion.

- A vendor-owned tanker truck carrying caustic solution is connected to a DCRT riser, and with the DCRT agitator operating, a predetermined quantity of solution is added directly to the DCRT. This method can be used when the hydroxyl ion concentration in the waste is low enough to potentially cause serious corrosion.

Water is added to tanks to replace water lost by evaporative cooling (e.g., Tank 241-C-106) or during the installation, removal, and decontamination of in-tank or process pit equipment. When water is added to replace water lost by evaporative cooling, raw water or potable water (Section 2.8.1) is added directly to the tank.

Water (i.e., raw, potable, or deoxygenated water) is also added to waste tanks during instrument tree installation, pump pit flushing, salt cake lancing, and equipment removal decontamination. The water is supplied by the raw water supply system or tanker trucks.

2.5.2 Waste Transfer

Preestablished routes are used to transfer liquid waste safely from one location to another in response to processing requirements, changing tank storage needs, or tank leaks. The waste transfer operations are as follows:

- Internal transfers
  - Tank farm to tank farm
  - DST to DST within a tank farm
  - SST to DST
  - SST to DCRT
  - DCRT to DST
  - Catch tank to DST or DCRT
  - 204-AR Waste Unloading Facility to DST
  - 242-A Evaporator to or from tank farm.

- External transfers
  - Between process facilities and DCRTs
  - 204-AR Waste Unloading Facility to DST.

Before transferring waste, Tank Farm Operations performs several activities. These activities include verifying that sufficient space is available in the receiving tank, verifying the waste chemistry (by sampling and characterization) to ensure that the waste to be transferred is compatible with the receiving tank waste, performing criticality safety analyses to ensure that stored waste will remain in a subcritical state, and verifying equipment operability. A baseline material balance is developed before the transfer for both the sending and receiving storage tanks. Before cross-site transfers, the transfer line is prefilled with water to verify valve lineups, routing line integrity, and to heat the line prior to the transfer. The material balance is reviewed periodically during the transfer to provide early leak detection and avoid filling tanks above safe levels. After the transfer, all associated equipment is de-energized. Transfer lines are flushed with water, if required, and a final material balance is recorded for both tanks.

2.5.2.1 Salt Well Jet Pump Design and Description. The SWP process uses a motor/pump and jet pump. A typical installation is shown for reference in the salt well jet pump isometric view, Figure 2-46. Minor variations may occur in some applications. The jet pump is located near the bottom of the salt well screen. The motive power for the pumping process is provided by a centrifugal pump/induction motor (squirrel cage) unit that is located on top of the salt well screen assembly in the pump pit. The motor and centrifugal pump assembly is hermetically sealed and thus is ideal for pumping hazardous materials. No part of the pump shaft is exposed, which could be a source of leakage if a packing gland were to fail. The pump and motor assembly, as currently procured for SWP, is rated for or otherwise qualifies for service in Ignition Control Set 2 environments.

A recirculation line flushing system is included so that the pump motor and recirculation line can be flushed. The SWP instrumentation includes a pressure sensor that monitors the pump discharge pressure. The pump inlet and discharge legs run inside the salt well screen. Adjacent to the pump-discharge leg are dip tubes. The dip tube system allows the liquid level and specific gravity in the salt well screen to be determined. This instrumentation allows the SWP system to be placed in the automatic mode. In this mode, the pump runs continuously, and the flow through the pump to the transfer system is regulated by the operation of a diaphragm-operated valve. In some instances, a dip tube may be added to provide real time waste dilution during pumping. In normal operation, the pump export flow rates will vary between 19 - 0.19 L/min (~5 and 0.05 gal/min.).

Water-lancing of the tank waste and the waste surface inside the salt well screen may be necessary to minimize installation interferences. The water-lancing procedure would use hot (<93 °C [<200 °F]) water to penetrate any crust within the salt well screen and create a circular entry area that is large enough for the jet pump unit and dip tubes within the salt well screen. The amount of water used with the lance is metered at the supply source, usually a portable water truck.

The following paragraphs describe the various components that make up the SWP operation:

2.5.2.1.1 Salt Well Screen. The salt well screen is a purely mechanical device. The screen assembly consists of several components: the top flange, pipe, screen assembly, bottom cap, and the flush line. The top or open end has a flange welded around a schedule-40 steel pipe. The flange is used to support and stabilize the screen assembly after it has been installed in an available tank riser. The steel pipe portion of the screen extends approximately one-third of the overall length of the screen assembly. The remaining length is made up of a stainless-steel screen assembly. The length of the screen portion of the salt well assembly is normally established for a particular tank so that, when installed, the screen extends above the surface of the waste.

The salt well casing assembly description provided here is typical, and minor variations (e.g., pipe diameter, location and size of openings, etc.) may occur in some applications. The screen portion extending above the waste surface helps ensure that any liquids in the tank can migrate to and into the screen cavity for pumping. The bottom of the salt well screen assembly consists of two flat plates welded to the stainless-steel screen cylinder. These two plates have a solid cylindrical spacer that keeps them apart. The lower plate has several small holes drilled uniformly around the plate with one hole in the center. A small pipe is connected to the space between the two plates. This pipe extends the length of the salt well screen, inside the screen cavity, and terminates at a threaded coupling just inside the top of the salt well pipe assembly.

During installation, a water hose is connected to this pipe for flushing. Water exits the lower plate holes as the salt well screen assembly is lowered into the waste. This flushing water helps to clear the waste away so that the salt well screen will seat properly in the waste. The bottom of the salt well screen is normally close to the bottom of the tank (nominally 5 cm [2 in.]) when fully installed. The screen is equivalent to a number 400 mesh size, which allows liquid waste to pass through the salt well screen (enter the pump cavity) while preventing solid waste from migrating to the jet pump. The jet pump is installed near the bottom of the salt well screen cavity to maximize the amount of interstitial liquid that can be pumped.

2.5.2.1.2 Jet Pump Unit. The jet pump is located at the bottom of the salt well screen. A typical installation is shown for reference in the Jet Pump Unit and Foot Valve, Figure 2-67. Minor variations may occur in some applications. It is suspended in the screen cavity by supply and return lines. These lines are connected to the salt well pump plate that is installed in the pump pit. Variable pumping rates are achieved in the SWP operations by using a recirculation configuration with bypass valving to allow slower export rates, while maintaining higher circulation rates. The centrifugal pump pressurizes the motive fluid that is pumped to the jet assembly. The motive fluid passes through the nozzle in the jet assembly and converts the fluid pressure head to velocity head, thus reducing the pressure in the jet assembly chamber. The reduction in pressure allows the interstitial liquid to enter the jet assembly chamber and mix with the motive fluid. Velocity head is then converted to pressure head above the nozzle, lifting the motive fluid and interstitial liquid to the pump-discharge leg.

The jet-pump unit includes an integral foot valve, which is a check valve that is intended to prevent the drainage of the pumped fluid if the salt well pump is shut down for any reason. The foot valve can be opened to allow drainage of the pump legs as required.

The jet pump unit is connected to the inlet and outlet (downcomer) piping using pipe union fittings and quick-disconnect couplings. Thus, in the event of failure of the jet pump unit, it is possible to remove the pipe and jet pump unit and install another jet pump unit in the field.

2.5.2.1.3 SWP System Piping and Valves. The SWP process uses a unique pipe and valving arrangement to convey pumped waste from the tanks. The typical overall piping arrangement is depicted for reference in Figure 2-68, Salt Well Pump Piping and Instrument Diagram. Minor variations may occur in some applications. Not shown is the tank in which the jet pump and salt well screen are installed, or the details of the jet pump recirculation line flushing and flow monitoring subsystem (which is shown schematically in Figure 2-46). Each of the valves in the main system is described below.

Foot Valve: The foot valve is an integral component of the jet-pump assembly, discussed in section 2.5.2.1.2. It is a check valve that prevents liquid from draining from the supply and return lines of the pumping system.

Drain and Pump Valve (JP-1): This is a two-position, three-way valve. It is located above the salt well pump in the pump pit. The valve is actuated manually by a "T" bar-type valve handle extension by operations personnel standing on the pump pit cover. The valve can be aligned in the recirculate mode, in which case waste fluid is circulated between the centrifugal pump and the jet pump unit, with pumped liquid leaving the system through the diaphragm-operated valve (DOV) or bypass valve (JR-2). In the drain position, flush water passes through the salt well jumper and then into the tank through the salt well casing drain line. In this mode, flushing water goes through the centrifugal pump and the jet pump, and the foot valve prevents flushing water from entering the tank. In the recirculate position, the pump, jet pump, and foot valve may be flushed by operating the foot valve and allowing the flush water to run out the foot valve.

Bypass Valve (JR-2): JR-2 is a manually operated valve used to bypass flow around the main flow control valve (i.e., the DOV). JR-2 also is operated by a "T" bar handle by operations personnel standing on the pump pit cover. JR-2 usually is opened at the beginning of SWP activities. JR-2 also may be opened for flushing and priming operations.

DOV: The DOV is a plug valve with an air operator attached to position (incrementally open or close) the valve to regulate the flow and therefore the pumping rate of the salt well jet pump system. The salt well pump and jet pump essentially act as a closed-loop flow system. When the DOV and JR-2 valve are closed, fluid is simply pumped around the loop. When the DOV or the JR-2 valve are open, the fluid exits the pumping loop and travels toward its final destination. The DOV is calibrated by adjusting the spring tension in the valve operator to offset the supplied air pressure.

Discharge and Flush Valve (JR-1): JR-1 is a three-way manually operated valve. It is operated by a "T" bar valve handle by an operator standing on the pump pit cover. JR-1 can be positioned to allow the pumped waste fluid to enter the transfer line or to allow flush water to flush either the transfer line or the salt well pump and jet pump unit. JR-1 has a position indication such that the SWP control system can monitor the valve's position.

Flush Water Check Valves: The flush water supply line is provided with two in-series check valves to prevent tank waste from accidentally being pumped into the flush water supply.

Discharge and Flush Jumper Connections: The flush line and the discharge line are connected to the salt well pump assembly. The discharge line of the salt well assembly is connected to a transfer line nozzle in the pump pit by a flexible jumper. The flushing connection is brought out of the top of the pump pit cover, where a quick-disconnect hose connector is used to allow a flush water hose to be connected.

DOV Control Air Line: The DOV control air line is a flexible air hose that is brought out of the pump pit and is connected to an electrical current-to-pneumatic pressure converter in the SWP control cabinet.

2.5.2.1.4 Salt Well Assembly Instruments. This section describes the instruments that are mounted on the jet pump assembly in the pump pit and in the SWP control cabinet. All of the instruments in the salt well pump pit are rated for or otherwise qualify for service in Ignition Control Set 2 environments.

Pump Discharge Pressure Sensors: The discharge header has a pressure sensor to protect the pump. The pressure sensor is calibrated to detect low or high discharge pressure. Low pressure may be caused by a plugged jet pump unit, a plugged salt well screen, or another problem causing poor pump prime. Low discharge pressure results in an alarm and a pump trip after a few seconds of low pressure. High discharge pressure could be caused by a blocked transfer path (e.g., mis-positioned valve or a plugged line). High discharge pressure results in an alarm and pump trip.

Flush Water Supply Pressure Detection System: The flush water supply line is provided with a detection system. The system is activated by a change in pressure in the supply line, indicating a possible waste leak into the flush system. Activation of the pressure detection system while pumping is in progress will cause an alarm and pump trip.

Process Flow Transmitter and Totalizer: A flow transmitter and associated flow totalizer are provided. The flow transmitter is a non-contact magnetic instrument that measures total system flow from the jet pump assembly to the site transfer system. This instrument includes the flow totalizer which displays flow rate and total gallons pumped.

Pump Suction and Discharge Pressure Transmitters: Pressure transmitters are installed on the SWP suction and discharge header. These transmitters are connected to the SWP control system. The suction and discharge pressure readings, in conjunction with the pump flow readings, are used to evaluate pump performance and to detect possible line blockage (either suction or discharge). These devices also can be used to provide backup pressure interlocks in the event the pressure sensor fails or is found unserviceable.

2.5.2.1.5 Salt Well Pump Control System. The SWP control system is designed so that several salt well pumps in different tanks can discharge into a common line. Each pump is interlocked with other pumps in its group to provide safe and orderly shutdown of the group in the event of any single pump shutdown, unless the shutdown pump is isolated from the common header. The following paragraphs provide additional detail of the SWP control system. In some cases, existing tank farm equipment, including weight factor instrument enclosures, pump and leak detector control stations, water and air services may be used for SWP in lieu of the skid mounted system. The operation of this equipment will be similar to that described herein for the skid mounted system.

2.5.2.1.5.1 Control Skid and Enclosures (If Used). The control system is skid mounted on a fabricated frame containing four major enclosures. These enclosures, which protect the equipment contained within them, include:

1. Power Rack: This assembly provides the connection point for the incoming power and contains the distribution panel, transformer, intrinsic safety panel and motor starters. Connections to some of the pit instruments and jet pump tie into this assembly.

2. Water Tank Enclosure: This enclosure holds a water tank containing sufficient water to allow the dip tube system to operate for extended periods of time between refills from a water truck. The water is freeze-protected and pressurized. The enclosure contains instruments to monitor tank water level and pressure.

3. Weight Factor Enclosure: This enclosure contains instruments and dip tubes for determining liquid waste specific gravity and waste tank level. There is instrumentation for control of the diaphragm-operated valve (DOV). On older model skids, the enclosure contains a flow meter and jet pump discharge and suction pressure indicators.

4. Air Compressor Enclosure: This cabinet contains an air compressor that provides pressurized clean air to the water tank, and pressurized instrument grade air to the dip tubes. The cabinet also contains an electrical current-to-pneumatic pressure controller for the DOV, and flammable gas monitors. A temperature probe monitors the enclosure temperature.

5. Control Assembly or Instrument Enclosure: The Control Assembly on the older model skids contains an instrument panel, leak detection panel, and an interconnect panel. The assembly contains connection points for the programmable logic controller (PLC), leak detection relays, and pump and jumper heat trace control relays. Newer model skids contain an instrument enclosure which contains the PLC, leak detection relays, heat trace control relays, flow meter, and jet pump discharge and suction pressure indicators.

The skid is located next to the pump pit to ensure a "downhill" slope for the portable instrument lines. These lines connect the dip tubes in the salt well pump pit to the weight factor cabinet. All exposed metal on the skid and cabinets is painted to protect against corrosion.

2.5.2.1.5.2 Power System. AC power will be provided by a temporary connection to the tank farm electrical distribution system. All electrical equipment is grounded to the skid, and a ground conductor is connected to a facility grounding point (field determined).

2.5.2.1.5.3 Compressed Air System. The compressed air system consists of an oil-free direct drive compressor typically rated at 91 L/min at 0.62 Mpa (3.2 scfm at 90 psig) for the many of the older model skids and rated at 198.2 L/min at 6.89 Bar (7 scfm at 100 psig) for the newer model skids. Air leaves the compressor and routes through instrument air filters and dryers before reaching the air receiver tank. A pressure gauge visible from the outside of the compressor enclosure provides operations personnel a means to monitor the system air pressure.

2.5.2.1.5.4 Dip Tube System - Salt Well Level, Specific Gravity, and Weight Factor. A key instrumentation system for the SWP activity is the dip tube system and related process instrumentation. The dip tube system consists of pressure measurement pipes that are positioned uniquely in the waste tank so that the tank liquid level and waste fluid specific gravity can be determined. Two of these pipes extend to the bottom of the salt well screen. One of the tubes extends almost to the bottom of the salt well screen, and another is cut accurately so that the vertical distance from the bottom tube opening is 25.4 cm (10 in.). A third tube is installed and terminates inside the salt well cavity to provide a reference leg for the dip tube system. Alternatively, the reference leg may be terminated outside the tank.

Because openings for two tubes in the bottom of the salt well are below the liquid surface, to measure differential and actual pressure, a "bubbler"-type level measurement system is used. This is a standard industrial process in which air is pumped through the submerged tubes and thus air "bubbles" up through the waste liquid. The amount of air is regulated, and the flow rate can be read by a rotameter in the weight factor cabinet. The pressure measured on each tube corresponds to the pressure head created by the waste liquid.

The dip tubes potentially could be plugged by the waste and create erroneous readings. To prevent this, a small amount of water is "dripped" (allowed to run) continuously down the dip tubes while SWP activities are in progress. This water helps prevent the formation of or solidification of waste crystals in the dip tubes. The water is supplied from the water tank on the salt well instrumentation skid (if used) or from the tank farm's raw water supply system. The ends

of the pipes at the bottom of the salt well also have a notch cut in them to help prevent waste from plugging the tubes.

2.5.2.1.5.5 Leak Detection System. The SWP process uses leak detectors in the various transfer pits to help detect possible waste leakage. These leak detectors are conductivity probes mounted ~1.5 cm (0.6 in.) above the floor of the valve and pump pits. Because these pits generally slope toward pit drains, the leak detectors are installed near the low point adjacent to these drains. The instruments work on the principle that liquid in the pits will contact these probes and allow an electrical current to flow. There are leak detectors in the salt well pump pit, valve pits (if any), the COBs (if any), DCRT pit (as applicable) and at the DST receiving pit. The leak detectors are interlocked with the SWP control system such that any leak detector setting off an alarm will result in a visual alarm, and the salt well pump will automatically shut down, causing an audible alarm.

2.5.2.1.5.6 Flammable Gas Monitoring. Flammable gas monitoring (WHC-SD-WM-FDC-050) is required in the pump pit and the tank vapor space. In addition to the periodic monitoring requirement in TSR AC 5.11.2 (HNF-SD-WM-TSR-006), continuous monitoring shall be performed (except in the tank vapor space of Tank 241-T-104) as an additional measure of conservatism above and beyond what is required by the analyzed consequences as directed by the U.S. Department of Energy, Richland Operations Office (RL) (Wagoner, 1998a, *Contract Number DE-AC06-96RL13200 - Authorization Basis Amendment Package Transmittal for Saltwell Jet Pumping of Single-Shell Tanks*). Flammable gas data collected can be used in considering future modifications to controls and as input to resolution of the Flammable Gas Safety Issue.

The pump pit monitor is equipped with an automatic interlock and the tank vapor space monitor with an alarm to shut down pumping if 25% of the lower flammability limit (LFL) is reached as an additional measure of conservatism not required as a result of analyzed consequences as directed by RL (Wagoner, 1998a). If any flammable gas monitoring device measures ≥ 25% of the LFL, SWP will be discontinued until all flammable gas monitors indicate < 25% of the LFL.

2.5.2.1.5.7 Ventilation. A portable exhauster (WHC-SD-WM-DB-035, *Functional Requirements for Portable Exhauster System to be Used During Saltwell Pumping*, and HNF-S-0490, *Specifications for a Portable Exhauster System for Waste Tank Ventilation*) will be used as a Defense-In-Depth measure for all tanks to be salt well pumped except Tanks 241-T-104 and 241-T-110 and the SX Farm tanks if the tanks are actively ventilated. The portable exhauster may be trailer mounted and is capable of being deployed to a tank if it exceeds 25 % of the LFL and it is determined that the exhauster could be beneficial to reduce the time at risk versus allowing passive ventilation to dilute the headspace below 25% of the LFL (Kinzer 1999). Use of a portable exhauster is an additional measure of conservatism that is not required as a result of analyzed consequences but is directed by RL (Wagoner 1998a). The portable exhauster is designed to provide a flow rate equal to or greater than 5,663 L/min. (200 scfm) and meets Ignition Control Set 2 and all environmental and regulatory requirements.

2.5.2.1.6 Single-Shell Tank, Double-Contained Receiver Tank, (as applicable) and Double Shell Tank Existing Instrumentation. The source tank (SST), DCRT (as applicable), and receiving tank (DST) have existing instrumentation that will be used in conjunction with SWP activities to provide monitoring for level and temperature.

2.5.3 Waste Characterization

Characterization of the waste (i.e., identifying the type, form, and quantity of radiological and chemical constituents) in each tank is an integral part of the effort to control the hazards associated with the radioactive waste stored in the tanks. Specifically, waste characterization data can be used for (1) understanding and resolving safety and operational issues; (2) enabling the continued safe storage and management of the wastes until retrieval operations begin; and (3) providing information to support the development and selection of waste removal, treatment, and final disposal options.

Tank waste is sampled for characterization in the underground SSTs and DSTs, DCRTs, catch tanks, and inactive miscellaneous underground storage tanks. Although waste sampling for characterization is performed at the other TWRS facilities (e.g., 209-E), those activities are performed to meet regulatory requirements and waste acceptance criteria. The samples are transported to analytical laboratories and analyzed. Tank waste characterization follows the tank waste analysis plan (WHC-SD-WM-PLN-091, *Fiscal Year 1995 Tank Waste Remediation System Tank Waste Analysis Plan*, and WHC-SD-WM-PLN-101.

2.5.4 Waste Concentration

The tank waste concentration process concentrates and evaporates low-heat-producing wastes stored in the underground DSTs to reduce the volume and generate more available space for waste storage. Evaporation of water and its removal from the waste is the principal process used to save tank space at TWRS.

The 242-A Evaporator in the 200 East Area (not included in the scope of this FSAR), passive evaporation of water from radioactive decay, and the evaporation of water into the induced draft ventilation air stream through actively ventilated tanks, all provide means for concentrating the waste.

2.5.5 Interim Stabilization

Interim stabilization involves the pumping of supernate or drainable interstitial liquid from SSTs through underground or surface transfer lines into DCRTs and eventually to a DST. A tank is considered to be interim stabilized if it contains less than 18,925 L (5,000 gal) of supernate and less than 189,250 L (50,000 gal) of drainable interstitial liquid.

Equipment used for interim stabilization is described in Section 2.5.2.1.

2.5.6 Activities at Miscellaneous Tank Farm Facilities

Operations at the 209-E less than 90-day waste storage pad; low-level waste storage pad; cribs, ditches, and ponds; and the vertical storage units support other aspects of managing radioactive and hazardous waste and are discussed briefly in the following sections.

2.5.6.1 209-E Less Than 90-Day Waste Storage Pad. Activities at this facility, which complies with *Resource Conservation and Recovery Act of 1976*, are governed by tank farm operating procedures and include the following:

- Waste acceptance from waste generators
- Waste acceptance at the 209-E less than 90-day waste storage pad
- Inspection of the 209-E less than 90-day waste storage pad
- Waste repackaging at the 209-E less than 90-day waste storage pad
- Investigation of unknown or suspect waste from a tank farm facility.

2.5.6.2 Low-Level Waste Storage Pad. Activities at this facility are governed by tank farm operating procedures and include the following:

- Preparing the bulk low-level waste box
- Preparing the low-level waste sample box
- Filling the bulk and sample low-level waste boxes
- Inspecting the low-level waste staging area weekly
- Assisting the vendor in performing assay service
- Assisting the crane crew in weighing wooden boxes
- Preparing low-level waste boxes for shipment.

2.5.6.3 Cribs, Ditches, and Ponds. Cribs, ditches, and ponds were used in processing operations to decant low-level radioactive and hazardous waste streams to the soil. This practice is no longer acceptable and has been discontinued. The cribs, ditches, and trenches described in Section 2.4 are inactive facilities. As discussed in Section 2.4, B Pond (lobe 216-B-3C) is active.

2.5.6.4 Vertical Storage Units. The vertical storage units described in Section 2.4.9.2 stored various pieces of contaminated equipment related to the safe storage and transfer of tank wastes. These facilities are inactive.

2.5.7 Equipment Installation or Removal

It will be necessary during the operation, maintenance, and decontamination and decommissioning of TWRS facilities to install or remove equipment from the facilities. The process followed to install, maintain, or remove equipment is an integrated effort among

facilities operations and engineering personnel, safety (radiation and hazardous chemical protection) personnel, and crafts or maintenance personnel.

The installation and removal of equipment from nonhazardous areas (i.e., areas with no potential for radiological or toxicological exposure) are performed using techniques and equipment typically found in industry. Although the installation or removal of equipment within hazardous areas may generally be performed using industry techniques and equipment, additional protective measures are required.

As discussed in Chapters 7.0 through 10.0, TWRS operations and engineering, radiation and hazardous chemical safety, and crafts or maintenance personnel evaluate the planned activity before starting work in a hazardous (potentially contaminated) area. Based on the activity and the known or suspected hazards, the evaluation will determine what protective measures are required to maintain personnel exposures As Low As Reasonably Achievable. Additional protective measures can include pre-job planning; flammable gas, radiation, and toxicological monitoring; and providing temporary confinement structures, temporary shielding, spark resistant tools, in-tank or in-pit decontamination spray wands, cranes, fixtures (e.g., positioning guides); or waste packaging, handling, and disposal.

2.5.8 Waste Surveillance Activities

Operators are required to monitor waste within the tanks and other ancillary systems (e.g., DCRTs). Those parameters that are routinely monitored to ensure safe operations are identified in the TWRS TSR controls. Monitoring of the waste can be performed using the existing automated systems (i.e., TMACS) discussed in Section 2.4.11.1 or the manually operated systems (i.e., ENRAFs, manual tapes) discussed in Section 2.4.11.2. These systems primarily are used to monitor waste levels within the tanks and ancillary systems. As discussed in Section 2.4.11.1, the TMACS also monitors performance of supporting systems (e.g., ventilation systems). The TMACS, which replaced the CASS, provides real-time dynamic graphics depicting the status of all parameters associated with the tank monitoring, including temperatures, liquid levels, tank pressures, ventilation flows, and hydrogen gas concentrations. This data is reviewed and trended by operations to determine current tank status and identify off-normal conditions.

2.6 CONFINEMENT SYSTEMS

Confinement systems accomplish the following:

- Minimize the spread of radioactive and hazardous materials within unoccupied process areas
- Prevent or minimize the spread of radioactive and hazardous materials to occupied areas

- Minimize the release of radioactive and hazardous materials in facility effluents during normal operation and anticipated operational occurrences

- Limit the release of radioactive and other hazardous materials resulting from evaluation basis accidents, including severe natural phenomena and manmade events, in compliance with the guidelines contained in DOE 6430.1A, Section 1300-1.4.2, "Accidental Releases."

Because TWRS manages large volumes of liquid wastes, confinement systems are not limited to those for the confinement of airborne materials. The same principles apply for those systems relied on to confine liquids. Therefore, the confinement systems at TWRS include tanks, transfer equipment (e.g., piping, diversion boxes, valve pits), structures, and ventilation systems. The confinement systems within TWRS that are applicable to a particular facility, structure, or process are described in Section 2.4.

2.7 SAFETY SUPPORT SYSTEMS

Safety support systems for the TWRS facilities consist of radiation protection, effluent monitoring, and fire protection.

2.7.1 Radiation Protection Systems

In addition to inherent radiation protection features (e.g., buried tanks and piping, thick concrete walls, roofs, and ceilings), the radiation protection system relies on portable and fixed instruments for detecting radioactivity.

2.7.1.1 Portable Radiation Monitoring Systems. Portable radiation monitoring systems are used as needed at the tank farms. Portable CAMs are generally placed inside operating facilities where deemed necessary for personnel safety. The radiation protection program and selection and use of portable instruments are discussed in Chapter 7.0.

2.7.1.2 Fixed Radiation Monitoring Systems. Fixed radiation monitoring systems in TWRS facilities include radiation detectors and exhaust CAMs.

- **Radiation Detectors**—Radiation detection probes are located in the dry wells adjacent to leak detection pits. The systems serve dual purposes: (1) indicating radiation levels and (2) serving as a backup for the radioactive liquid leak detection systems.

- **Continuous Air Monitors**—CAMs sample and monitor air for the presence of radionuclides in areas of potential airborne radioactivity. CAMs are installed to provide effluent monitoring. Process building CAMs are considered portable and are operated as part of the radiation protection program discussed in Chapter 7.0.

However, no fixed CAMs are present within the 200 West Area TWRS instrument and process buildings.

All tank farm fixed radiation detection instruments are designed with fail-safe mechanisms so that any system failure activates an alarm.

2.7.2 Effluent Monitoring Systems

One exhaust stack effluent monitoring program is associated with radionuclide sampling and monitoring, and a second is associated with ammonia sampling and monitoring. Programs associated with sampling and monitoring hydrogen gas and other flammable compounds are related to the tank vapor space. The following subsections contain general descriptions of the systems supporting the radionuclide and ammonia gas sampling and monitoring programs.

2.7.2.1 Stack Radionuclide Sampling and Monitoring Systems. The following sections discuss the stack sampling and monitoring systems for actively ventilated DSTs, AWF tanks, SSTs, DCRTs, and the 204-AR Waste Unloading Facility.

2.7.2.1.1 Elements. The stack radionuclide sampling and monitoring system consists of CAMs and fixed record samplers. A stack radionuclide sampling system consists of the following components:

- Sampling probe that collects the air sample from the stack
- Sample transport line that transports the sample to a sample collector point (i.e., fixed record sampler) or other detectors (i.e., CAMs)
- Collection or detection devices that collect the sample
- Rotameter that measures flow through the system
- Totalizer or gas meter that totals the sample volume
- Pressure or vacuum gauge that measures the vacuum in the system
- Flow switch that indicates when the sample flow rate falls below specified limits
- Flow regulator that adjusts the flow to maintain specified flow rates through the sampling system
- Vacuum pump that draws the sample stream through the sampling system
- Timer that indicates the time the collection devices have been operating.

The CAM system operates continuously while the exhaust system is operating and maintains representative sampling conditions as required to perform its safety function. The radionuclide monitoring systems used in TWRS are identified in Table 2-25 by facility and stack number.

2.7.2.1.2 Equipment. The stack sampling and monitoring system (Figure 2-63) comprises record samplers and CAMs.

- **Record Samplers (fixed)**—Data from record samplers is used for regulatory purposes. Record samplers quantify the dose the public receives from operation of that particular emission point.

- **Continuous Air Monitors**—CAMs are used for safety purposes. CAMs are set to alarm if emissions are detected above predetermined levels (WHC-EP-0479). CAMs can also be used to provide backup regulatory information.

A record sampler has only a collection filter. A CAM has a detector above or near the collection filter.

Some facility sampling systems have a sampling probe for the record sampler and a sampling probe for the CAM. Sampling systems at other facilities have a single sampling probe, from which the sample is split and routed separately to the record sampler and the CAM.

To ensure that a representative sample is obtained, flowmeters and regulators, flow totalizers, and vacuum pumps control and measure the flow rate through the sampling system, as shown in Figure 2-63. Air coming from the stacks is run through the fixed record sampler filter paper, then the flowmeter and flow totalizer, and finally the vacuum pump, which sucks the air through the system. Flow regulators with flow switches automatically maintain a specified flow within the system.

2.7.2.2 Ammonia Sampling and Monitoring Systems. Ammonia gas monitors are installed in waste tank exhaust trains at 241-AW and 241-SY Tank Farms. Ammonia is also monitored using portable monitors. The two monitoring methods currently used at TWRS are the photoacoustic infrared detection method and the ammonia detector tube method.

2.7.2.2.1 Photoacoustic Infrared Detection Method. The ammonia monitor at 241-AW and 241-SY Tank Farms uses the photoacoustic infrared detection method. Samples of the 241-SY Tank Farm exhaust stream are obtained from the exhaust stack downstream of the HEPA filters. The sample probe, constructed of corrosion-resistant or process-compatible materials, is inserted in the ventilation duct through a flange and turned 90° into the flow at the center of the duct. The sample is drawn through a 5-mm- (0.2-in.-) outside diameter Teflon tube inside the 6.4-mm- (0.25-in.-) inside diameter stainless steel tube. The sample line is heat traced

between the sample point and the enclosure housing the instrument to avoid sample condensation and freezing. System requirements for the photoacoustic infrared detection method are as follows (WHC-SD-WM-WP-254, *Engineering Work Plan for SY Farm Ammonia Stack Monitor 531-1972*):

- The system shall be capable of measuring ammonia from 10 ppm to 15,000 ppm in a gaseous mixture of ammonia, hydrogen, nitrous oxide, and moist air. Interference from the noted gases will be less than 2% of the total reading.

- Ammonia is to be measured in gas streams with temperatures ranging from 4.4 to 54.4 °C (40 to 130 °F).

- The ammonia monitor shall have an accuracy of ±10% of reading at 500 ppm.

- The ammonia monitor shall be qualified to sample process gases that are classified by NFPA 70 as Class I, Division 1, Group B.

2.7.2.2.2 Ammonia Detector Tube Method. The second ammonia monitoring method used at TWRS facilities where ammonia may be present depends upon ammonia detector tubes or similar devices, including a dräeger tube. The ammonia detector tube system consists of a tube containing gas absorption materials and a sample probe inserted into the exhaust stream. This system provides an indication of ammonia levels. This is a real-time monitoring method, but is not as accurate as the method used at the 241-SY Tank Farm by industrial hygiene personnel (Chapter 8.0).

2.7.3 Fire Protection Systems

Fire protection systems at tank farms consist of fire detection, alarm, and suppression elements. Details of the fire protection systems are provided in WHC-SD-WM-FHA-020, *Tank Farms Fire Hazards Analysis*, and details of the fire protection programs are described in Chapter 11.0. Important elements of the fire protection systems are discussed in the following subsections.

2.7.3.1 Water Supply. All water for the 200 East and 200 West Areas is supplied by two separate systems, the raw water system and the sanitary water system. The systems provide water for sanitary, process, and fire protection uses and are all piped and valved independently. See Section 2.8.1 for a more detailed description of the tank farm water supply systems.

2.7.3.2 Fire Suppression and Extinguishing Systems. Fire suppression and extinguishing systems in the tank farm facilities are limited to wet and dry pipe sprinkler systems and a Halon total flooding system. The fire suppression systems associated with each facility are identified in Table 2-26. The adequacy of these systems is discussed in WHC-SD-WM-FHA-020.

2.7.3.3 Tank Farm Fire Detection Systems. Smoke, heat, and manual fire detection are provided in tank farm facilities where required (Table 2-26). The detectors transmit alarms to the Hanford Fire Department by means of radio frequency alarm reporters, which transmit a radio signal to the Hanford Site 200 Area East/West Fire Station. Signal types are (1) a trouble alarm (i.e., problem with a system component), (2) a supervisory alarm (i.e., a monitored gate valve being closed), or (3) a fire alarm. The Hanford Fire Department takes appropriate action in response to an alarm. Installation and coverage of fire alarms are in accordance with NFPA 72, *National Fire Alarm Code*. Adequacy of the location and installation of detectors and alarms is assessed in WHC-SD-WM-FHA-020.

2.7.3.4 Fire Hydrants. Fire hydrants connected to the raw water system or sanitary water system grids are located throughout the 200 East and 200 West Areas. Coverage and adequacy of the hydrants are evaluated in WHC-SD-WM-FHA-020.

2.7.3.5 Fire Extinguishers. Portable fire extinguishers are provided throughout the tank farm facilities. If required (e.g., offroad or U.S. Department of Transportation required) mobile equipment is also equipped with portable fire extinguishers. Installation, inspection, and maintenance of extinguishers and employee training in their use are in compliance with NFPA 10, *Portable Fire Extinguishers*.

2.8 UTILITY DISTRIBUTION SYSTEMS

Utility distribution systems for the TWRS underground waste storage tanks and their associated facilities are as follows:

- Water supply
- Steam supply
- Compressed air
- Electrical power distribution.

2.8.1 Water Supply Systems

All water for the 200 East and 200 West Areas is supplied from the Hanford Site export water system. Export water is defined as water pumped from the Hanford Site reservoir to reservoirs located in the 200 East and 200 West Areas. Water is distributed throughout the area by two separate systems, the raw water system and the sanitary water system. Raw water is untreated and is used principally for cooling, flushing, and dilution systems. Sanitary water is treated and is used for drinking and sanitary facilities. Fire protection water supply is addressed in WHC-SD-WM-FHA-020.

Raw export water is pumped from the Columbia River through 1.1-m (42-in.) lines by means of 182-B (100-B Area) and 182-D (100-D Area) Pump Houses. The water is then pumped to the 2901-X Valve House, where two 0.8-m (30-in.) lines feed the water to the 2901-Y Valve

House. The water is again split at the 2901-Y Valve House. One 610-mm (24-in.) line goes to a 11.4-million-L (3.0-million-gal) storage reservoir (282-W), and two 0.6-m (24-in.) lines go to a 12.1-million-L (3.2-million-gal) storage reservoir (282-E). These two reservoirs supply raw water to facilities in the 200 East and 200 West Areas and the 283-E and 283-W Water Treatment Facilities. The two supply lines each have two different cross connections. The 283-E and 283-W Water Treatment Facilities process the raw water into sanitary water for use in the 200 East and 200 West Areas.

Raw water is pumped from the 282-E Reservoir by four manually started electric pumps and one standby steam pump that starts automatically. The steam pump is preset to start automatically when the water pressure drops to 621 kPa (90 lb/in^2). Each pump has a rating of 378 L/s (6,000 gal/min) at a total dynamic head of 82.3 to 107 m (270 to 350 ft). This raw water is used primarily for process needs and fire protection. The fire protection systems are discussed in Section 2.7.3.

A portion of the raw water from the 282-E Reservoir is diverted to the 283-E Water Treatment Facility for filtering and sanitizing. Water is similarly diverted from the 282-W Reservoir to the 283-W Water Treatment Facility. This sanitary water is supplied to the 200 East Area by electric pumps of 202 L/s (3,200 gal/min) total capacity equipped with two steam turbine standby pumps of 76 L/s (1,200 gal/min) total capacity. The sanitary water system provides water for sanitary, process, and fire protection uses.

Both the Columbia River and the emergency cooling water system provide cooling water for the condensers in the AWF tanks (Well 299-E2S-6, located approximately 268 m [880 ft] north of the 241-A-CT-400 cooling tower). This system consists of a cold water sump and warm water sump, each with two pumps, and an induced draft cooling tower, all located east of the 241-A-401 Condenser Building. The deep well pump and emergency cooling water equipment are supplied with standby power from the backup diesel generator.

All water supply piping that has the potential for contacting other water or radioactively contaminated liquids is protected with backflow preventers. In addition, to monitor raw water usage in TWRS facilities, flow totalizers have been installed in some systems (Table 2-27). The water supplies to the TWRS facilities are summarized by area and facility category (e.g., SST, DST, catch tank) in Table 2-27, and the uses of the water are identified. Additional detailed information is contained in WHC-SD-WM-FHA-020.

2.8.2 Steam Supply Systems

Although steam may be available at a TWRS facility, all systems that require steam to operate are out of service. All steam lines under direct control of TWRS that may directly impact a tank have been physically removed or isolated. As shown in Table 2-5, facilities not under direct control of TWRS (e.g., 242-A Evaporator) have the capability to transfer waste using steam.

2.8.3 Compressed Air Systems

Pressurized-air supply systems (portable or stationary) are provided and maintained for the air lift circulators, jets, process flowmeters (instrument air), ventilation controllers, and air samplers. Emergency (backup) air supply systems are readily available as either portable or stationary compressor units.

The compressors supply the instrument air systems essential for supplying purge air to the tank liquid-level FIC gauges and operating the pneumatic diaphragm differential pressure instruments and diaphragm-operated valves. The instrument air also purges the leak detection pit dip tubes, instruments, and instrument lines of condensate.

Interruption of power to the compressors cuts off the air supply needed for the instruments to operate correctly. Backup electrical generators restore power to the compressor motors to restore the air supply system to normal operation. However, in facilities lacking emergency or backup generators or if the backup generator will not start, backup air compressors are available.

In Table 2-28, the compressed air supply provided to the TWRS facilities is summarized by area and facility category (e.g., SST, DST, catch tank), and the use of the compressed air is identified. Additional detailed information can be found in WHC-SD-WM-HIE-007.

2.8.4 Electrical Power Distribution System

The Bonneville Power Administration (BPA) provides the main source of power to the 200 East and 200 West Areas by means of a major substation known as Midway. The BPA Midway Substation, which is located near Priest Rapids Dam, has three 230-kV buses. Each BPA Midway bus section is supplied by a line from the Priest Rapids generating station. BPA Midway buses No. 1 and No. 3 are also supplied by lines that are connected to the Grand Coulee 230-kV Substation and to 230-kV substations in the lower Columbia River power system. The Grand Coulee and lower Columbia River Substations are interconnected to the BPA 500-kV transmission system. The BPA 500-kV and 230-kV transmission systems are interconnected to all the Columbia and Snake River hydroelectric generating stations and northwest steam generating plants and are also interconnected to California and British Columbia power network systems.

In addition to supplying power to the Hanford Site and other U.S. Department of Energy substations, the Hanford Site 230-kV loop normally supplies power to Ashe and White Bluffs Substations. However, if both Midway power sources are lost, sufficient power for normal operations will flow into the Hanford Site 230-kV loop from the Ashe Substation.

Power from the Ashe Substation into the Hanford Site 230-kV loop is supplied by a 115-kV line connected to the White Bluffs Substation. One 115-kV line at the White Bluffs

Substation is connected to the BPA Franklin Substation. The other 115-kV line is connected to the BPA Benton Switch Substation.

Power is fed by two lines to the A-8 substation located near the intersection of the Yakima Barricade and 100-N highways (Route 11A and Route 4 North, respectively). The 251-W Building adjacent to the A-8 Substation contains the switchgear and control equipment. The A-8 Substation distributes it through four lines each to the 200 East and 200 West Areas. The power is then distributed to each individual tank farm by means of the 200 East and 200 West Areas power distribution system (Figures 2-64, 2-65, and 2-66).

Electrical power is managed and operated by the facility or plant manager and Electrical Utilities. Electrical Utilities is responsible for the operation, maintenance, and configuration management of the Site transmission and distribution system, up to and including the connection at the utility/facility interface. This includes auxiliary devices located downstream of the utility/ facility interface point that are used in conjunction with Electrical Utilities electrical power systems equipment.

The TWRS facility or plant manager is responsible for the operation, maintenance, and configuration management of facility electrical power systems. This includes auxiliary devices located upstream of the utility/facility interface that are used in conjunction with facility electrical power systems equipment.

2.9 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

Auxiliary systems and support facilities include administrative areas, control facilities, change trailers, communication systems, lighting, and sewage treatment.

2.9.1 Administrative Areas

The administrative areas within TWRS include the 200 East and 200 West Area tank farm operations buildings and document control centers. The 200 West Area operations offices are housed in mobile facilities that are located within the 200 West Area as needed and in the 272-WA Tank Farm Support Facility. The 200 East Area operations offices are housed in the 274-AW mobile offices and 272-AW Tank Farm Support Facility. Other TWRS staff are located in the 209-E, 2750-E, 2751-E, 2752-E, 2753-E, and 2704-HV buildings in the 200 East Area, the 1100 Jadwin Building, and the Federal Building in Richland.

2.9.2 Control Facilities and Change Trailers

Control facilities and change trailers for the SST and DST farms are listed in Table 2-29. The typical control facility (instrument building) houses all alarms and monitors for ventilation, temperature, and leak detection. Electrical power distribution is also routed from the control

facility. The steel frame building, typically 6.1 m (20 ft) by 9.8 m (32 ft), is constructed of fire-resistant materials. The walls are metal-insulated sandwich panels, and the steel-frame roof is insulated with fiberglass batting and a plastic backing. Other control facilities or control rooms are located within existing processing facilities. A typical change trailer is a trailer that has been modified to provide an area for workers to change their personal protective equipment when entering and leaving the tank farm area and to store personal protective equipment and personal radiation survey equipment.

The other control facilities or control rooms monitor alarms and support waste transfers between facilities. For example, within the 242-A Evaporator control room, monitors, alarm annunciators and control systems monitor 200 East Area tank farm system parameters (e.g., ventilation and tank level) or valve positioning, pump operation, and tank level data during waste transfers (WHC-SD-WM-SAR-023). Another example is the 242-S Evaporator control room in which monitors, alarm annunciators, and control systems monitor 200 West Area tank farm system parameters (e.g., ventilation and tank level) or valve positioning, pump operation, and tank-level data during waste transfers. The 242-S Evaporator control room is also used to monitor and control site transfers from the 200 West Area to the 200 East Area (WHC-SD-WM-SSP-002, *242-S Facility Shutdown/Standby Plan*).

2.9.3 Communication Systems

Telephones or handheld two-way radios are used for routine and emergency communications in the TWRS facilities. The telephones located in the control areas can be used to contact shift personnel. Telephones located in each change trailer are used to contact health physics technicians or other support personnel responsible for responding to abnormal events. All personnel within a facility are alerted to facility emergencies by in-plant signals (e.g., fire gongs and CAM alarms) and to Site emergencies by means of the public address system and crash telephone system.

2.9.4 Lighting

Lighting, either fixed or portable, is provided at all TWRS facilities to support 24-h surveillance and monitoring activities. In addition to the existing systems, high-mast lighting is provided in some tank farm facilities (e.g., 241-SY and 241-C) to support 24-h operations.

2.9.5 Sewage Treatment

Sewage streams originating in restrooms and change room toilets are routed by means of underground piping to septic tanks and tile fields for treatment. To prevent cross-contamination, these sewage streams are isolated from other facility liquid effluent streams.

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Figure 2-1. Facilities in the 200 East Area of the Hanford Site.

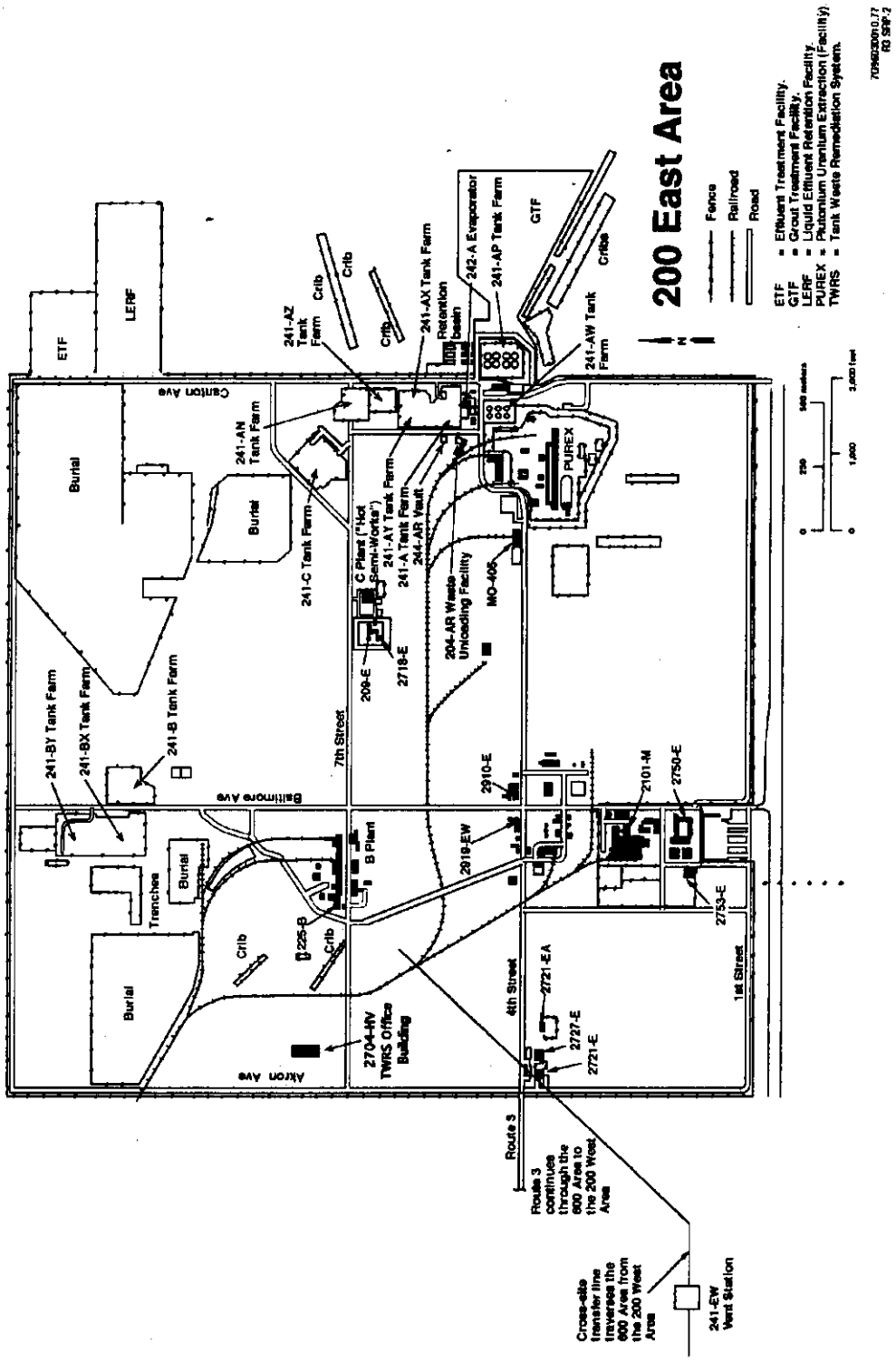

Figure 2-2. Facilities in the 200 West Area of the Hanford Site.

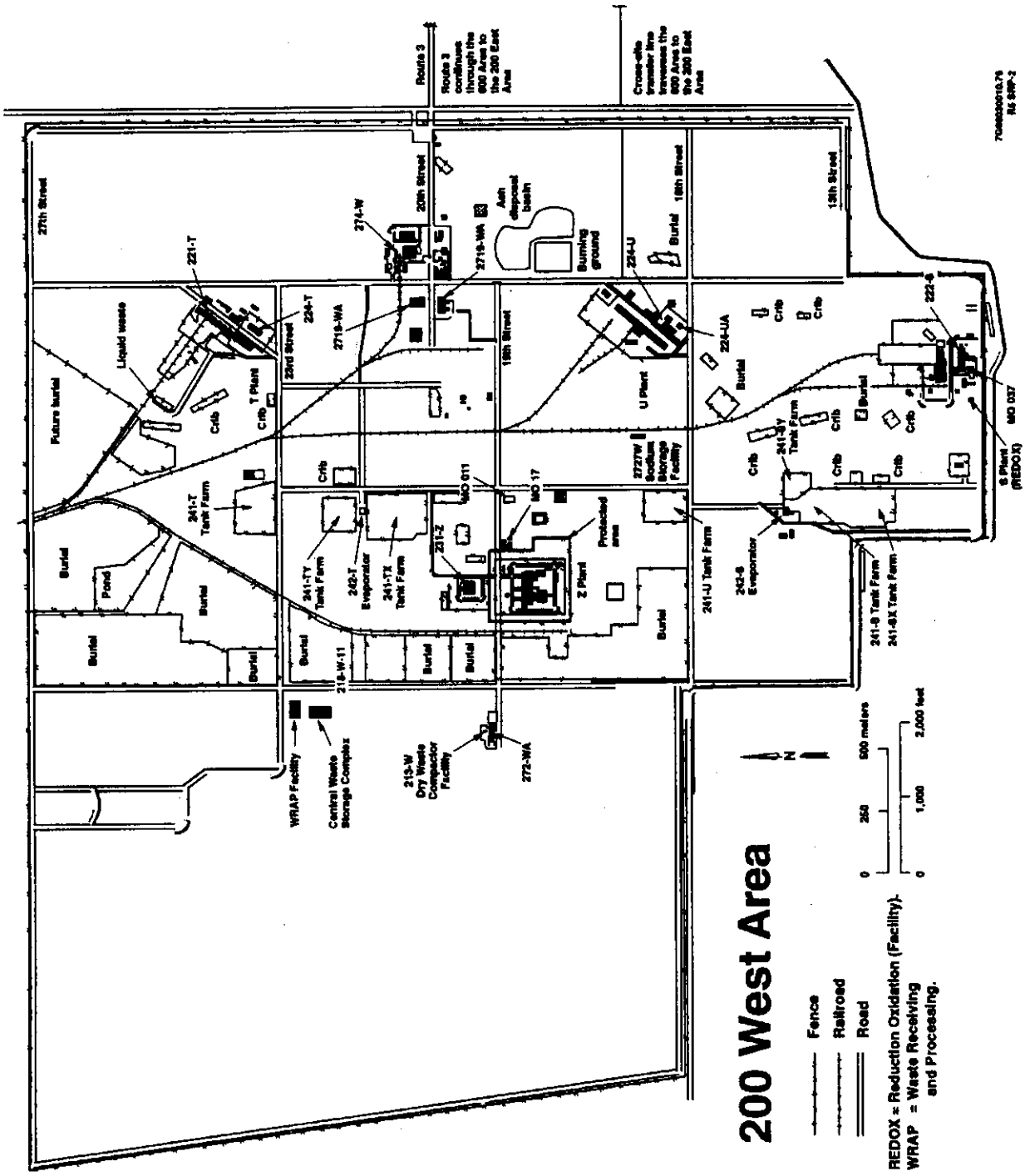

Figure 2-3. 200 East and 200 West Area Cribs, Ditches, and Ponds.

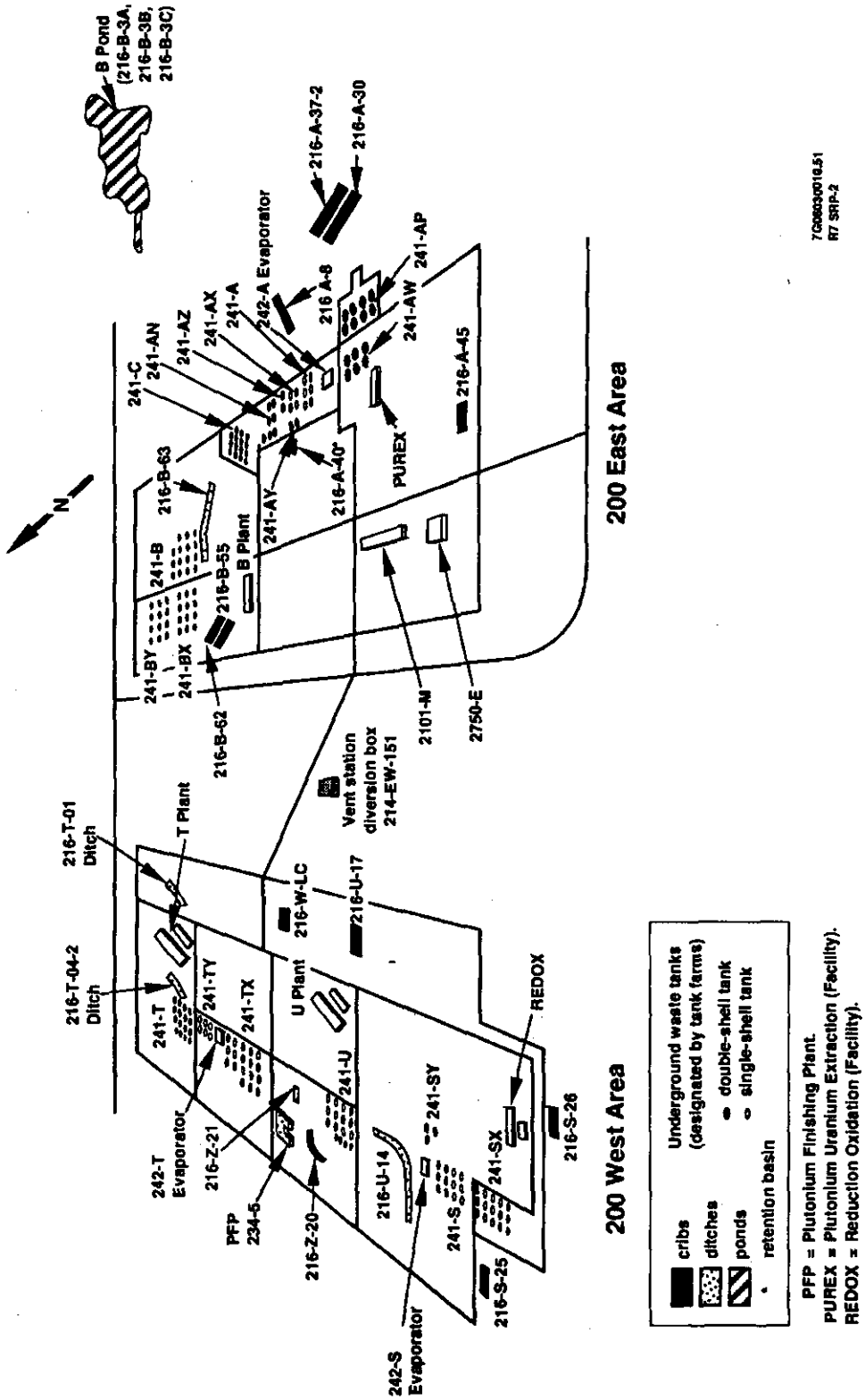

Figure 2-4. Tank Farm Facilities in the 200 East Area of the Hanford Site.

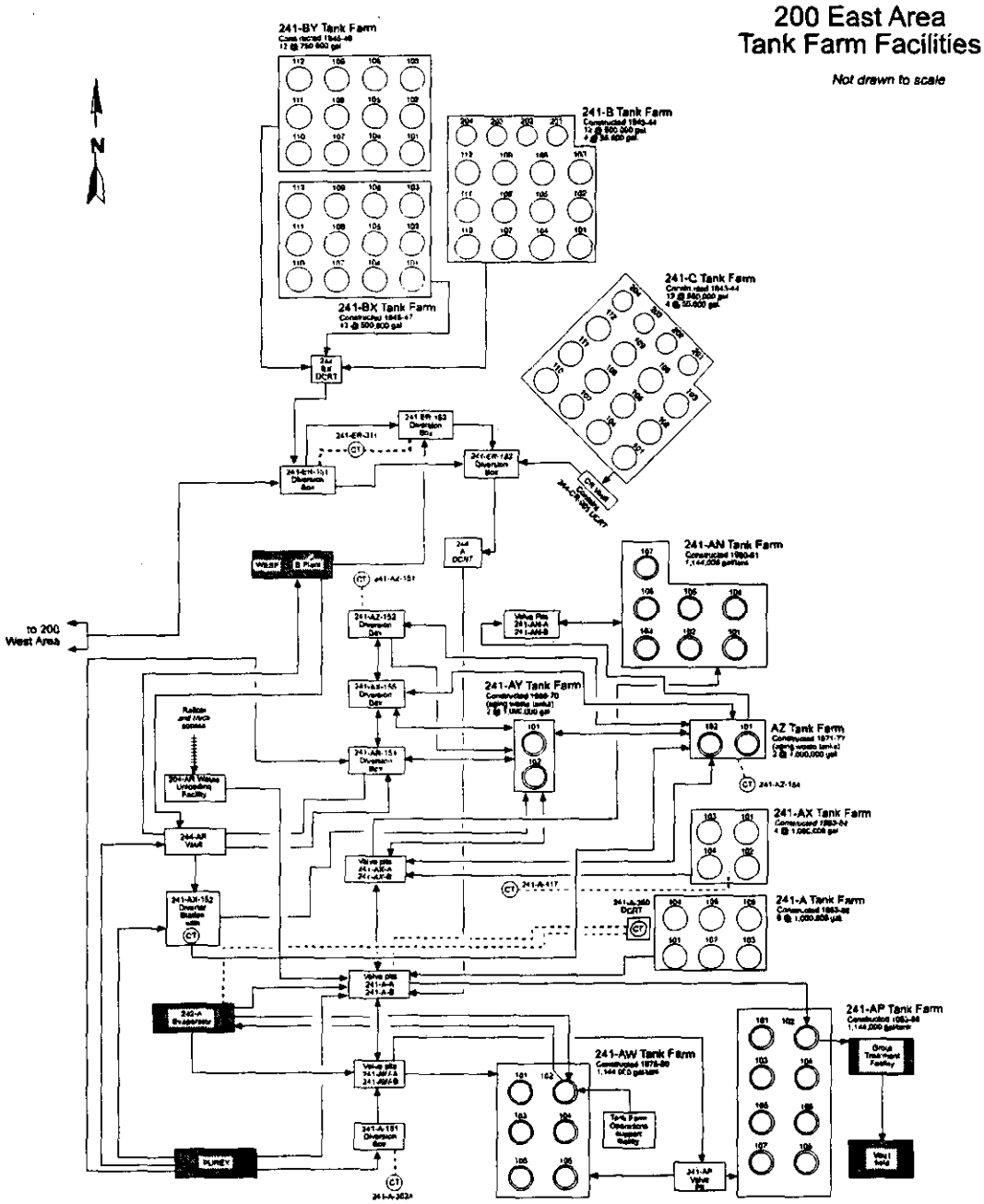

Figure 2-5. Tank Farm Facilities in the 200 West Area of the Hanford Site.

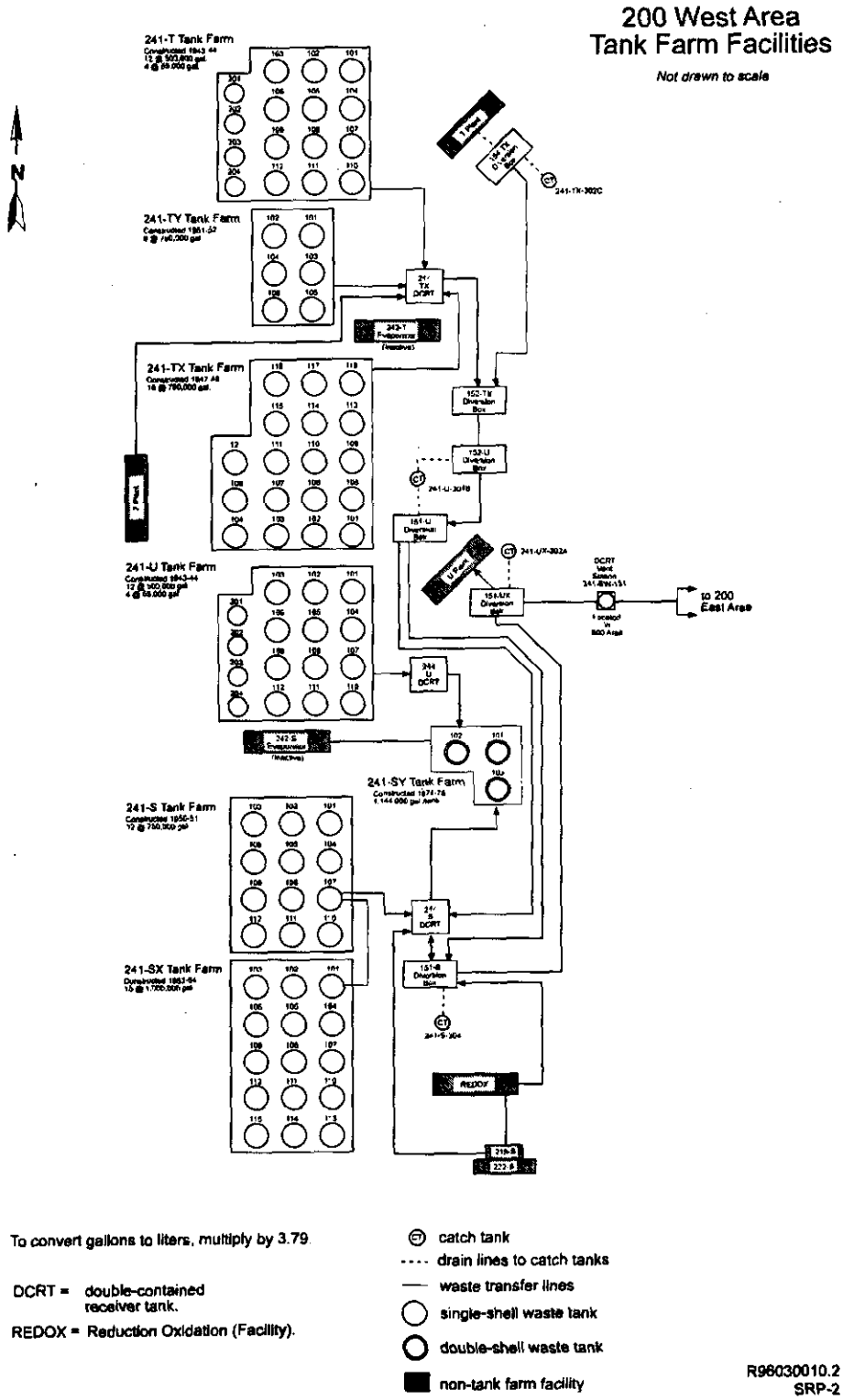

Figure 2-6. Examples of Liquid Waste Transfers to Tank Waste Remediation System Facilities for Use in Defining the Physical Scope.

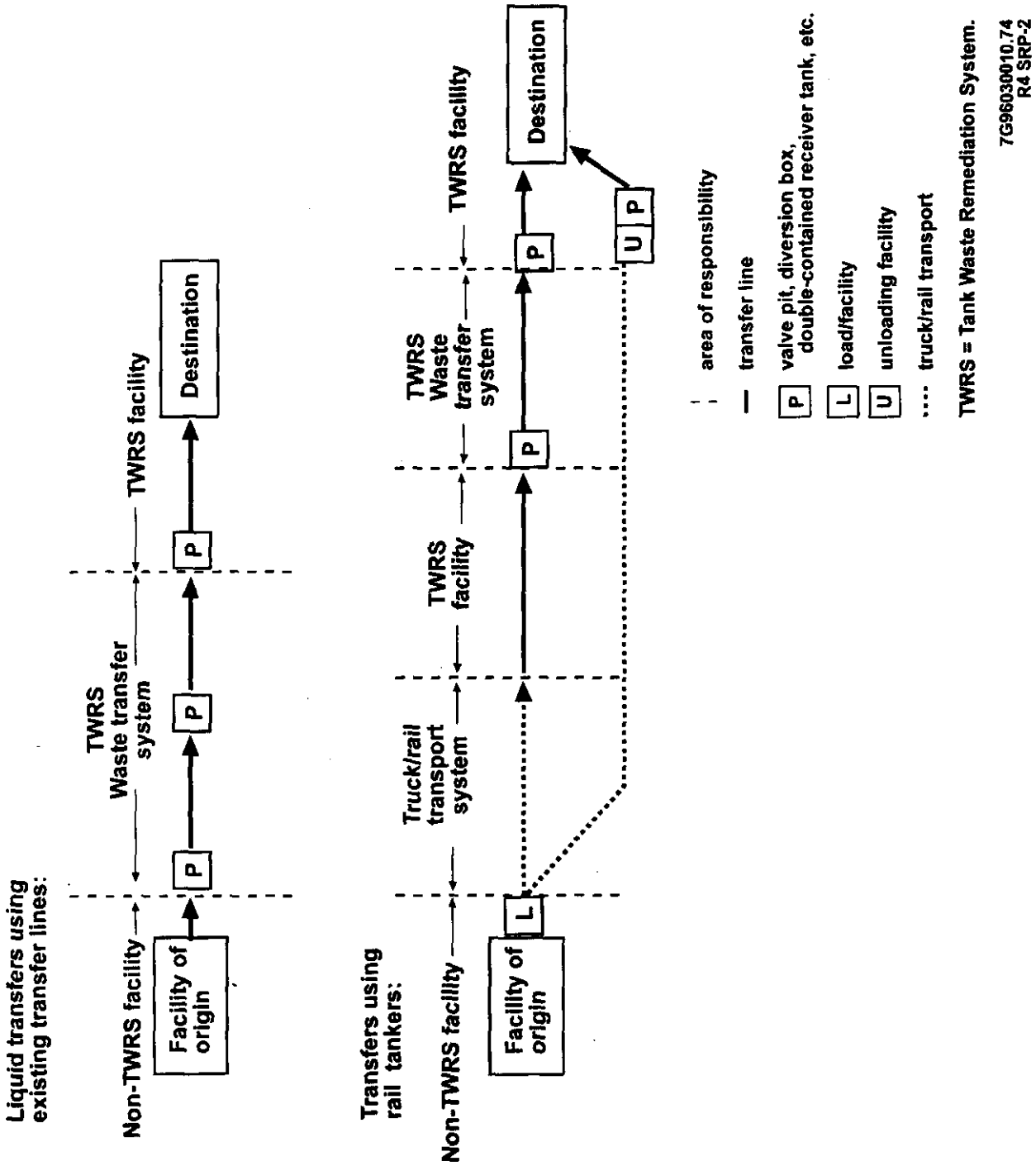

Figure 2-7. Examples of Liquid and Solid Waste Transfers from Tank Waste Remediation System Facilities for Use in Defining the Physical Scope.

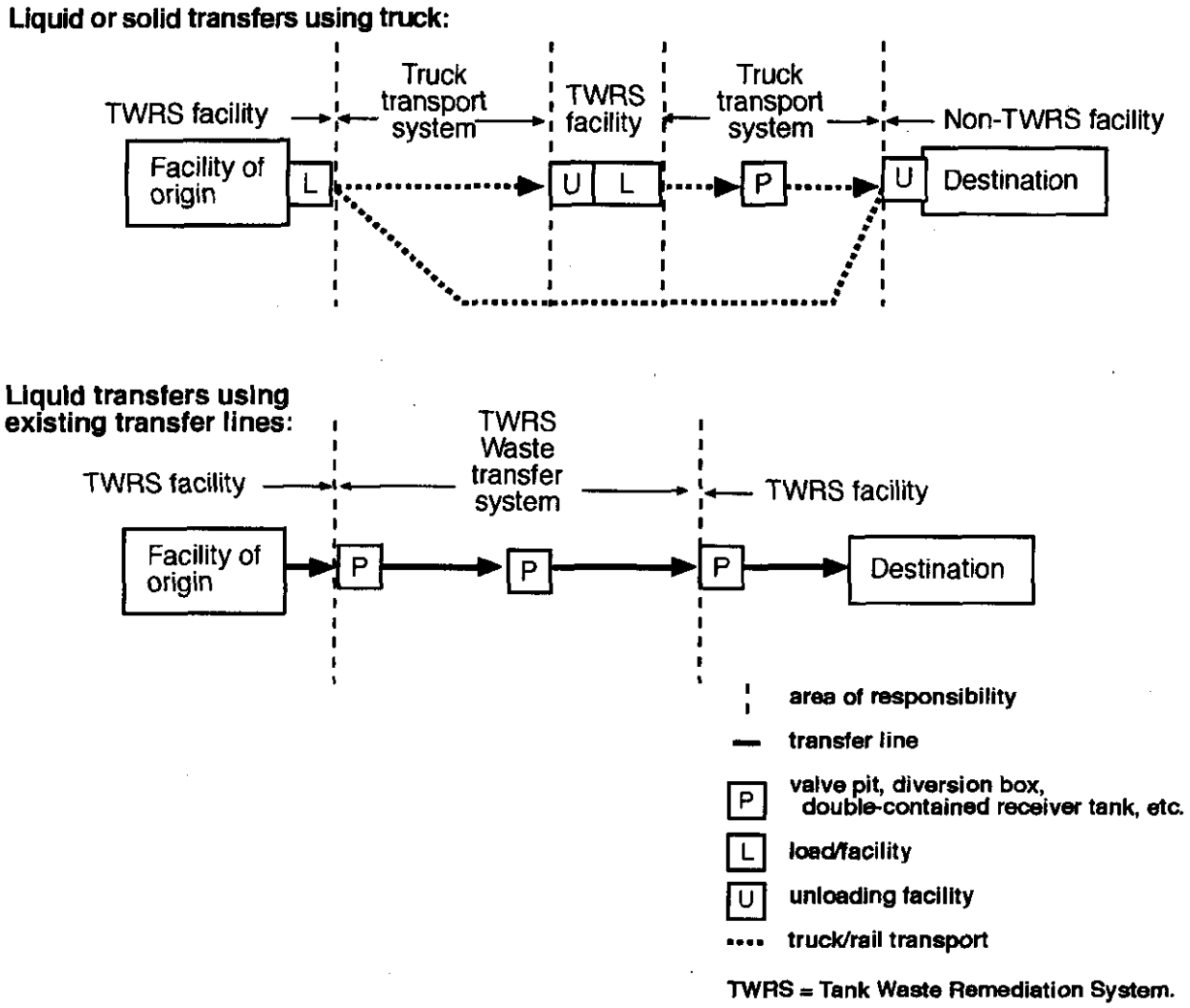

Figure 2-8. Graphic Representation of a Single-Shell Tank.

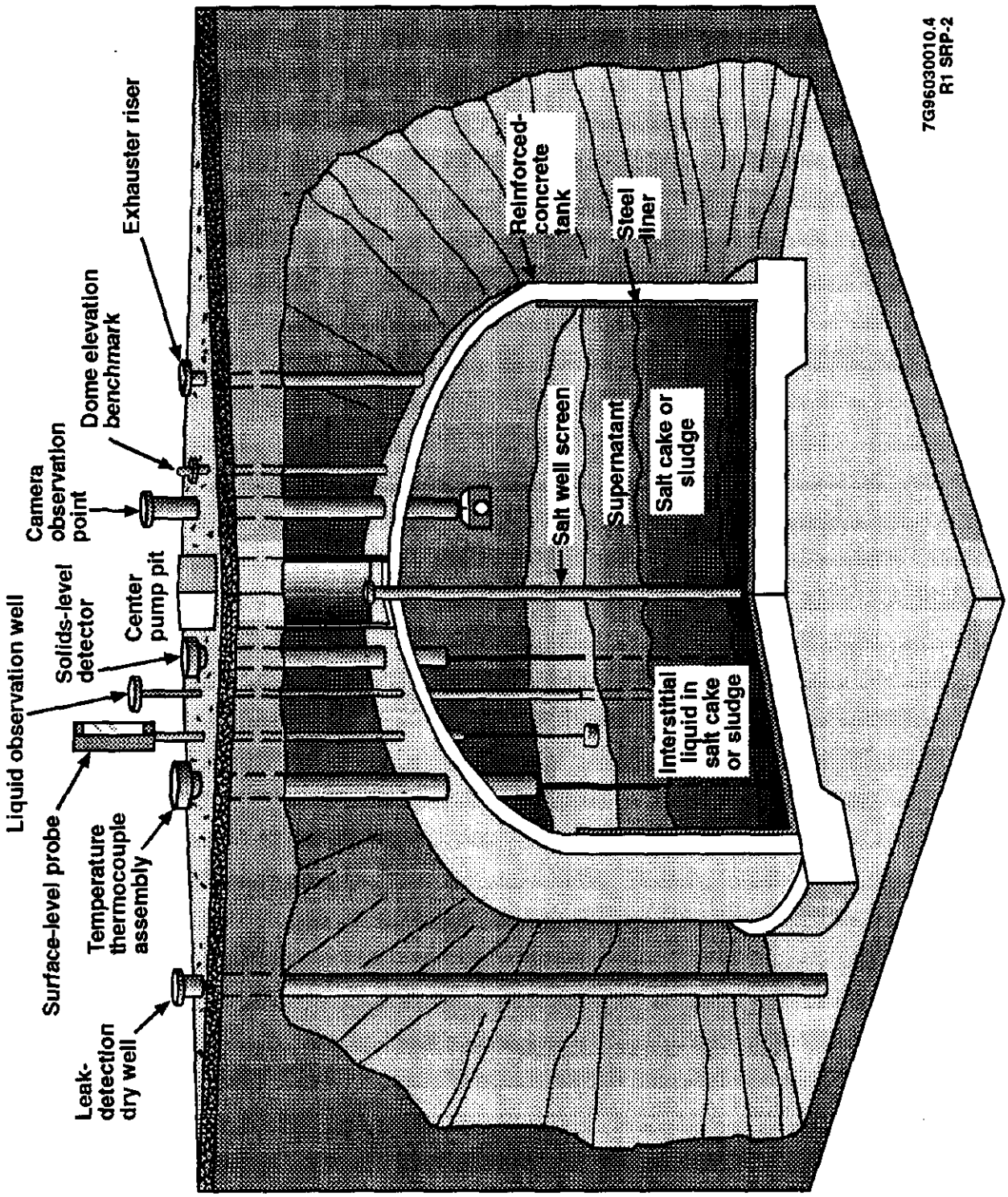

Figure 2-9. Typical Configurations of Single-Shell Tanks at the Hanford Site.

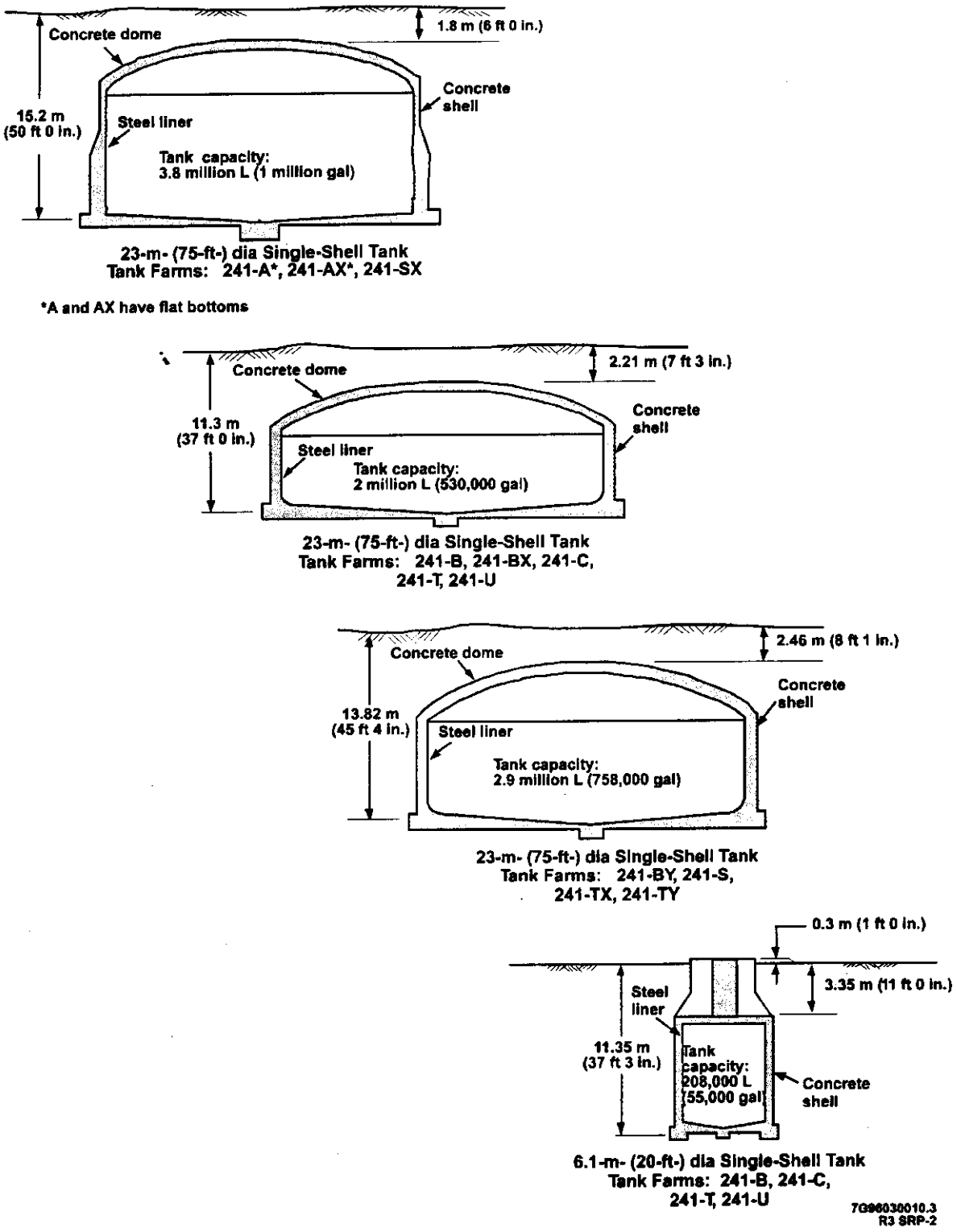

Figure 2-10. 241-C Tank Farm Active Ventilation System.

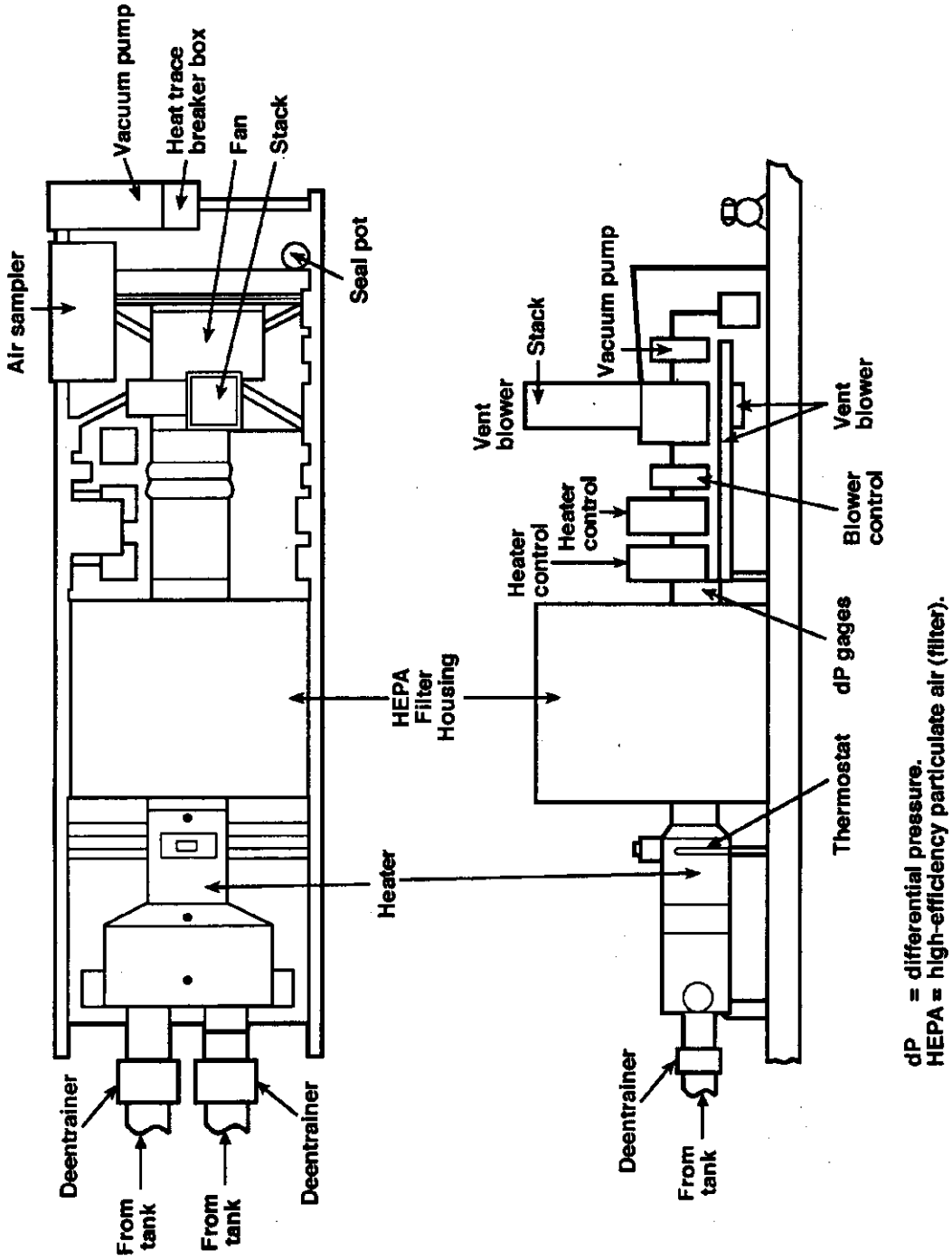

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Figure 2-11. 241-SX Tank Farm Active Ventilation System.

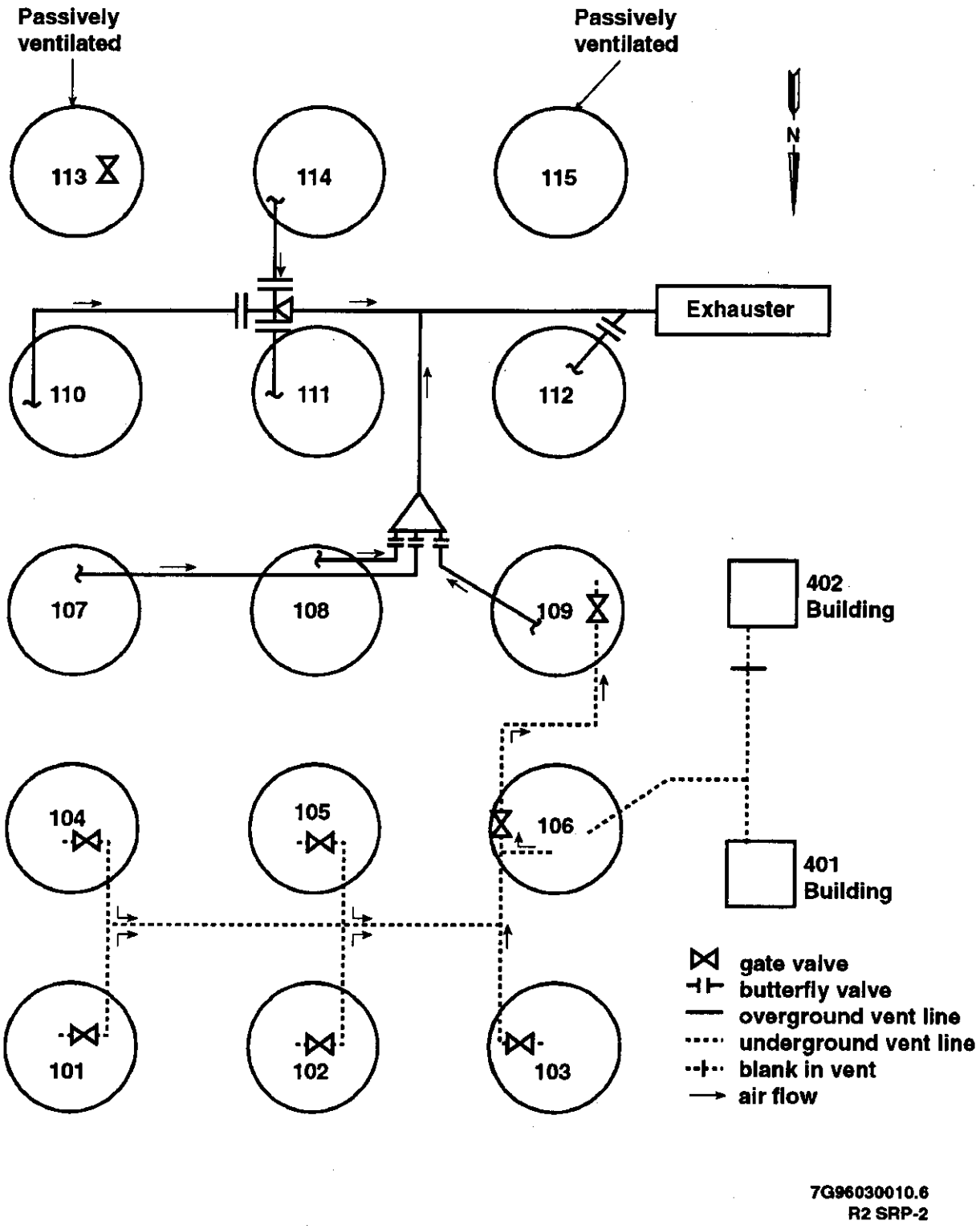


Figure 2-12. Passive Ventilation System for Single-Shell Tanks.

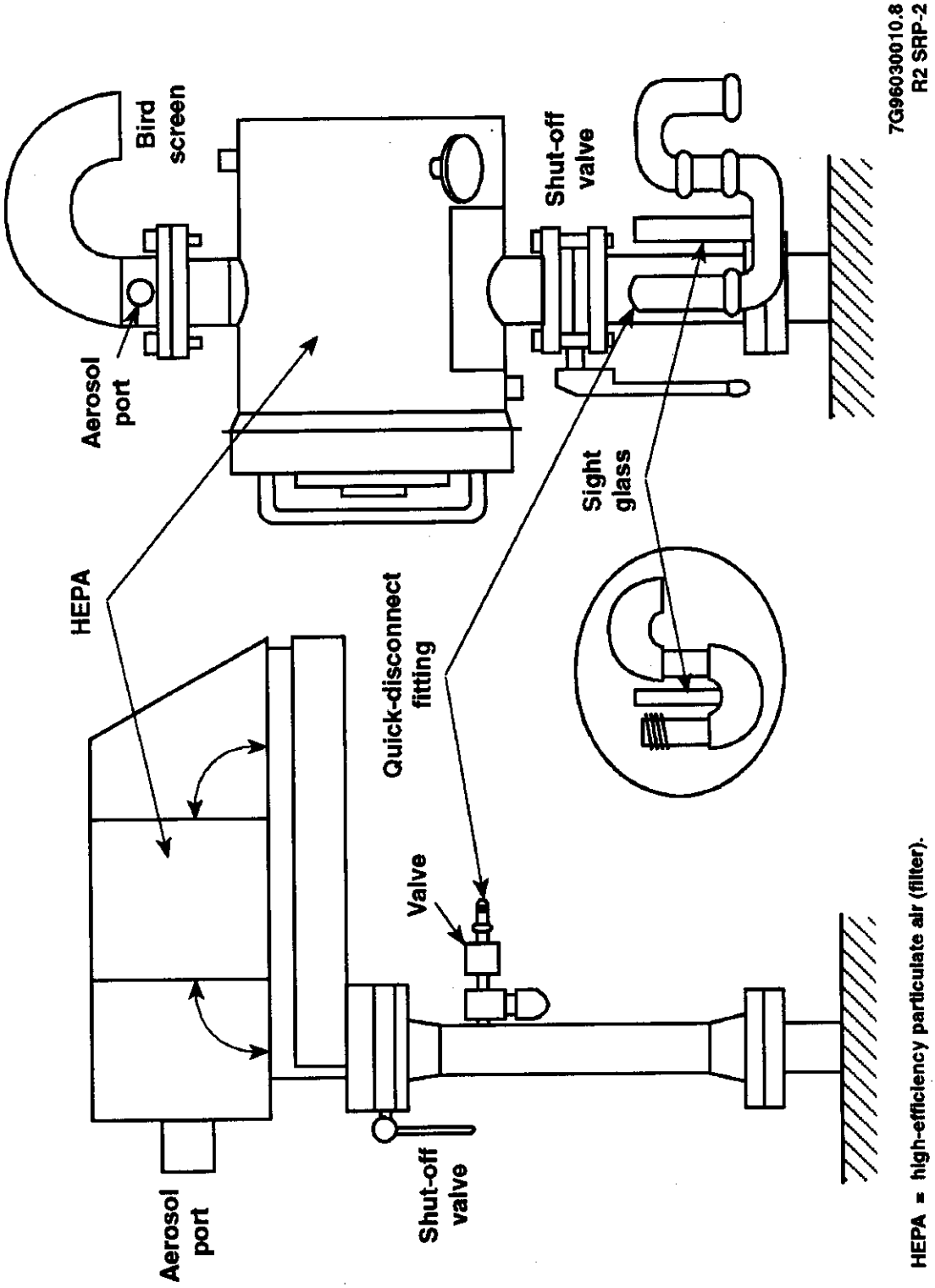


Figure 2-13. Graphic Representation of a Double-Shell Tank.

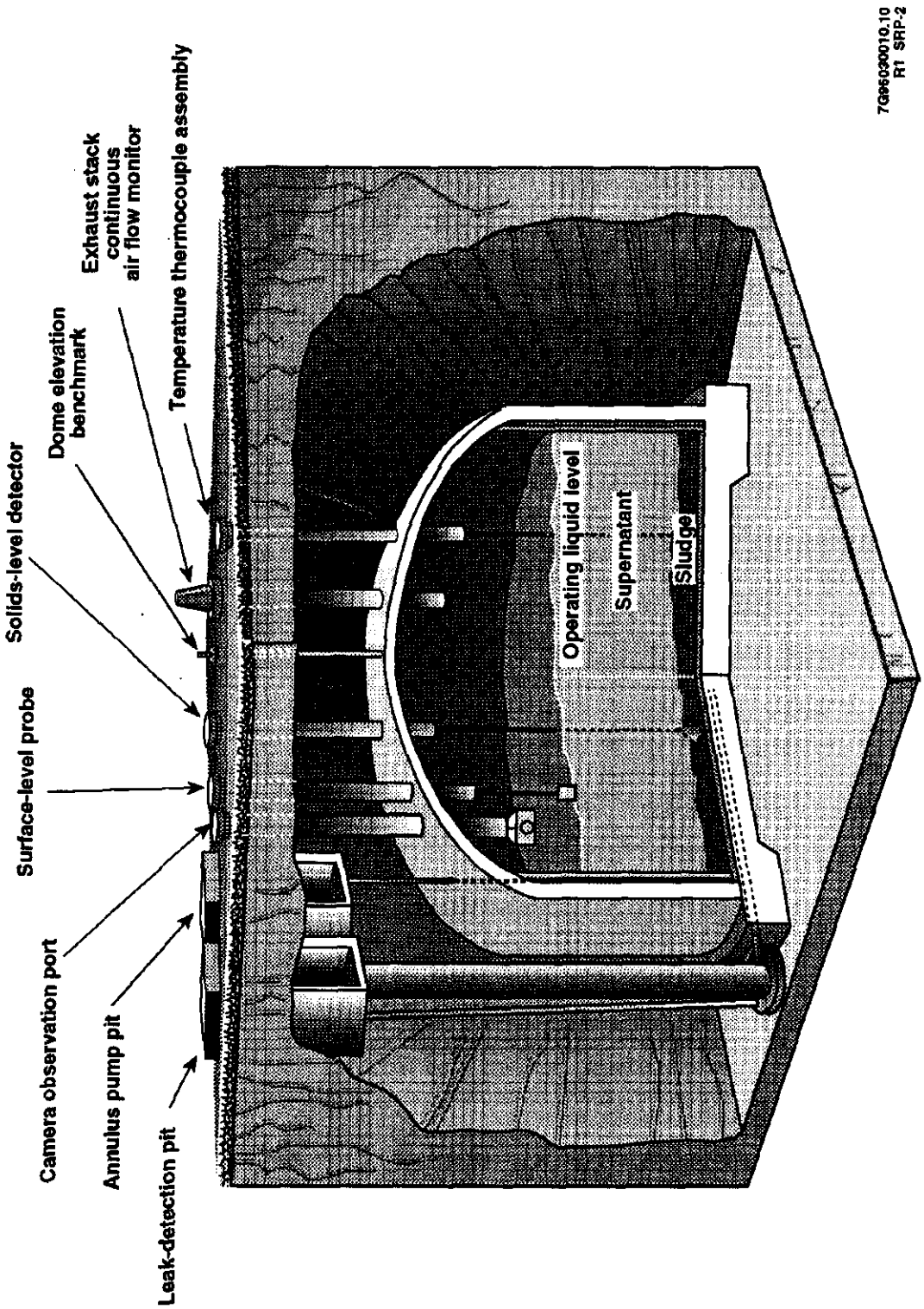


Figure 2-14. A Typical Double-Shell Tank Configuration.

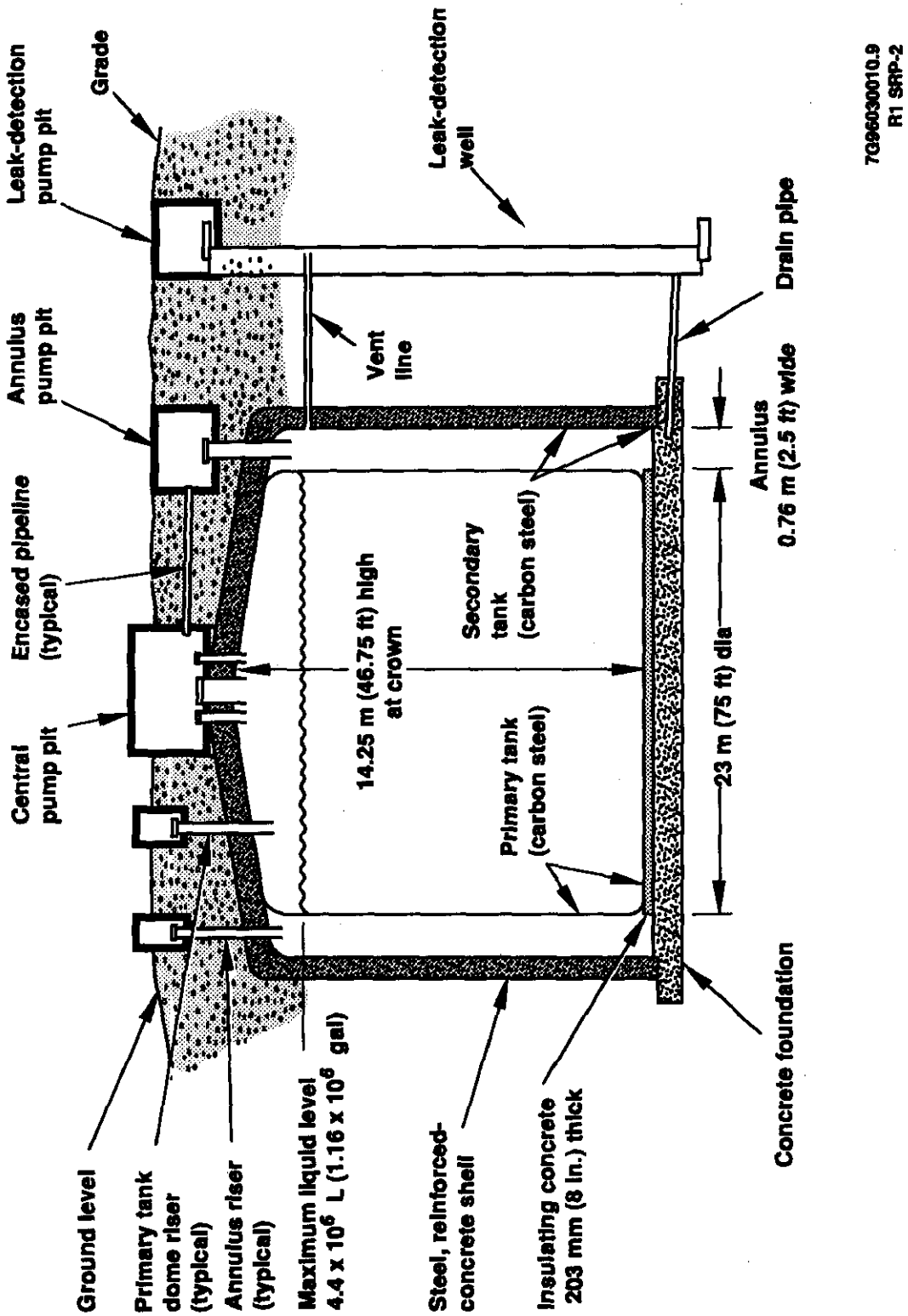
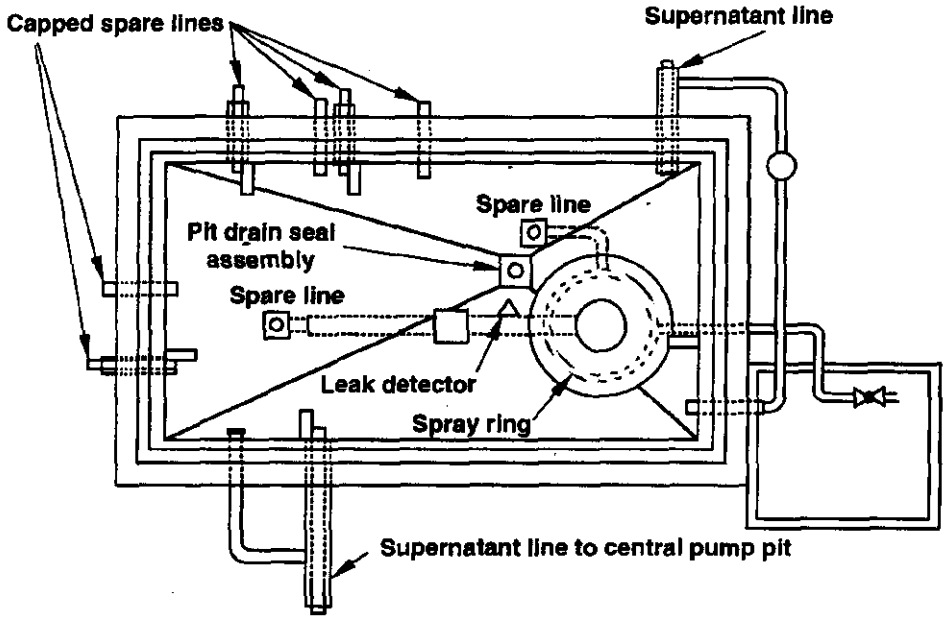
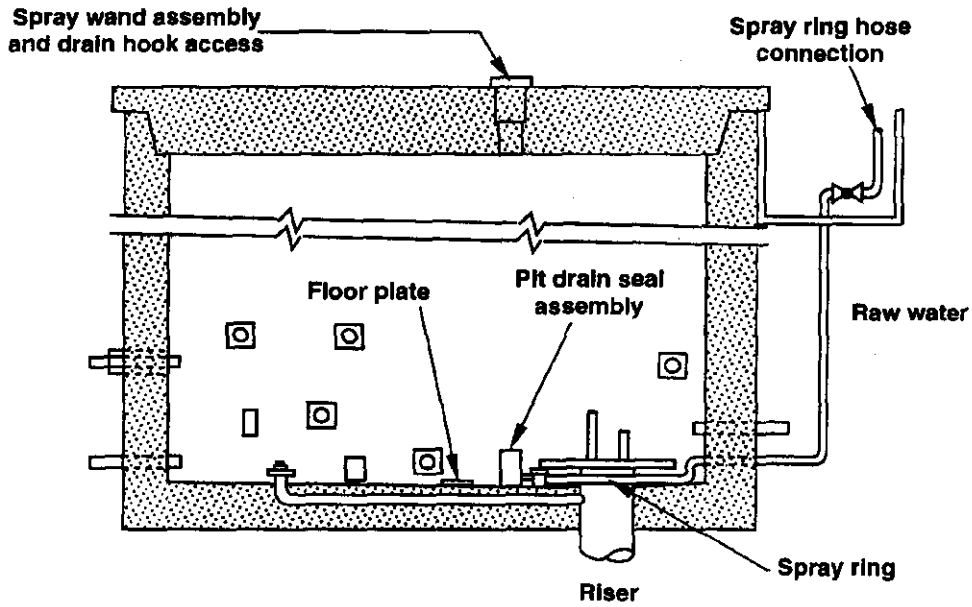


Figure 2-15. A Typical Central Pump or Distributor Pit.



Plan View



Section View

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Figure 2-16. A Typical Slurry Distributor.

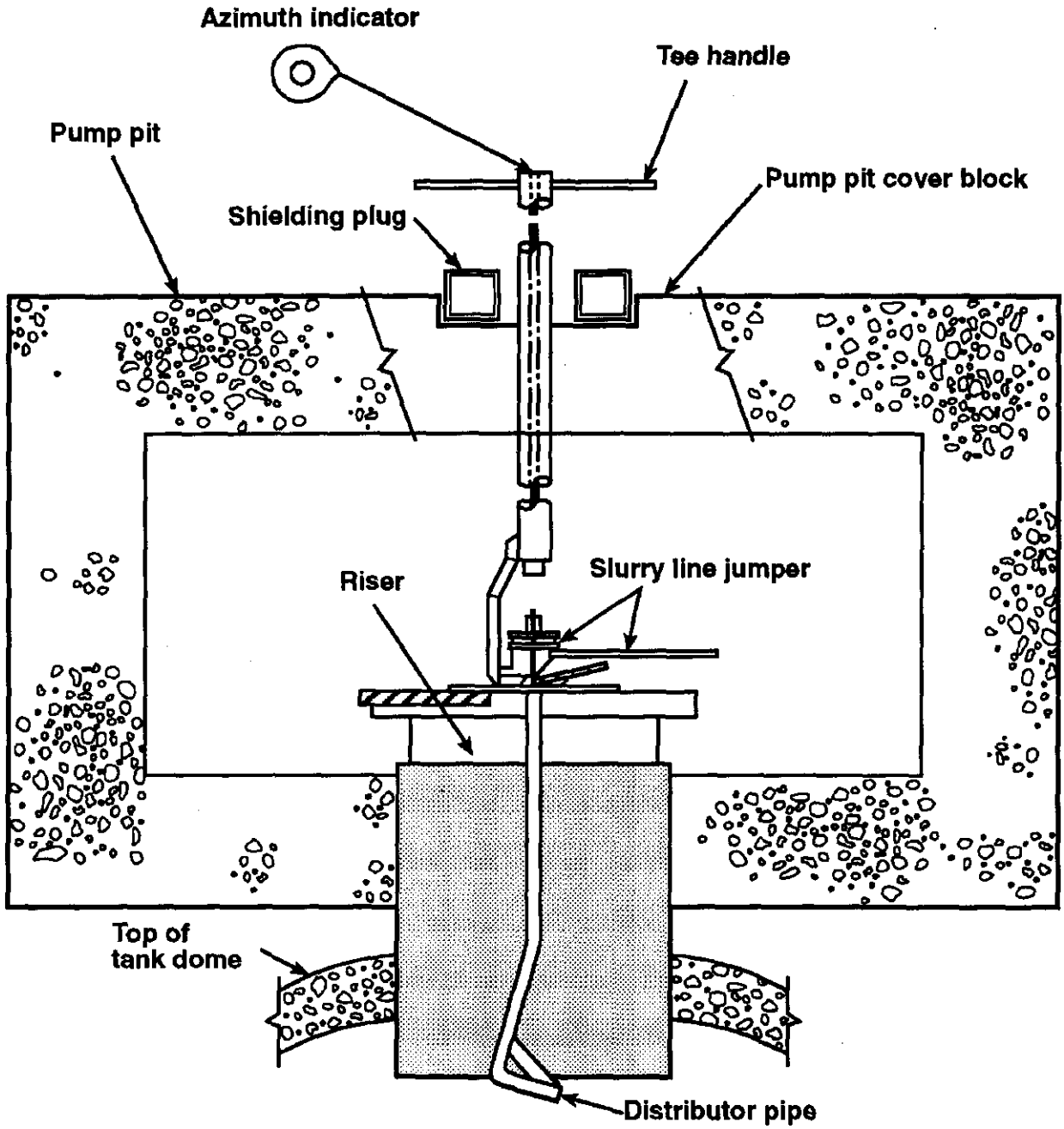

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Figure 2-17. A Typical Annulus Pump Pit.

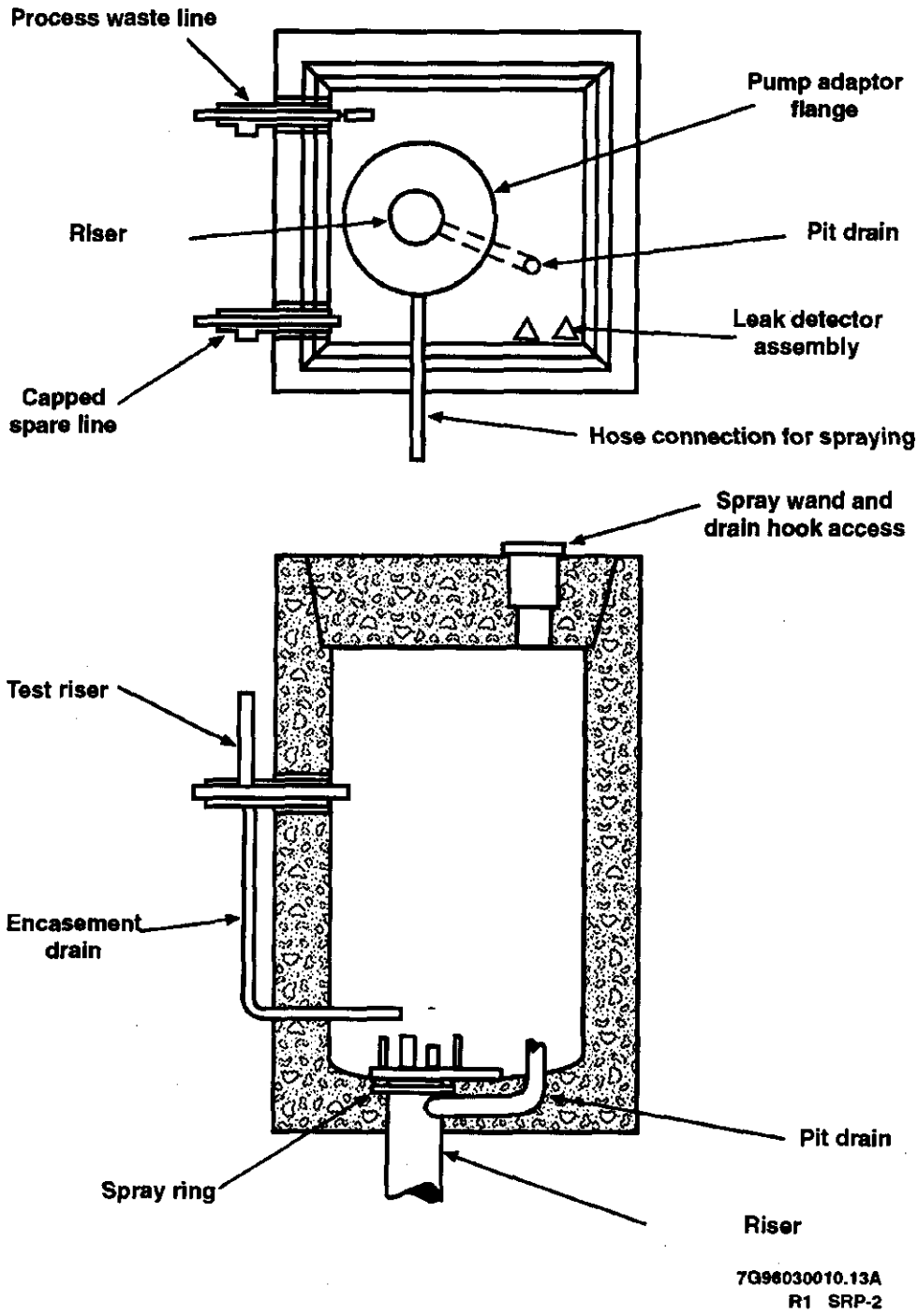

Figure 2-18. A Typical Feed Pump Pit.

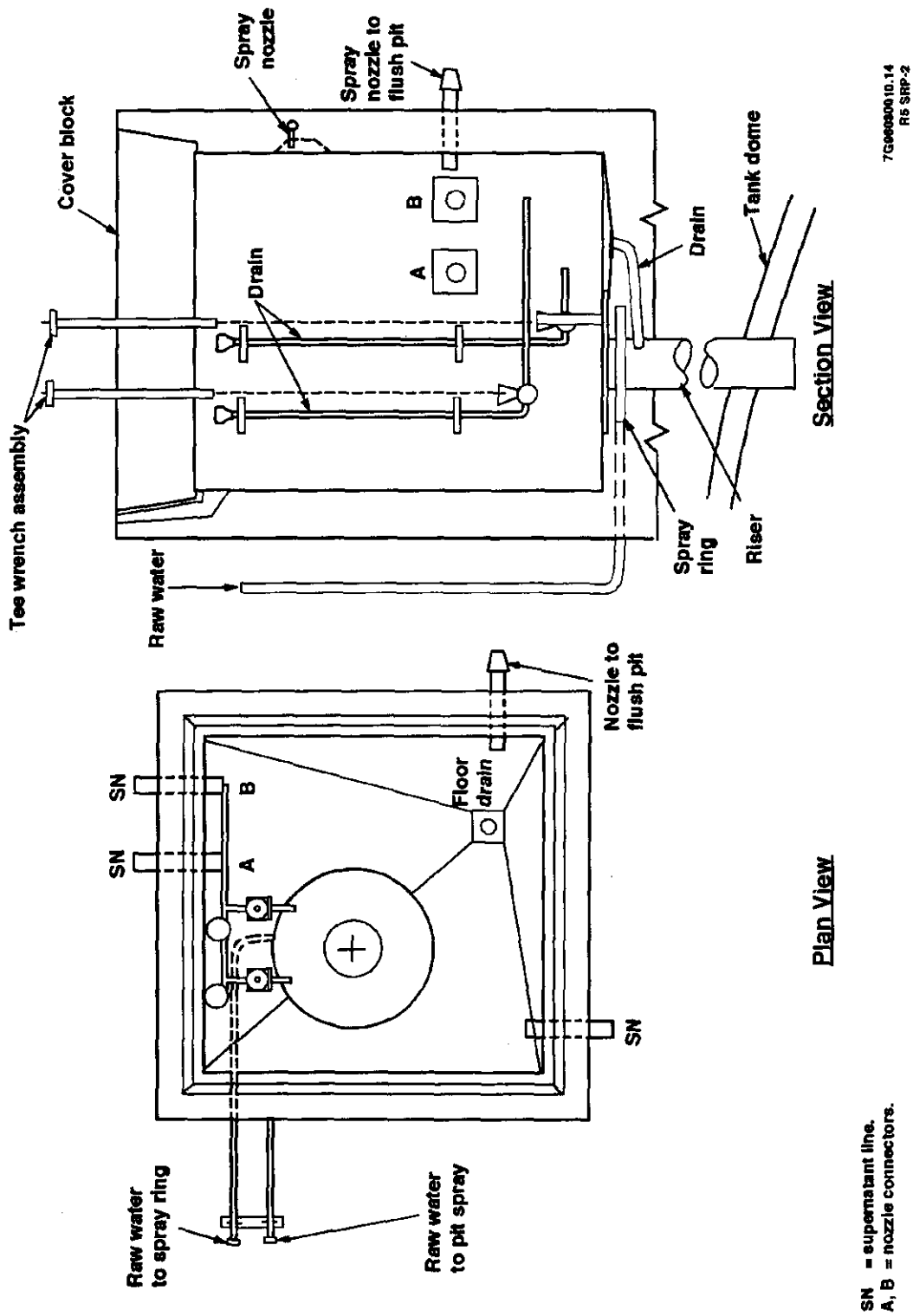

Figure 2-19. A Typical Leak Detection Pit.

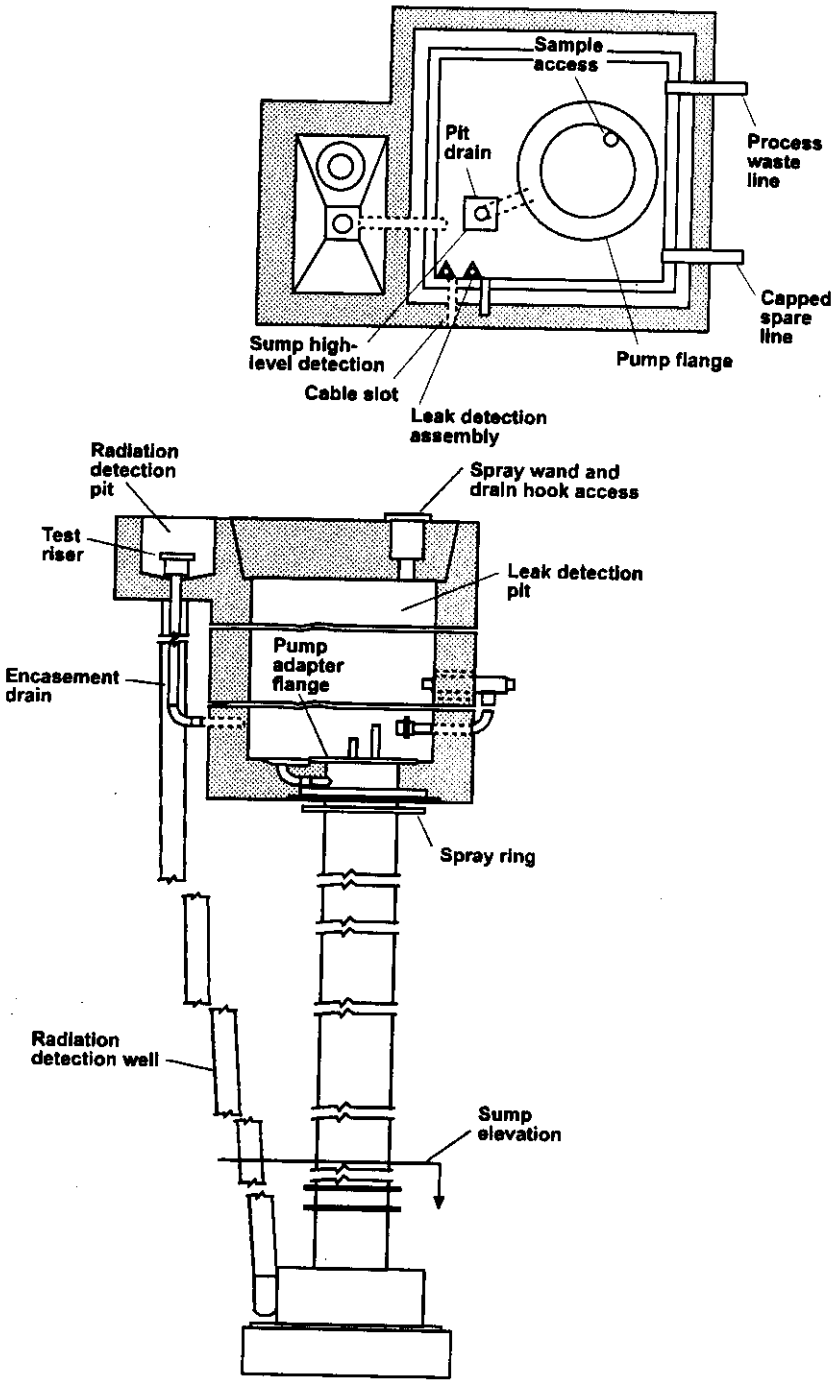

Figure 2-20. A Typical Drain Pit.

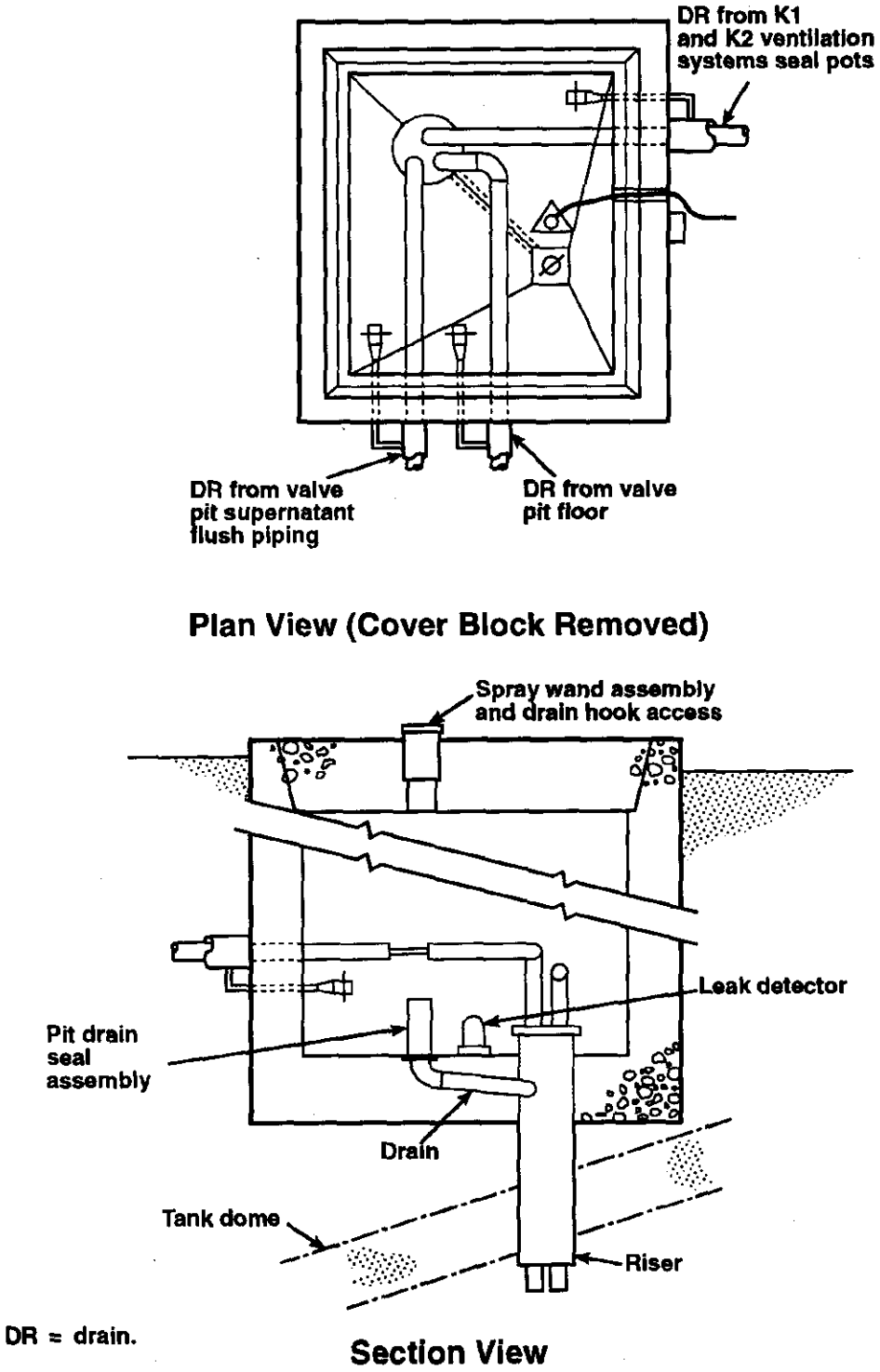

Figure 2-21. Primary Ventilation System for 241-AY and 241-AZ Tank Farms (Aging Waste Facility).

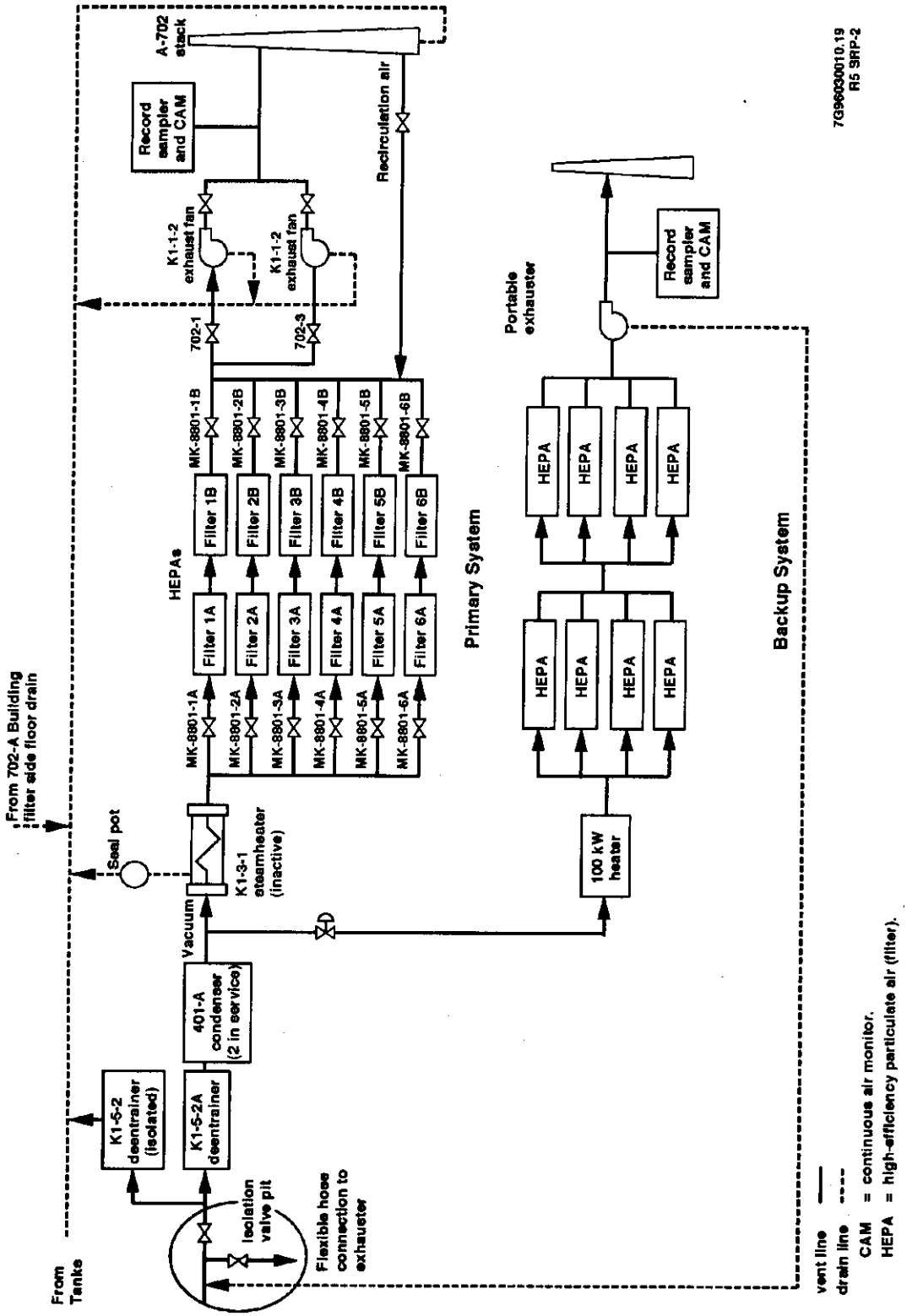

Figure 2-22. Typical Annulus Ventilation System for 241-AY and 241-AZ Tank Farms (Aging Waste Facility).

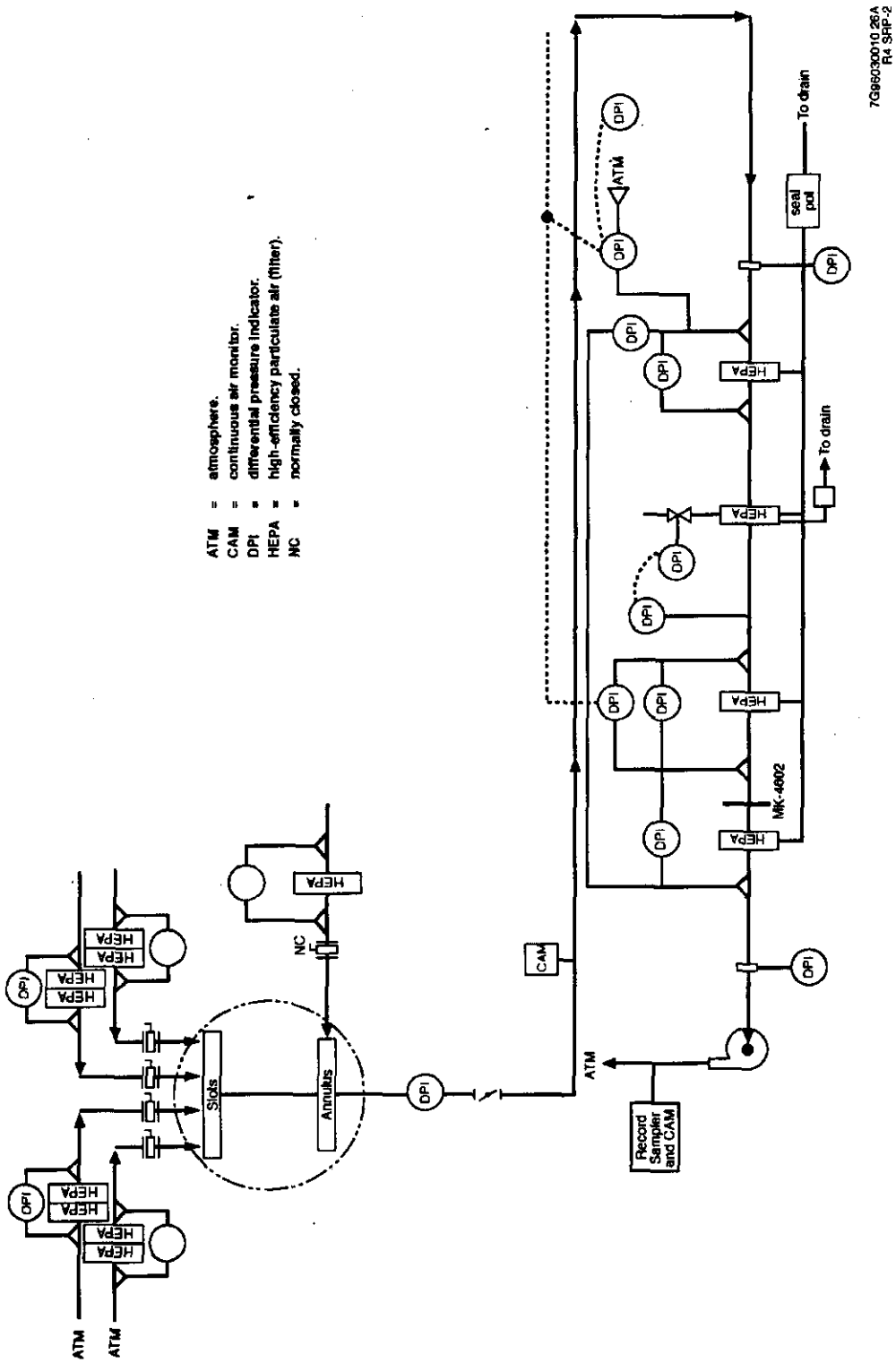

Figure 2-23. Primary Ventilation System for 241-AN, 241-AP, and 241-AW Tank Farms.

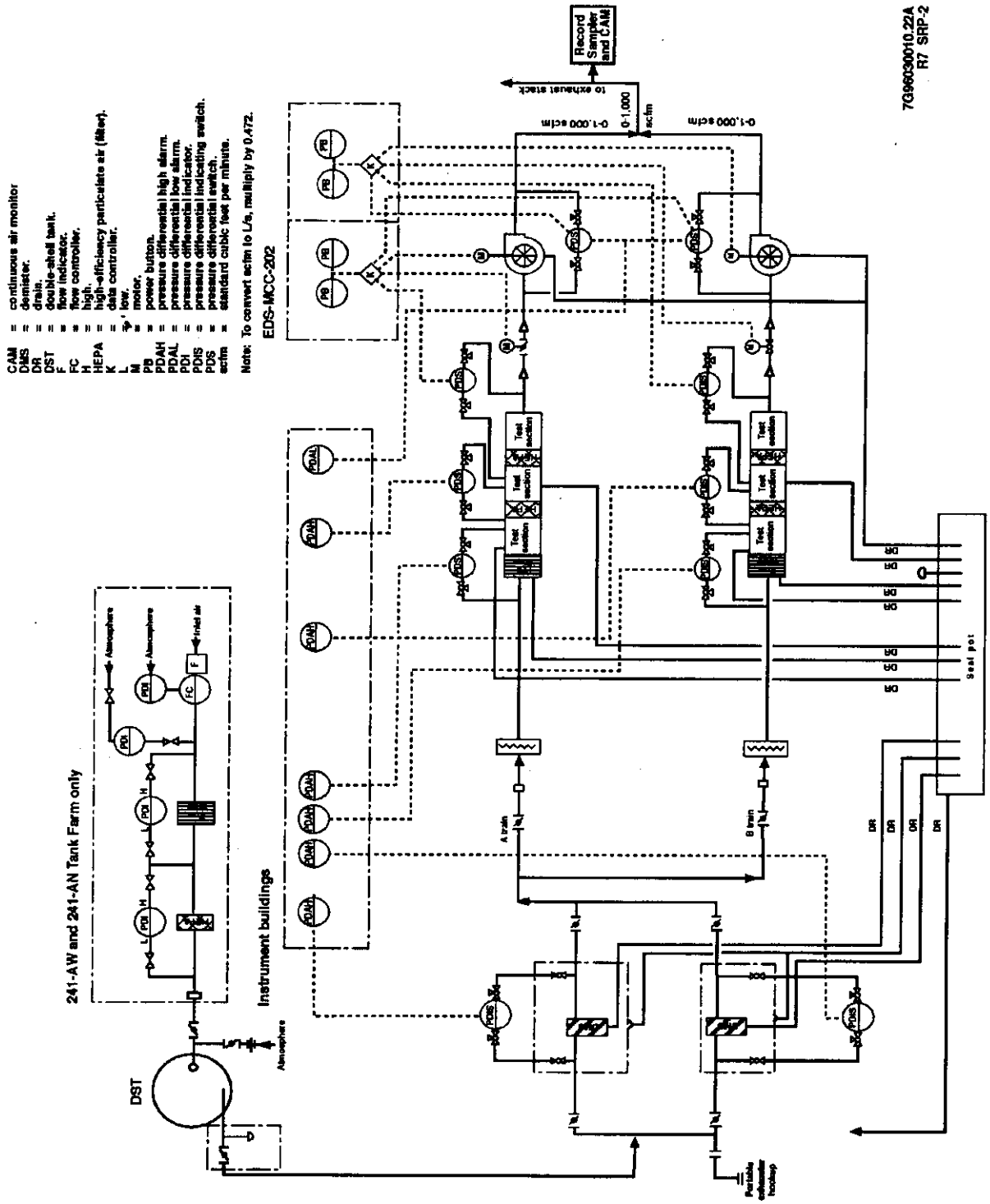

Figure 2-24. Typical Annulus Ventilation System for 241-AN, 241-AP, and 241-AW Tank Farms (241-AP Inlet Heater not Shown).

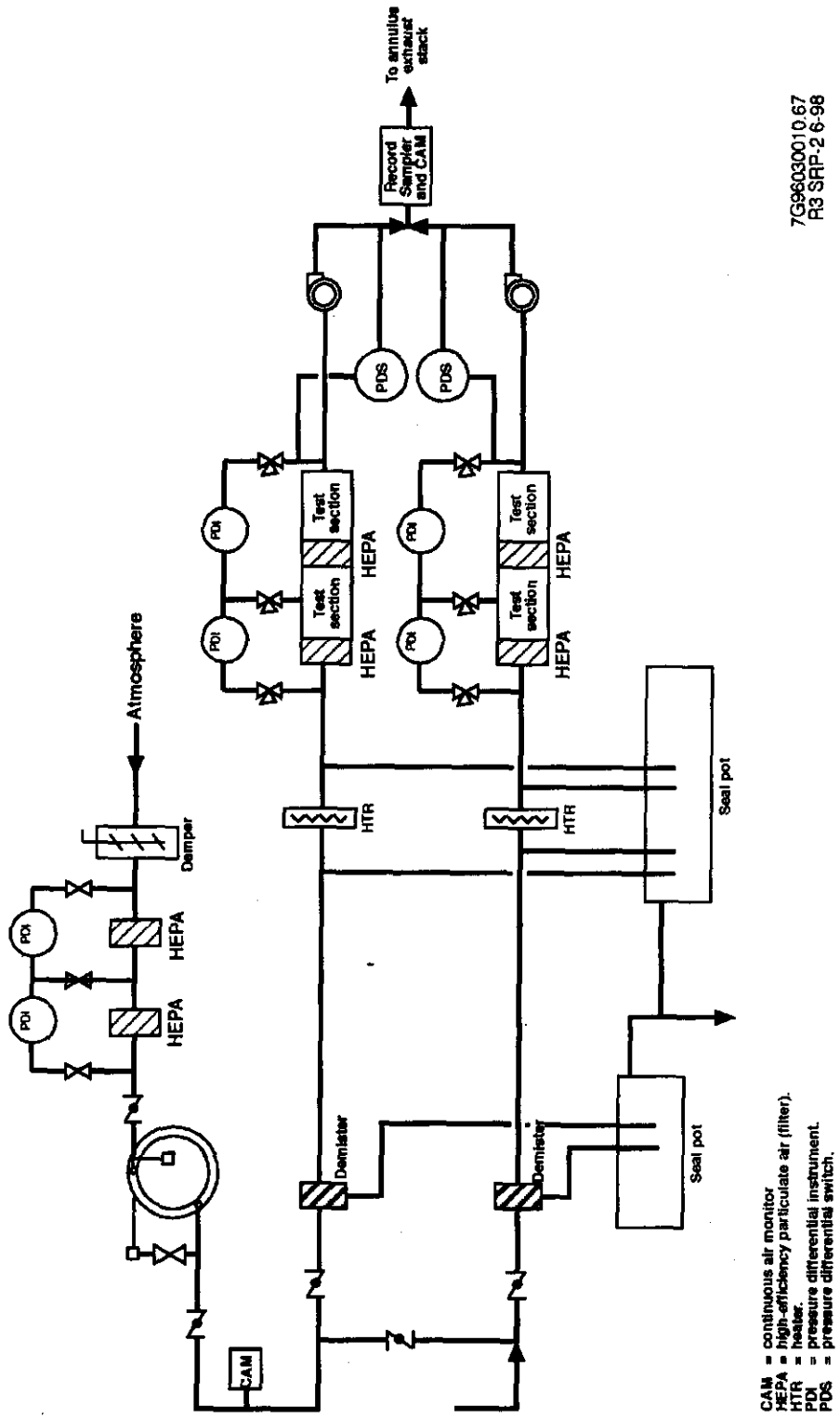

Figure 2-25. A Typical 241-AY or 241-AZ Tank (Aging Waste Facility) with Air Lift Circulators and Steam Coils.

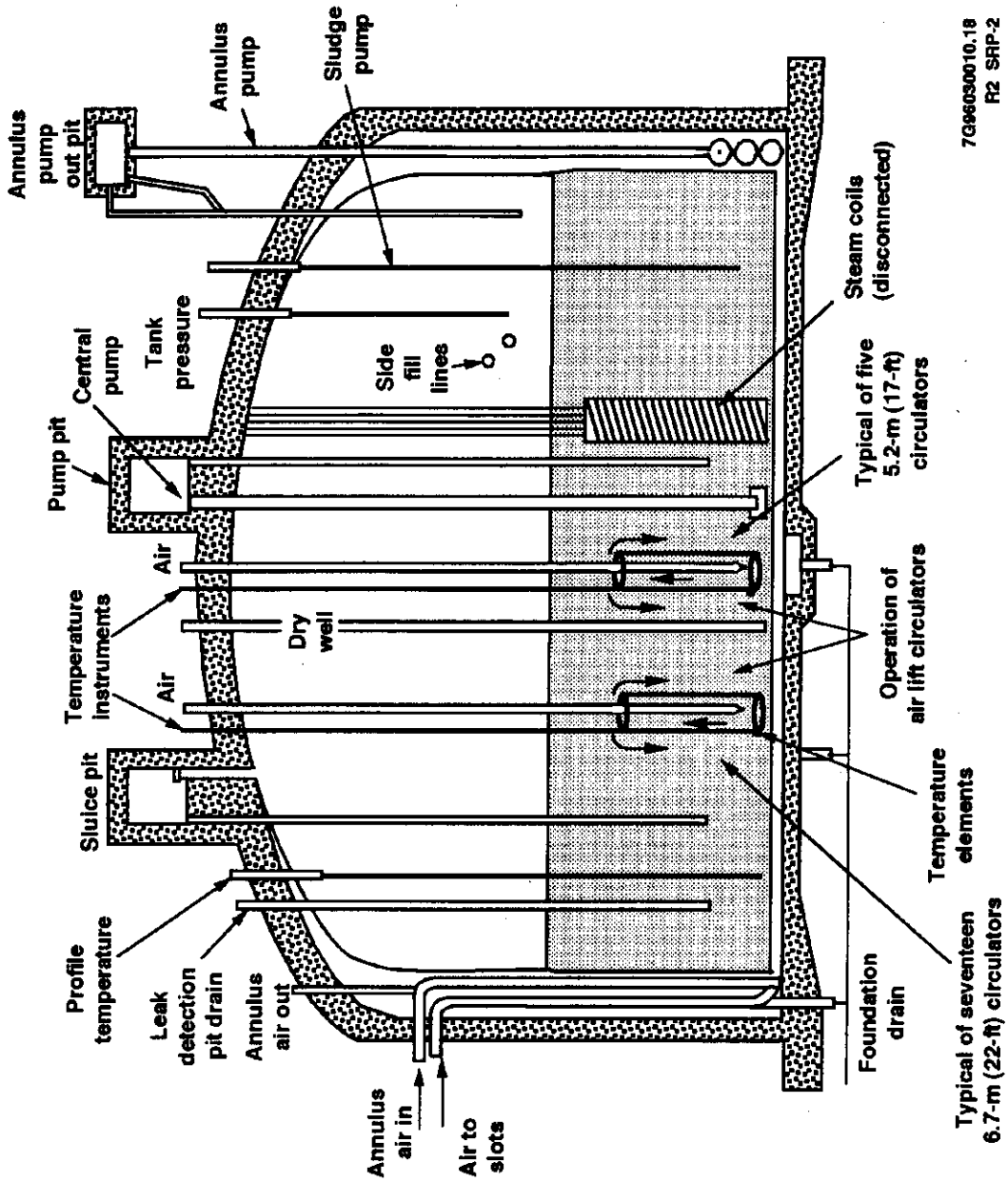

Figure 2-26. Typical Design for a Catch Tank in a Vault.

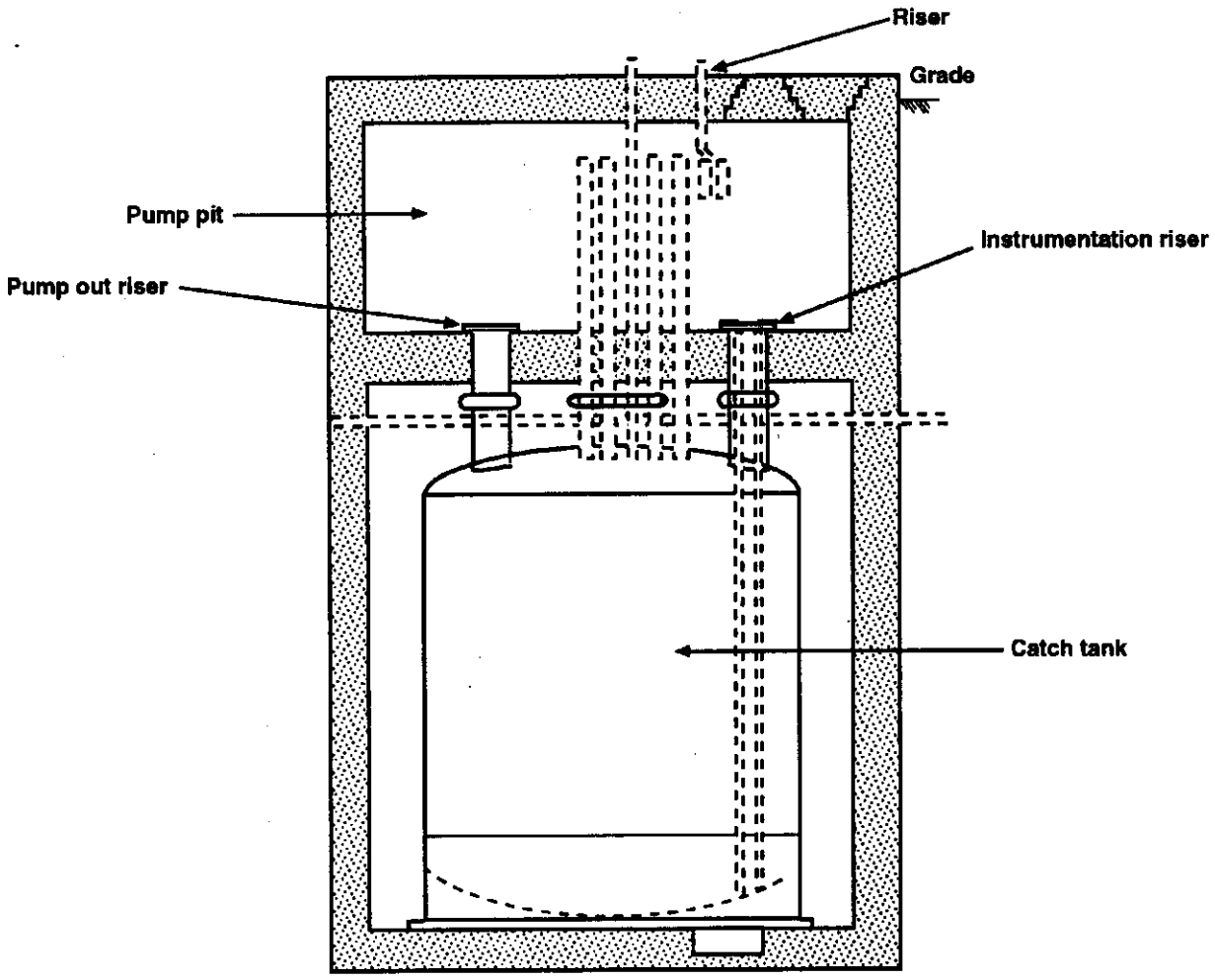

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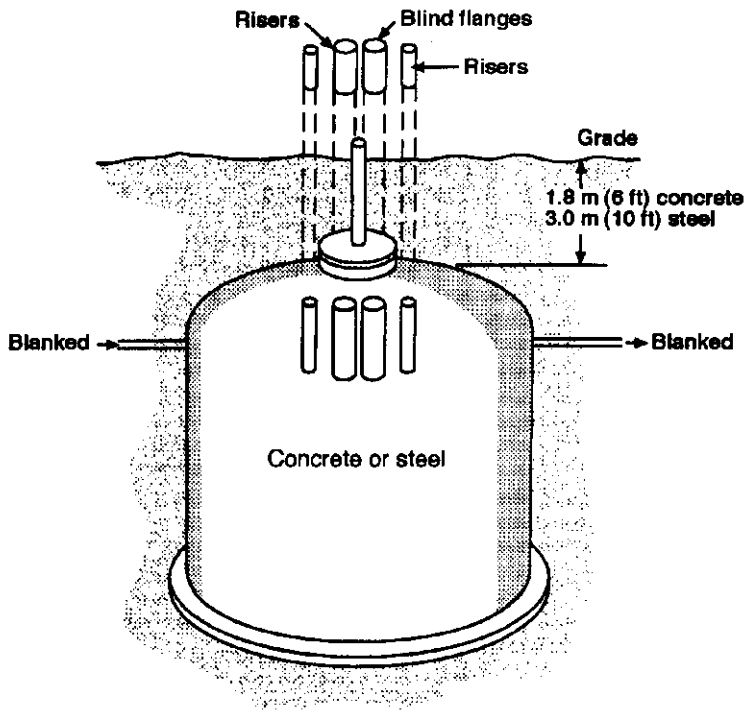
Figure 2-27. Typical Designs for Direct-Buried Catch Tanks.



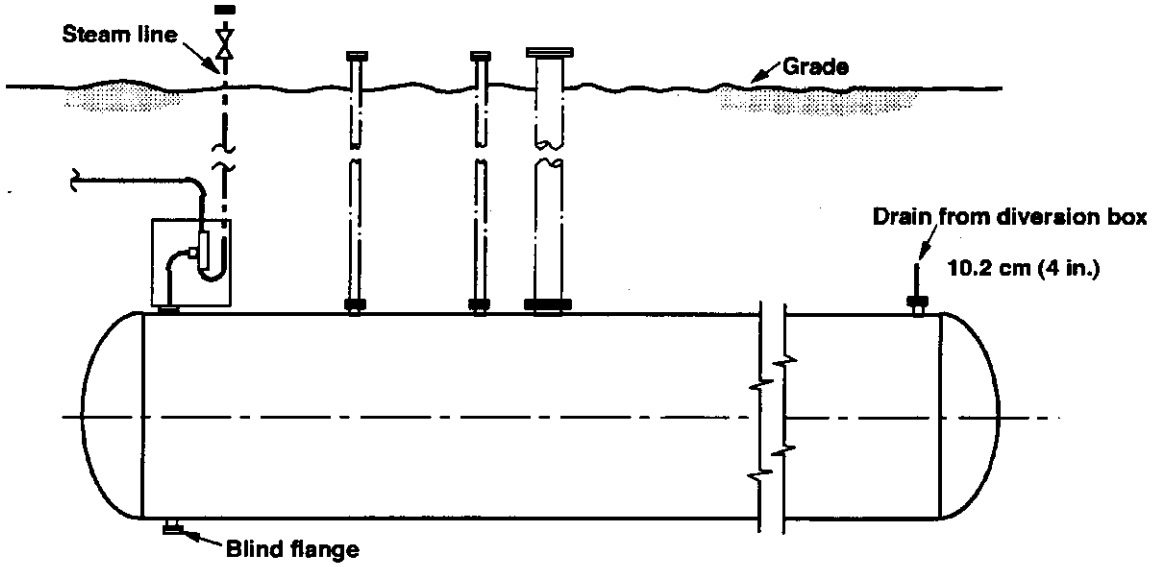


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Figure 2-28. Design of the 241-A-350 Catch Tank.

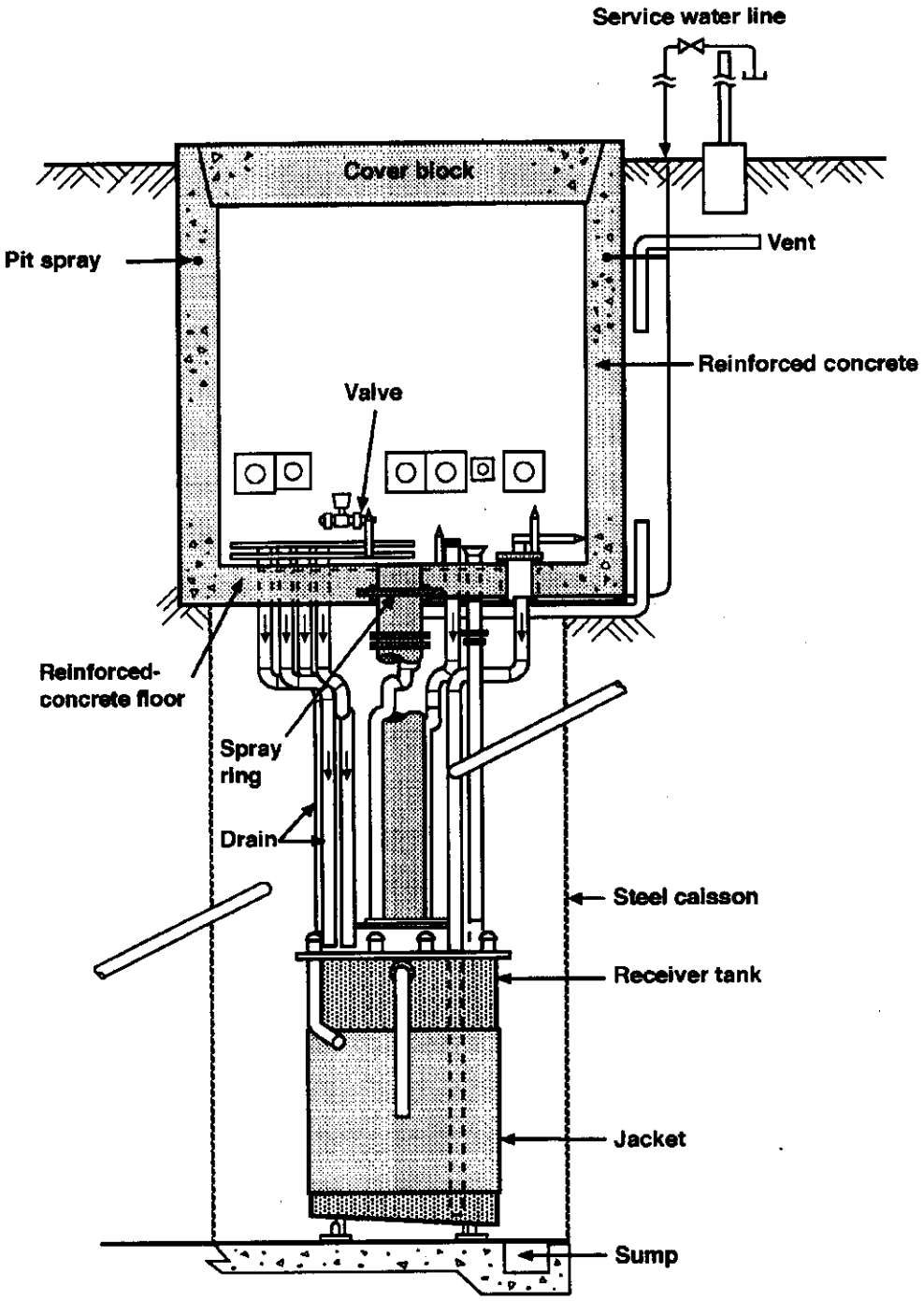

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Figure 2-29. An Illustration of a Double-Contained Receiver Tank.

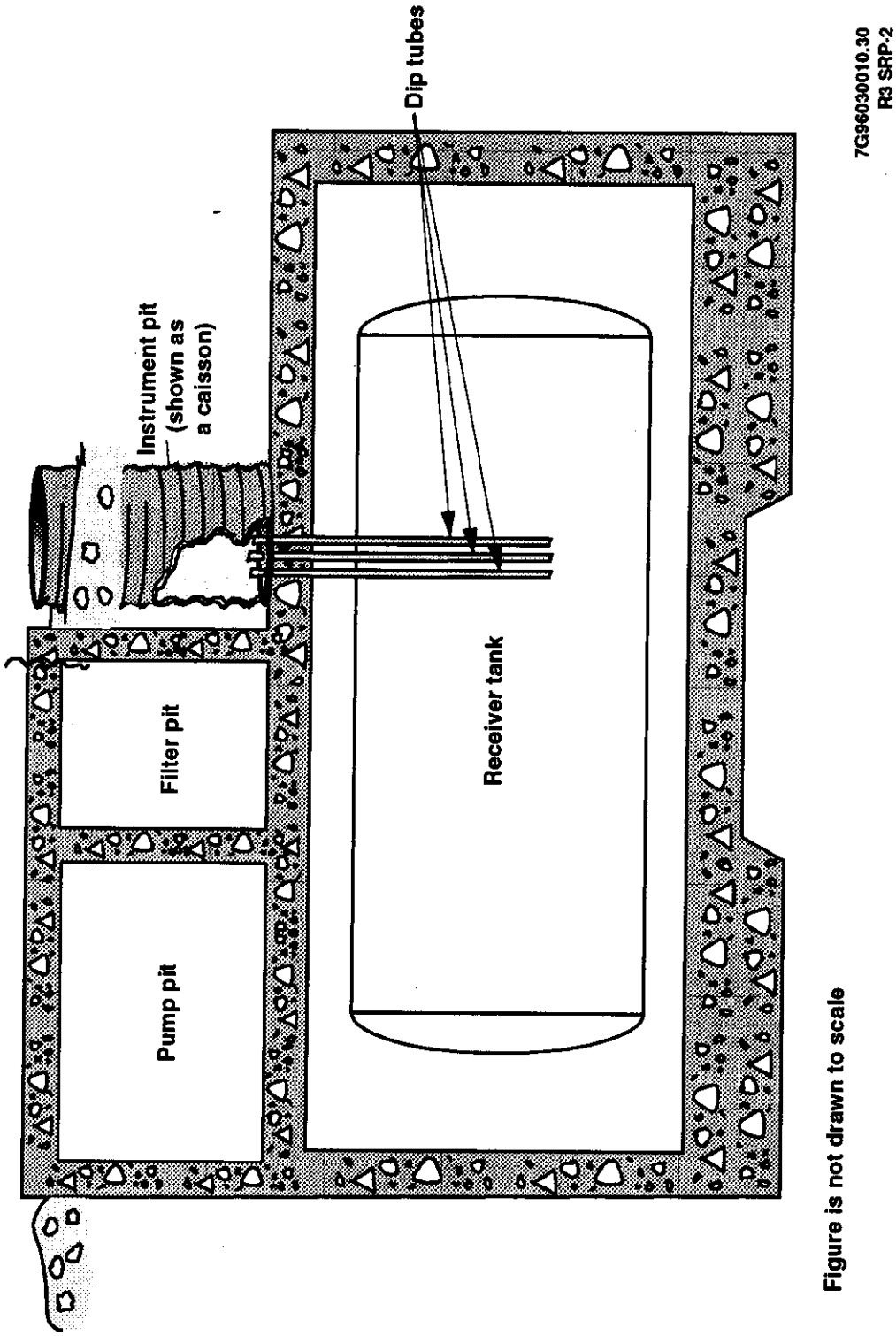


Figure 2-30. Location of the 200 East Area Radioactively Contaminated Miscellaneous Underground Storage Tanks.

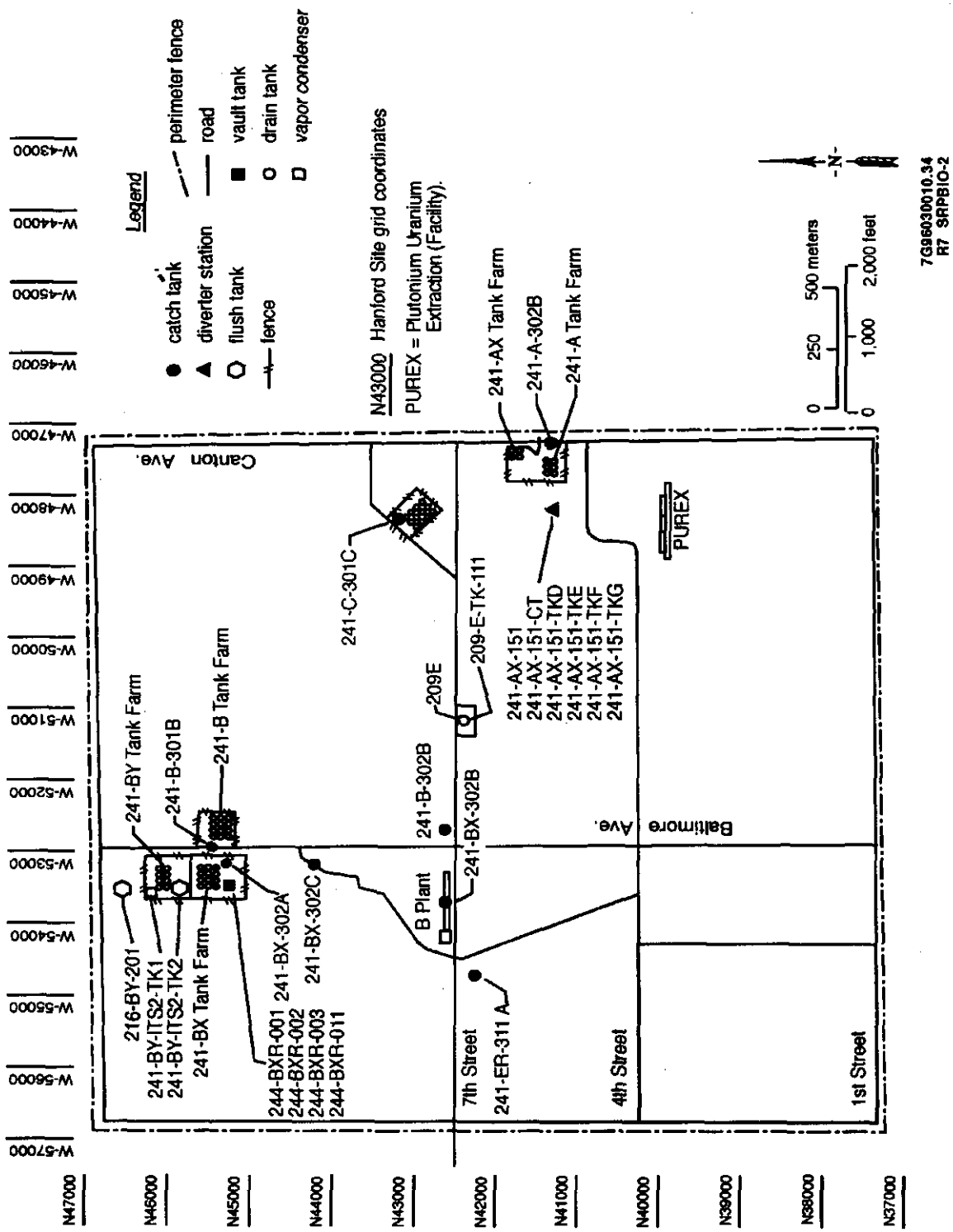


Figure 2-31. Location of the 200 West Area Radioactively Contaminated Miscellaneous Underground Storage Tanks.

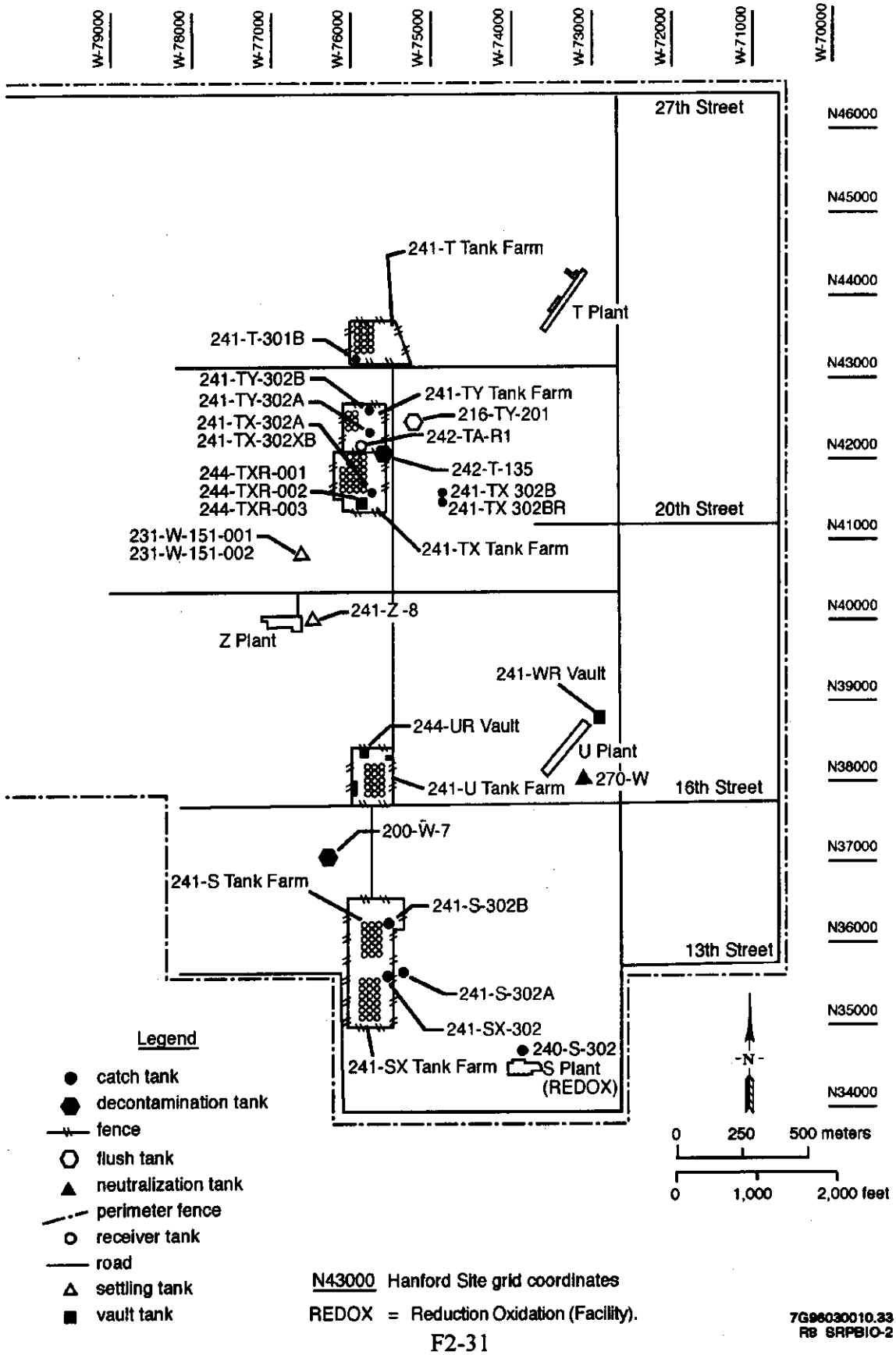
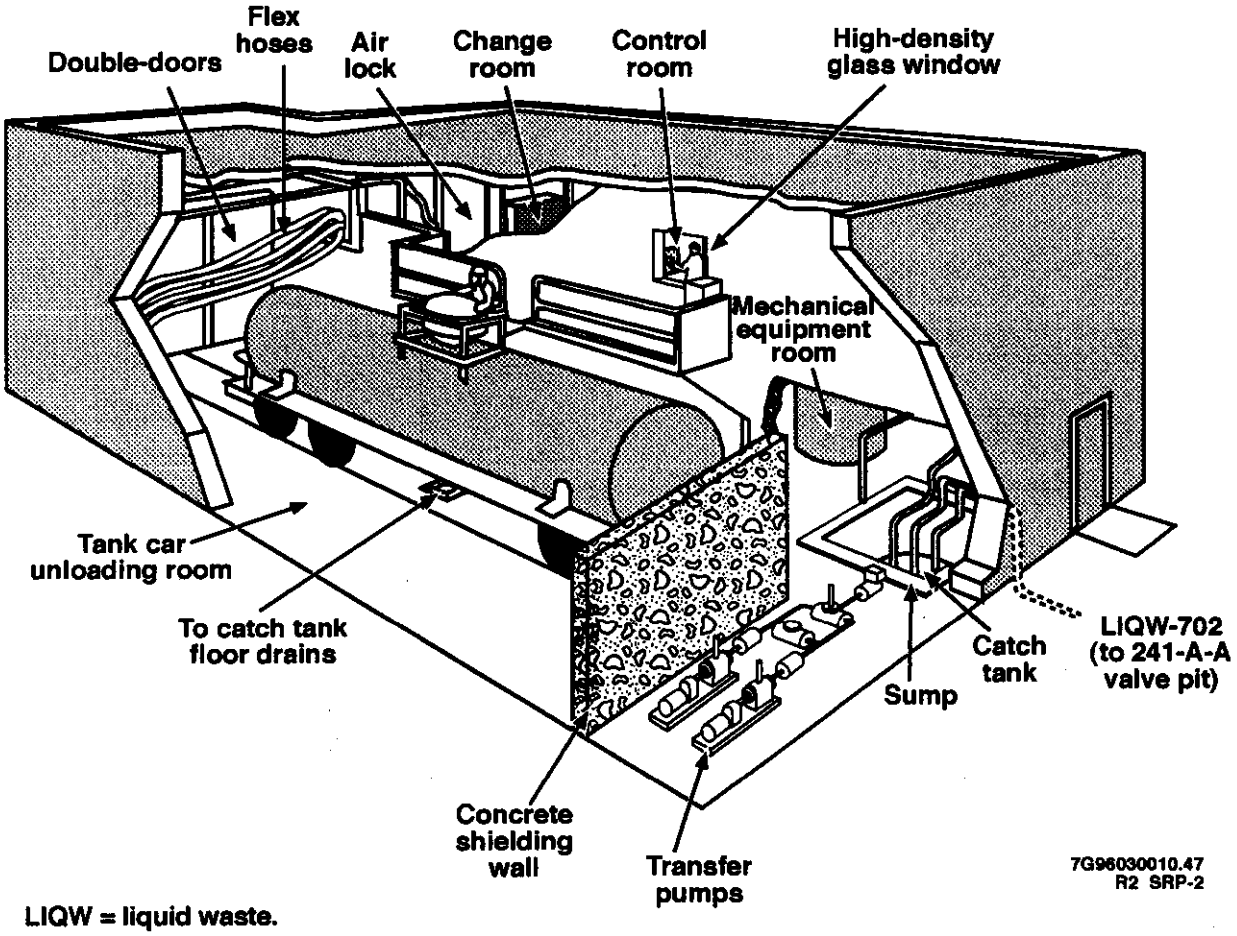
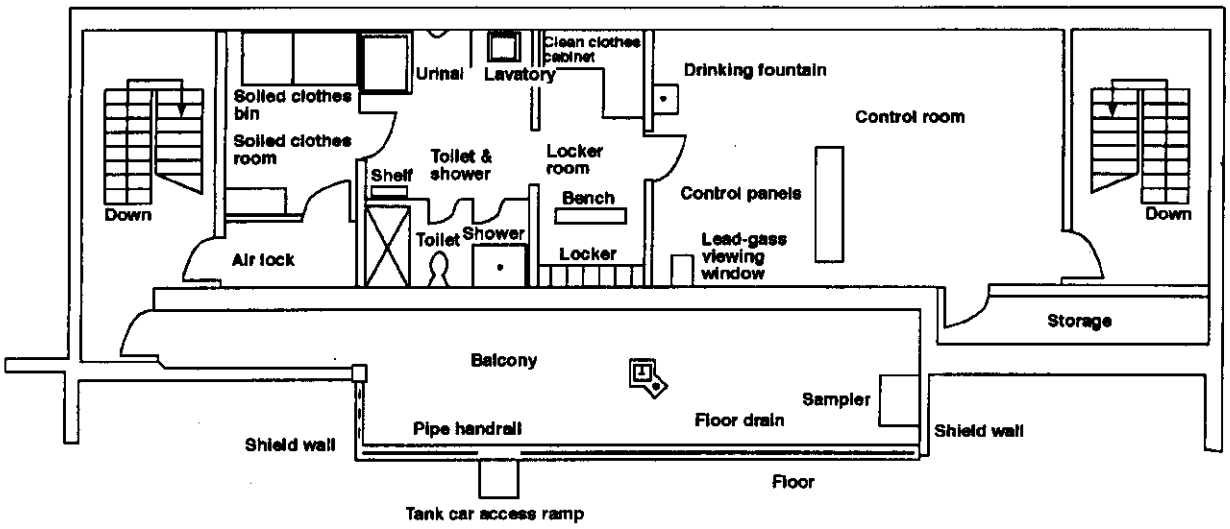


Figure 2-32. The 204-AR Waste Unloading Facility.

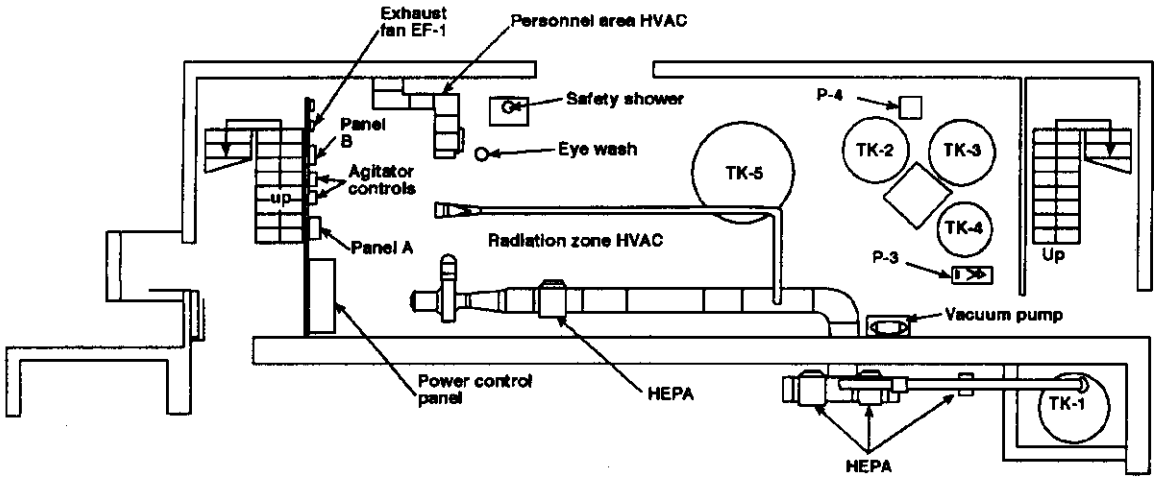


LIQW = liquid waste.

Figure 2-33. First and Second Floor Control Areas of the 204-AR Waste Unloading Facility.



Second Floor



First Floor

HEPA = high-efficiency particulate air (filter).
HVAC = heating, ventilation, and air conditioning.
P = pump.
TK = tank.

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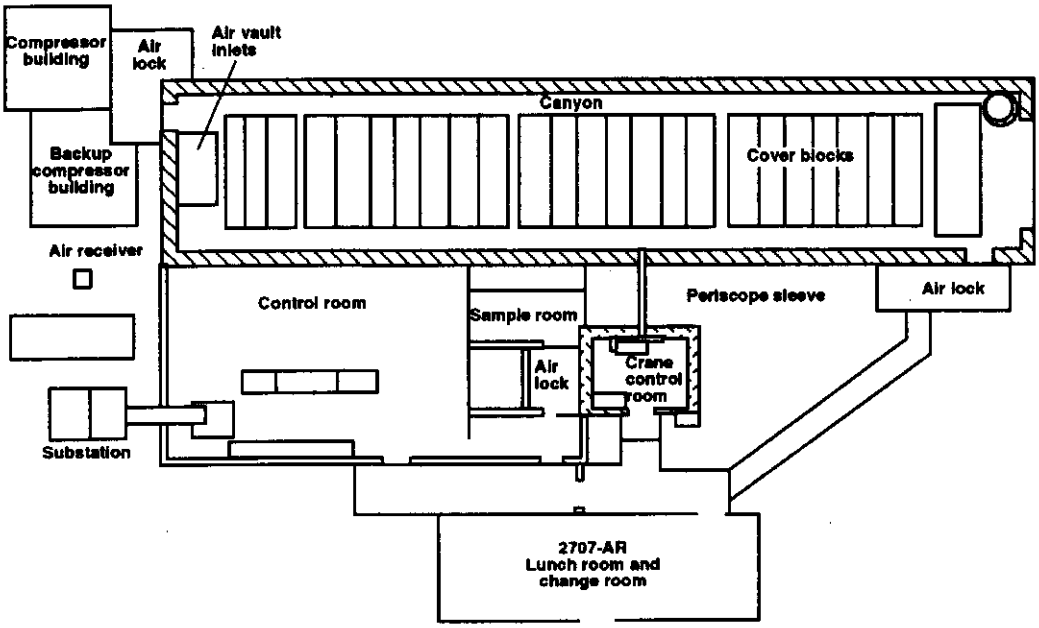
Figure 2-34. Canyon and Process Area Equipment Arrangement of the 244-AR Vault.



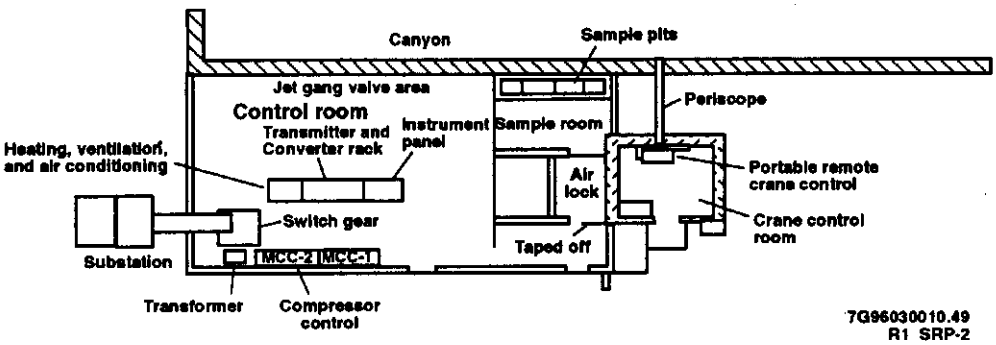


Figure 2-35. Cross-Section of the Process Area of the 244-AR Vault.

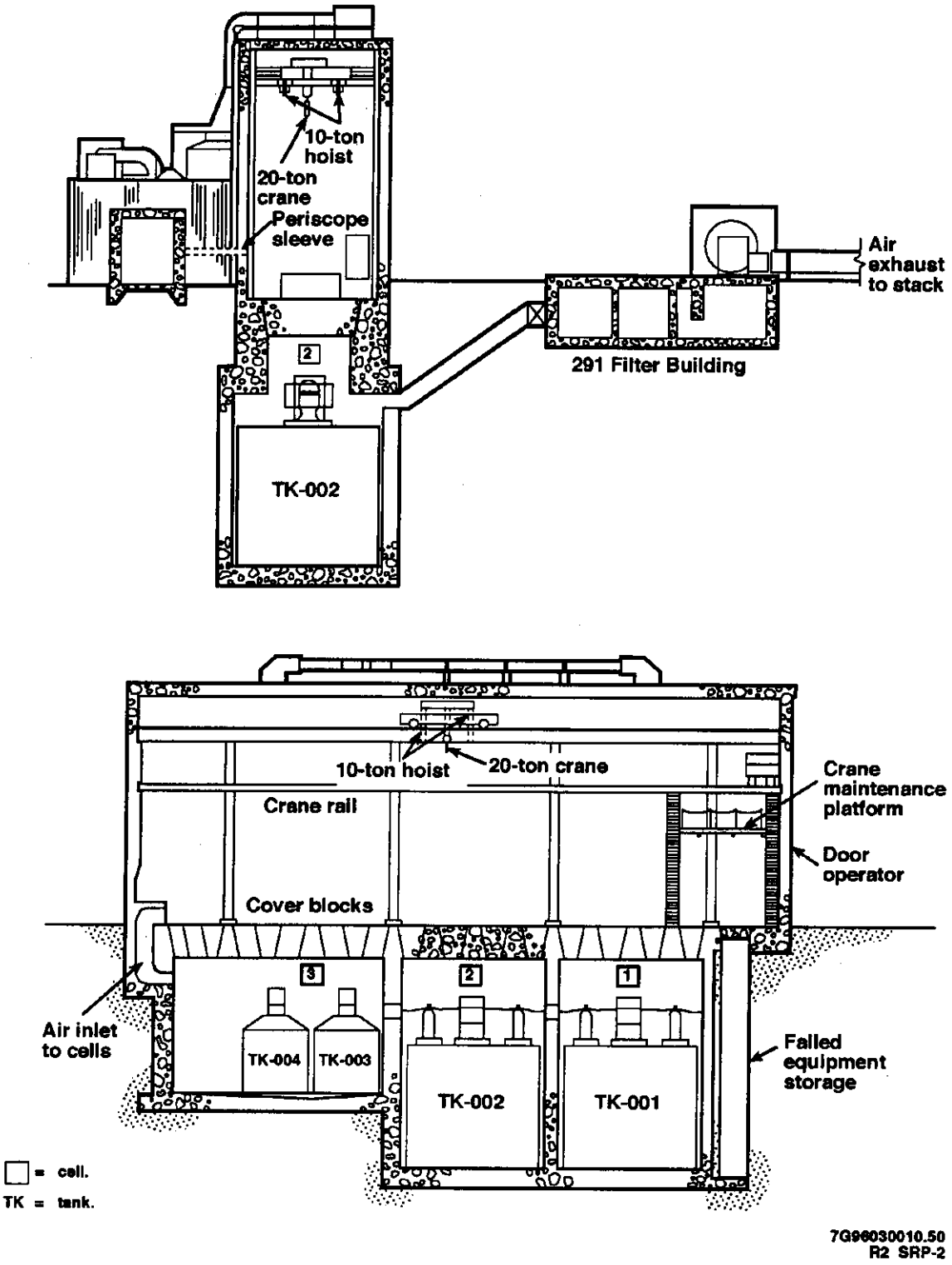


Figure 2-36. A Typical Crib Structure.

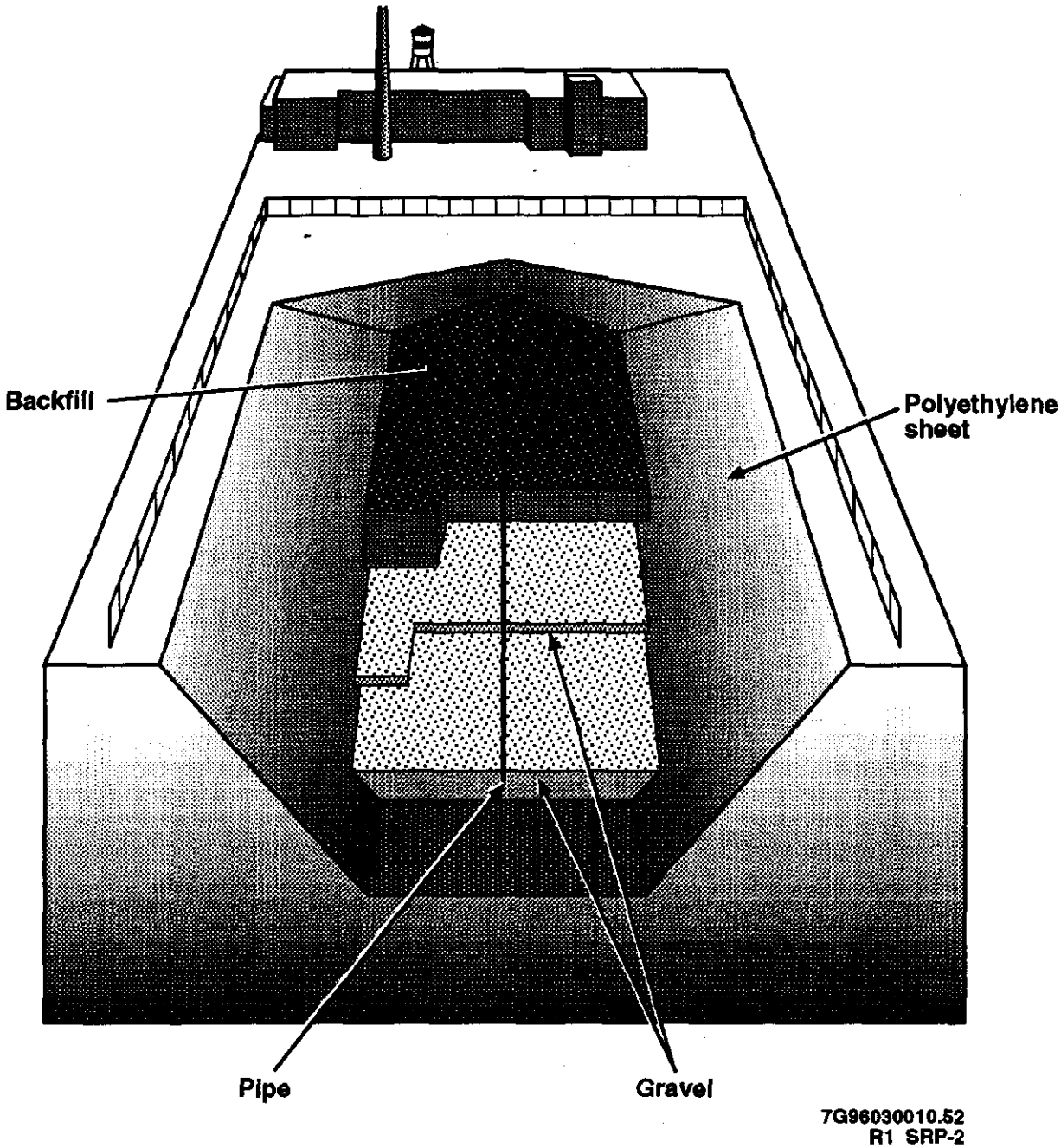


Figure 2-37. Typical Transfer Pipe Encasement Configurations.

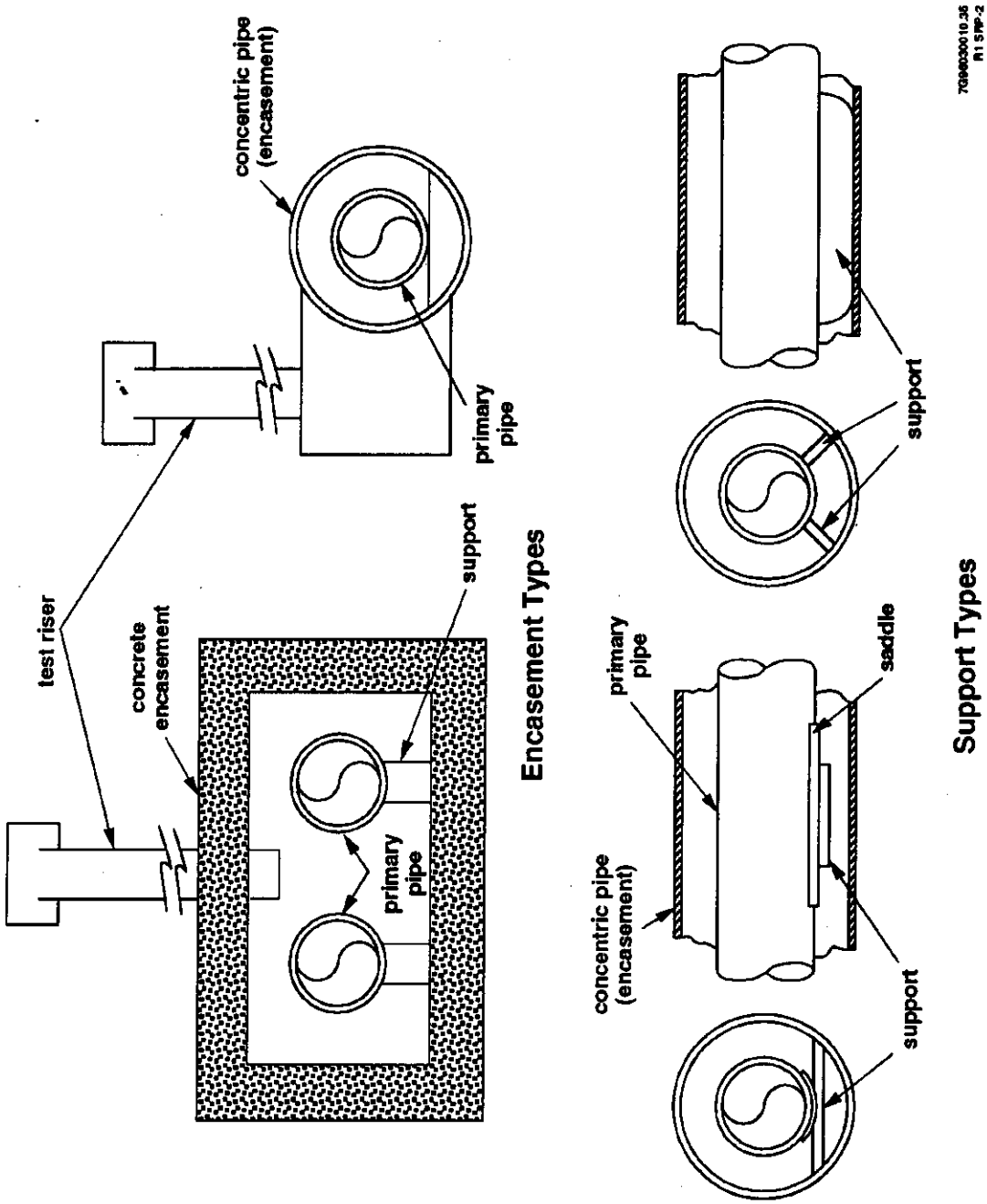


Figure 2-38. Cleanout Box Equipment and Design.

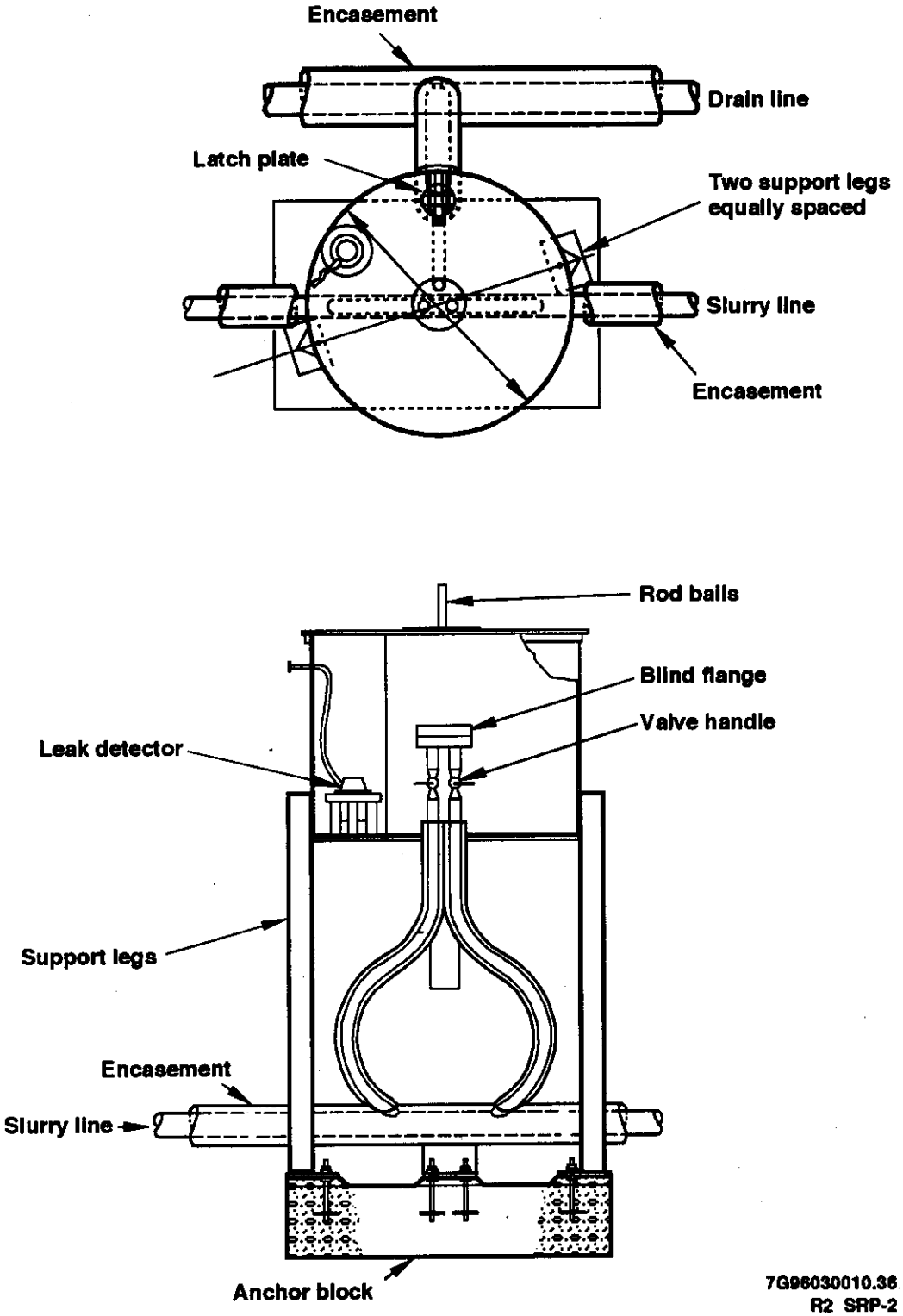


Figure 2-39. A Typical Cleanout Box.

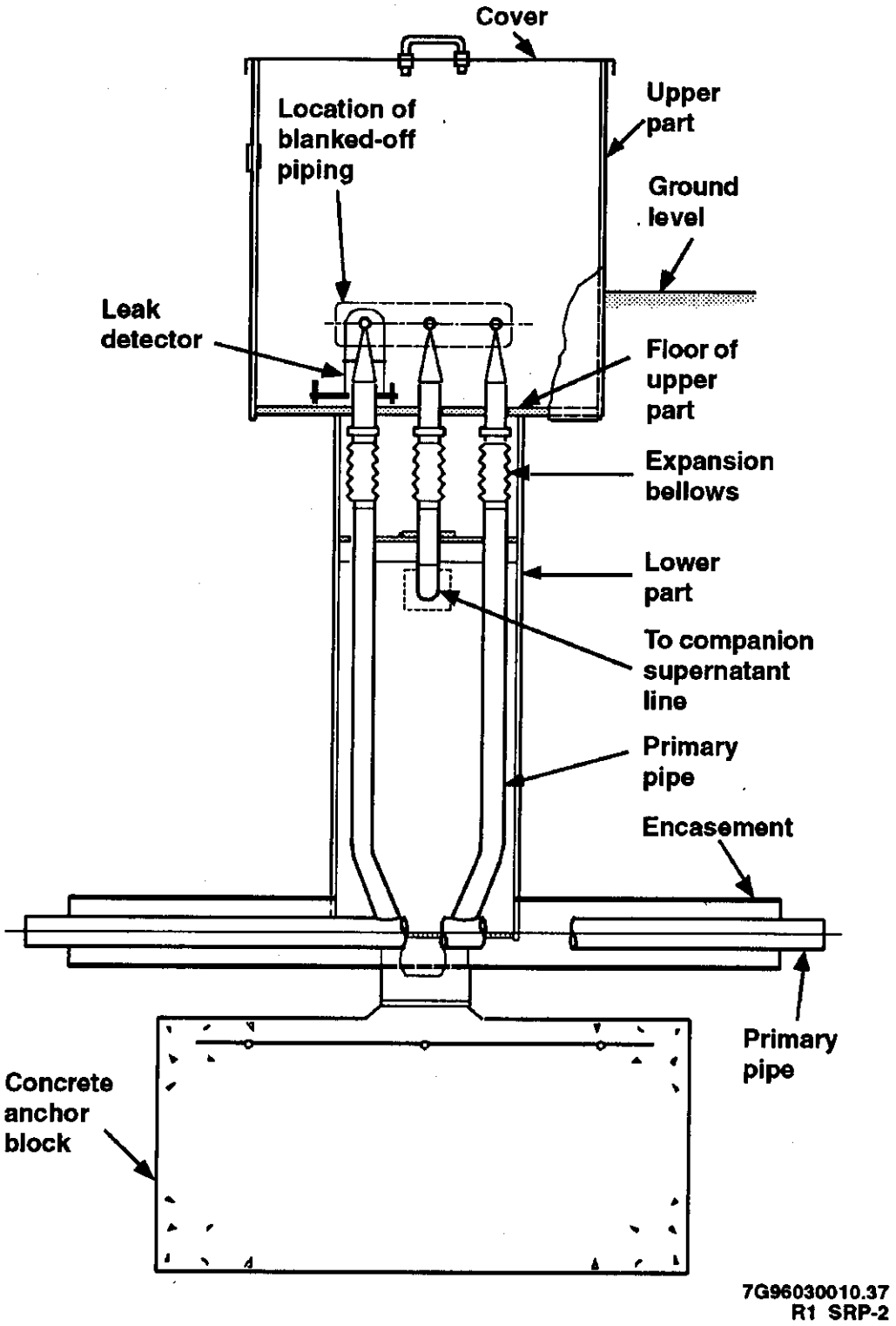


Figure 2-40. Typical Rigid and Flexible Jumpers.

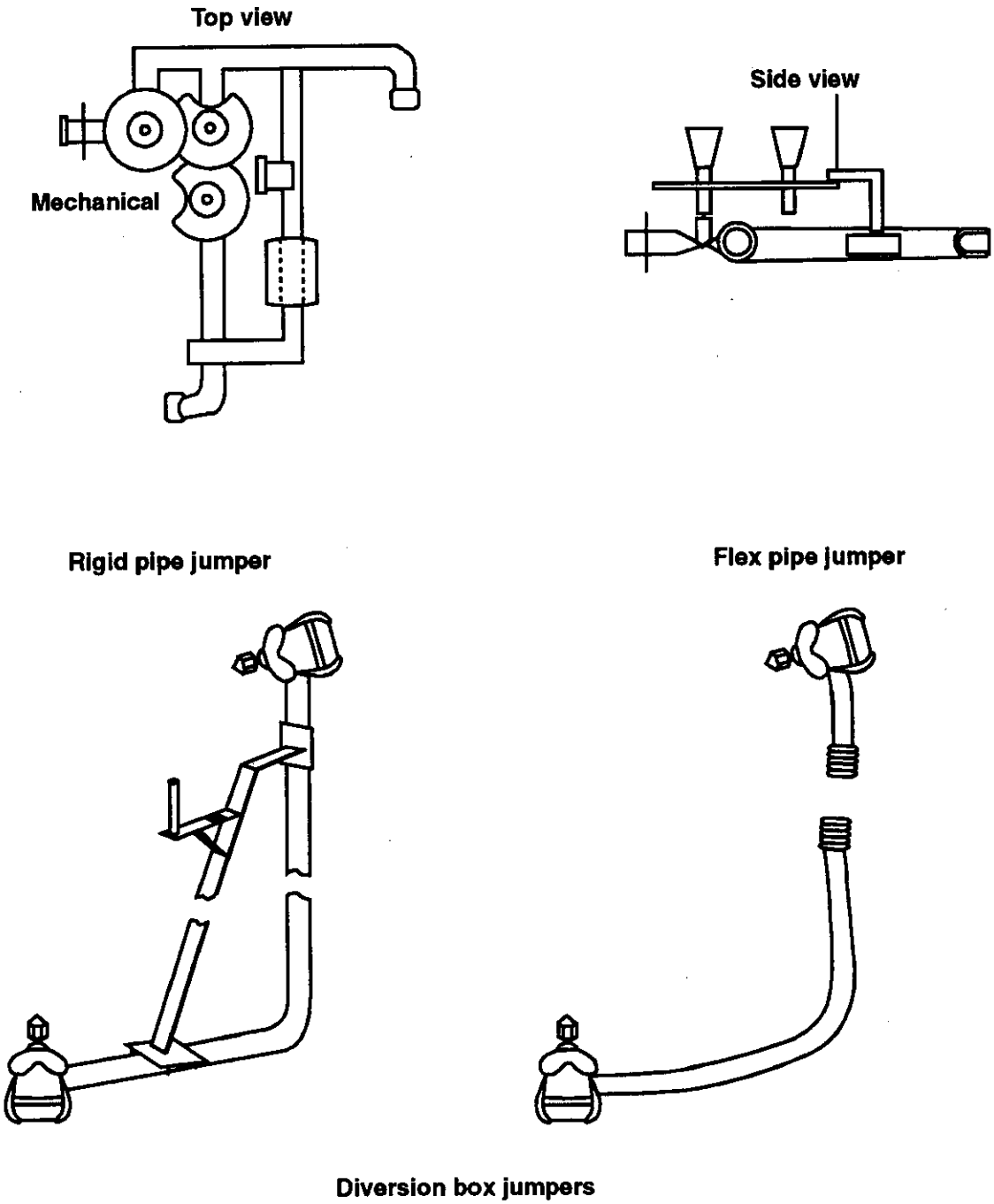
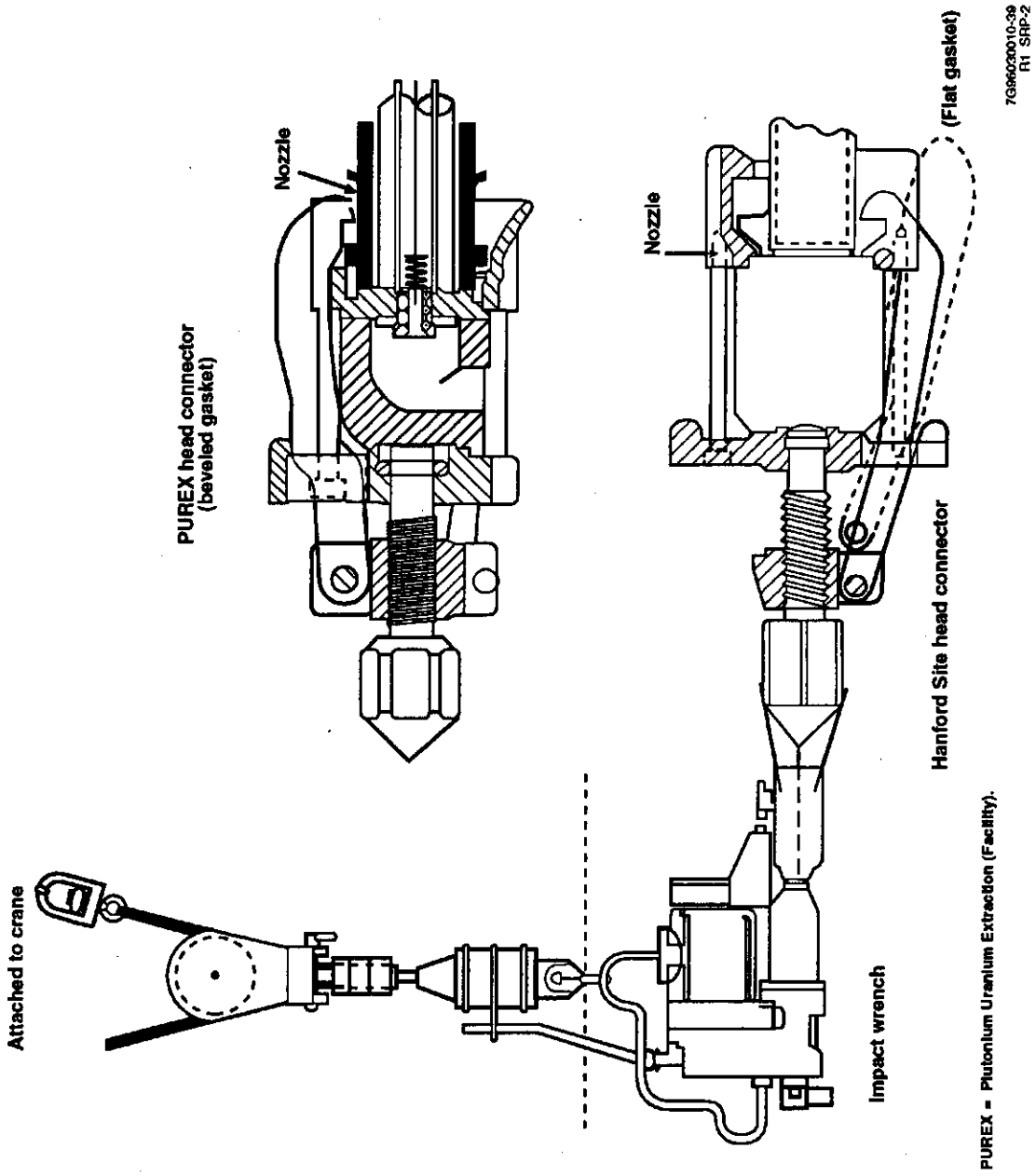


Figure 2-41. Hanford Site and Plutonium Uranium Extraction (PUREX) Head Connectors.



PUREX = Plutonium Uranium Extraction (Facility).

Figure 2-42. A Typical Valve Pit.

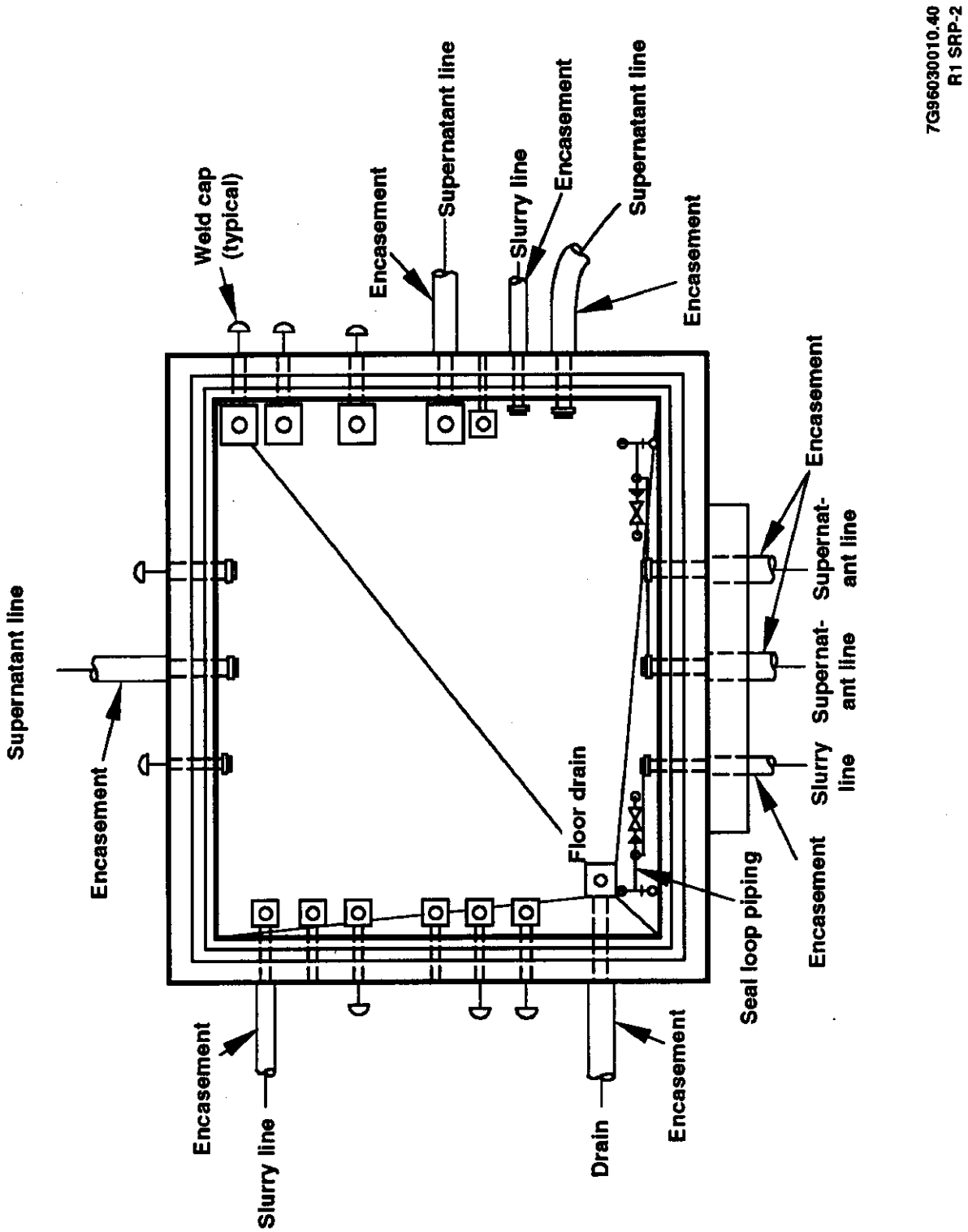


Figure 2-43. A Typical Diversion Box.

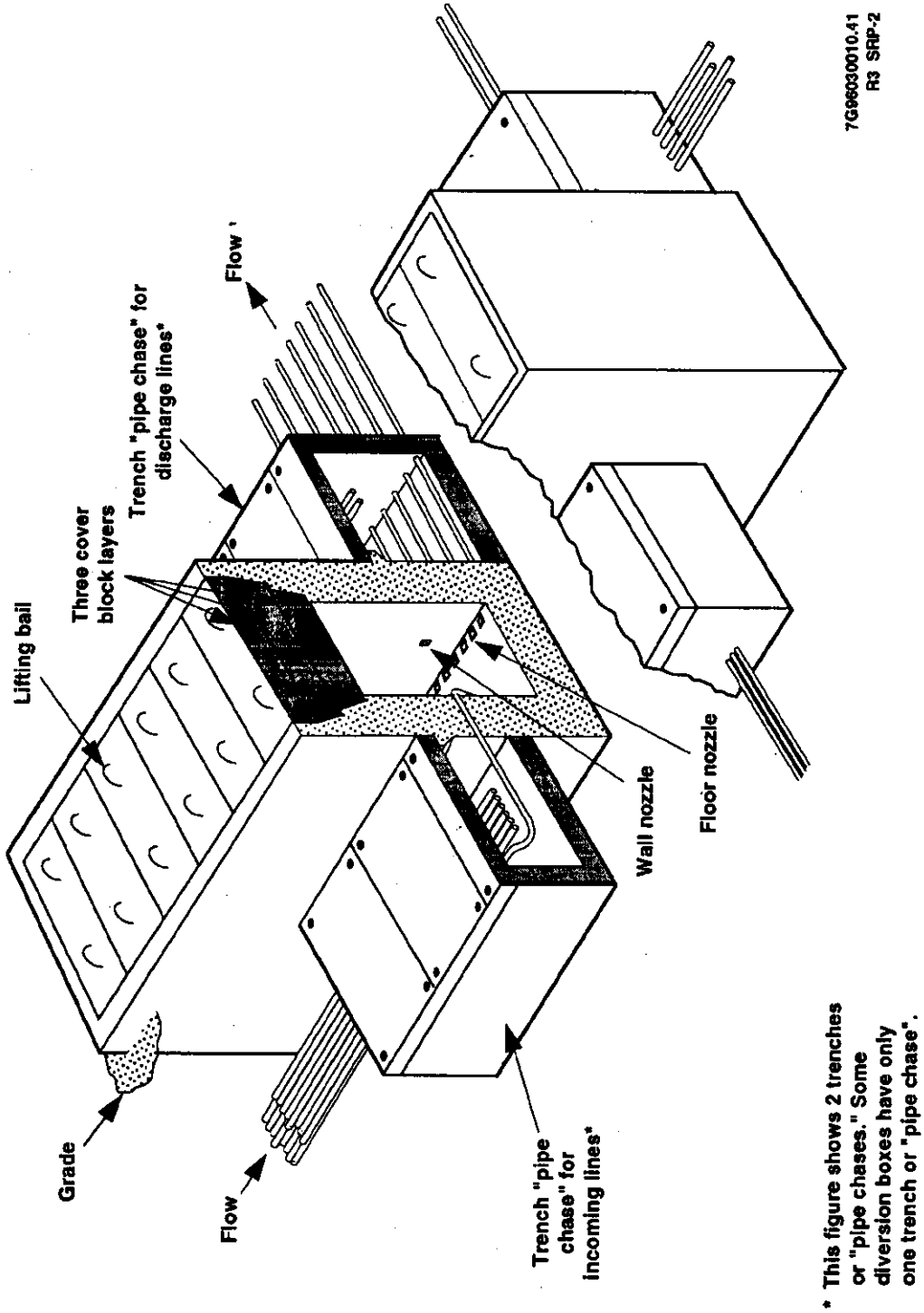


Figure 2-44. Typical Diversion Box Operating Connections.

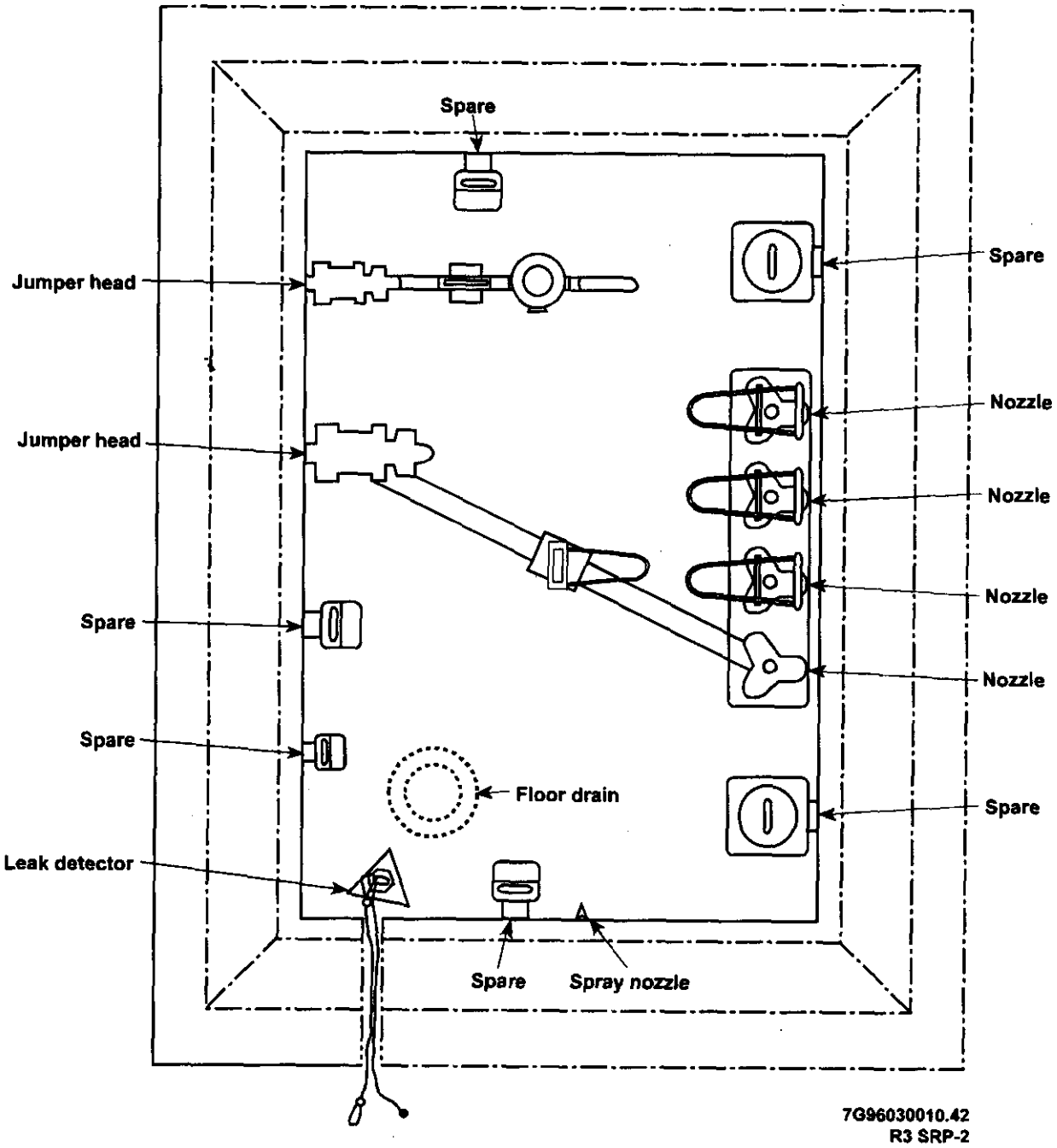


Figure 2-45. A Typical Diverter Station.

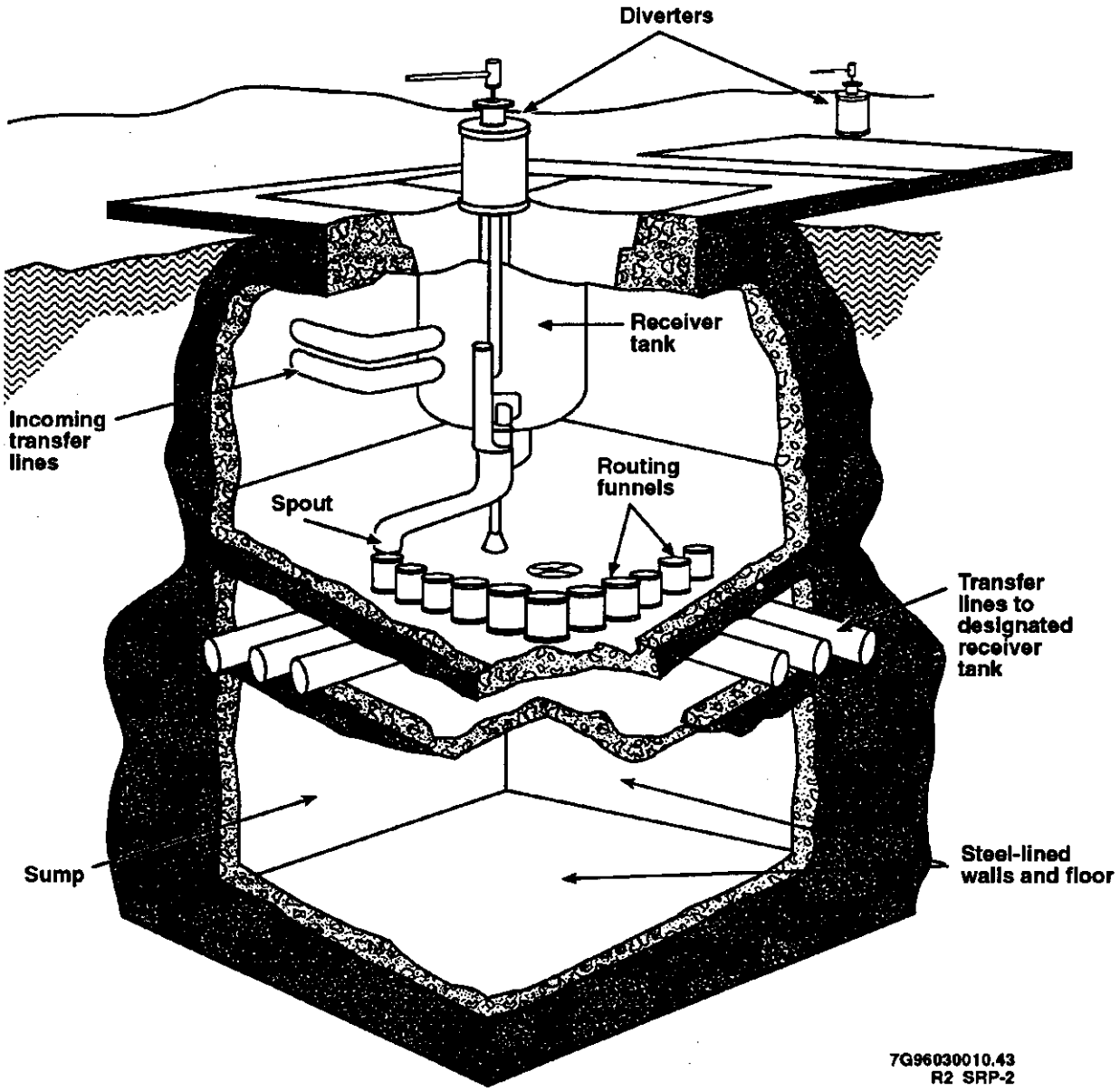


Figure 2-46. Jet Pump System.

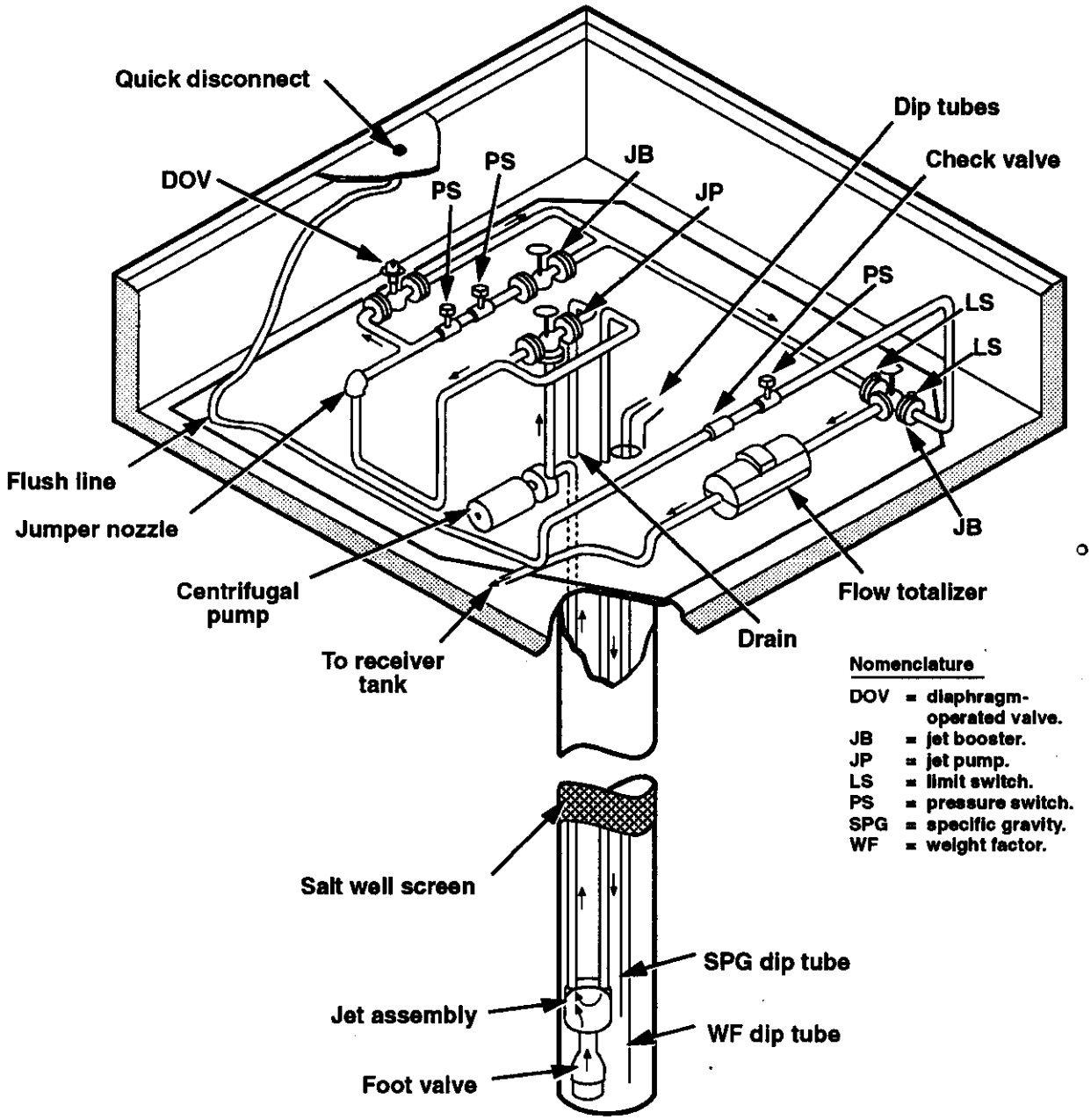


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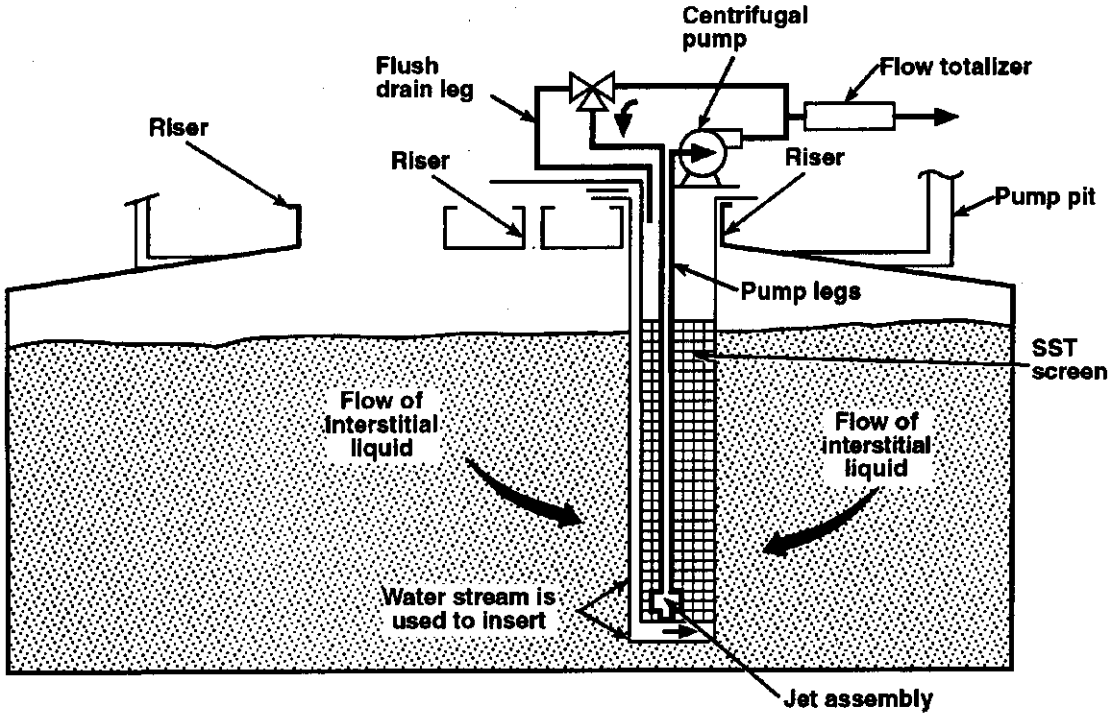
Figure 2-47. A Typical Centrifugal Pump.



SST = single-shell tank.

Salt cake with drainable interstitial liquid

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Figure 2-48. Drawing of a Food Instrument Corporation Gauge.

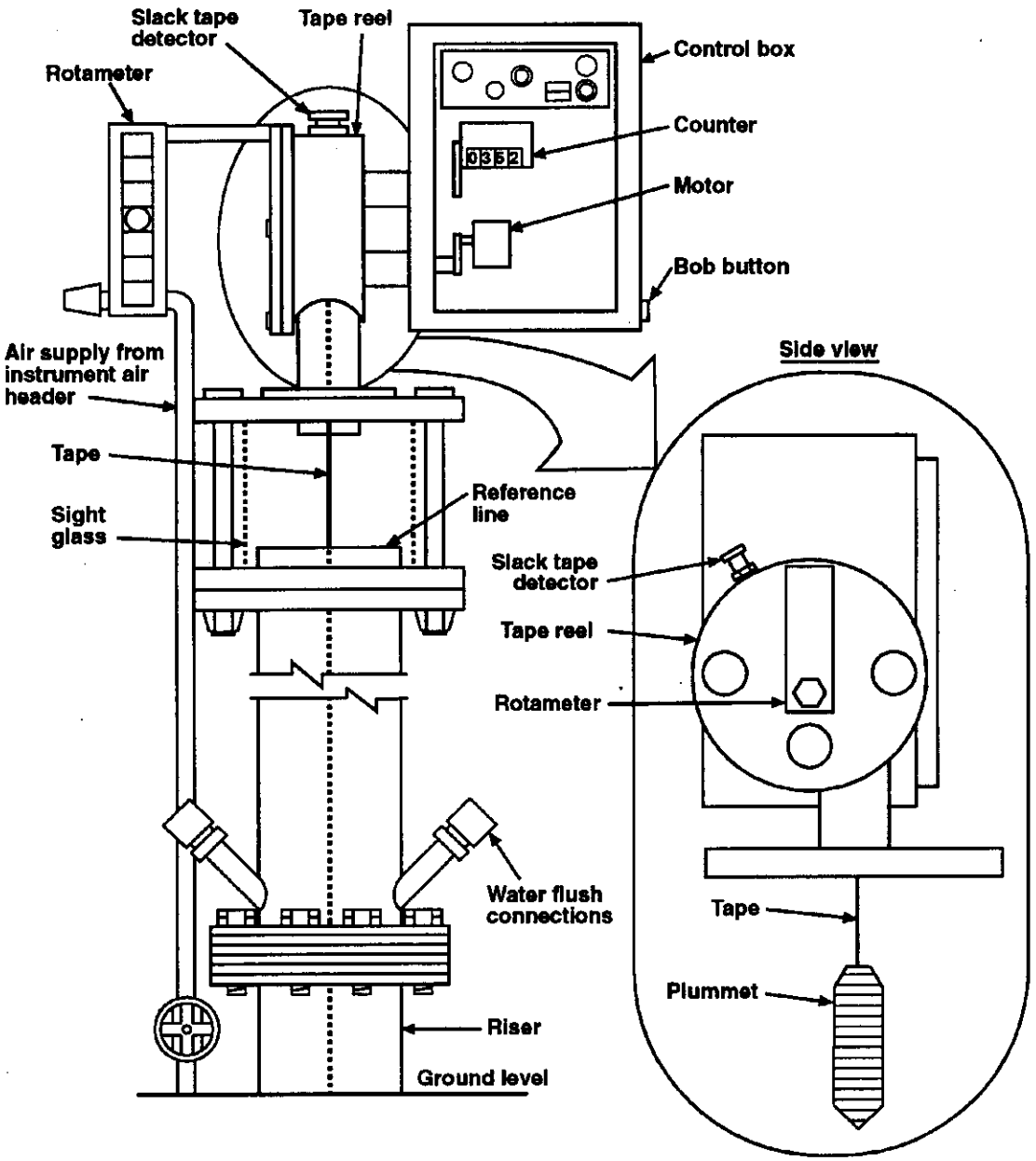

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Figure 2-49. Drawing of an ENRAF Gauge.

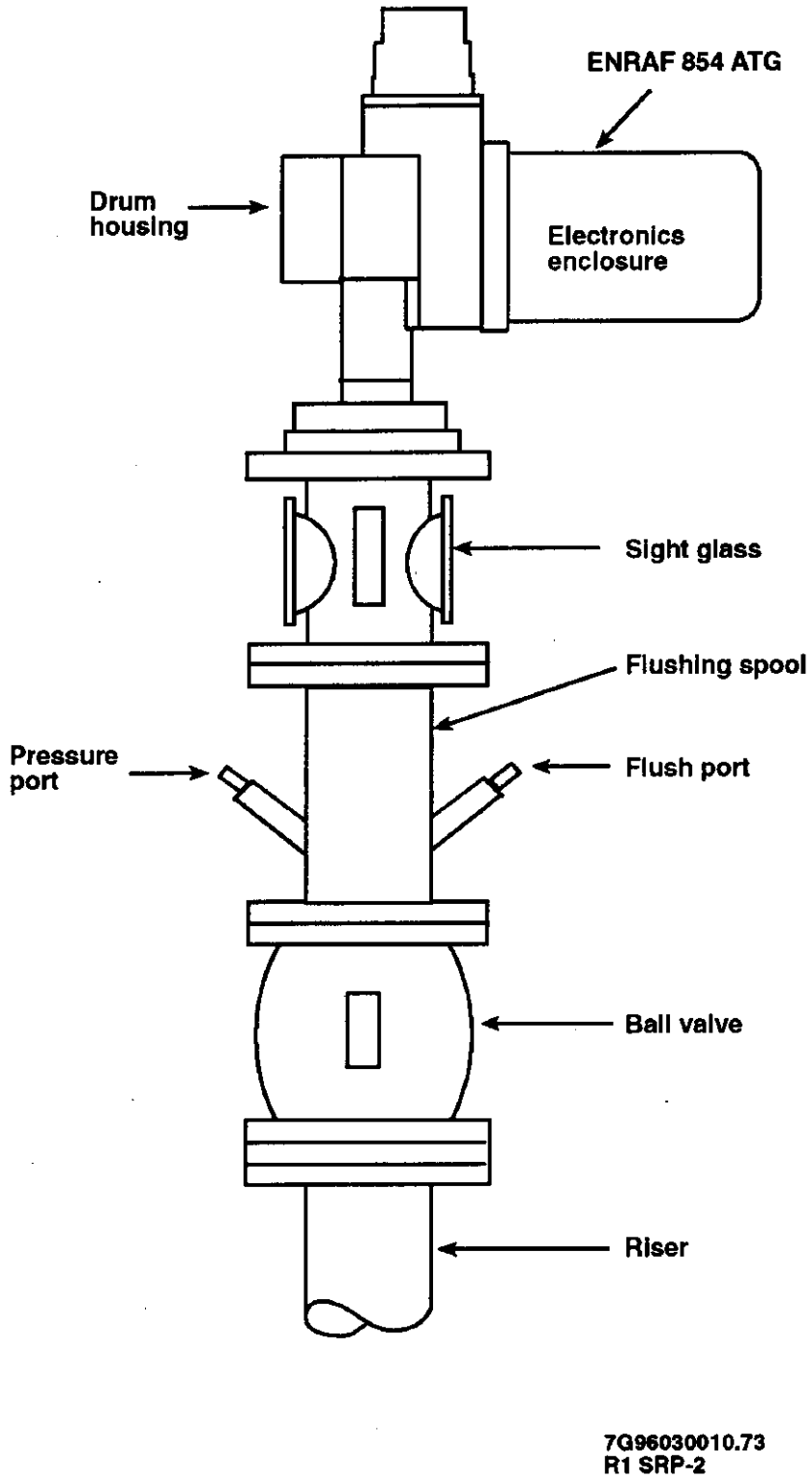

Figure 2-50. Specific Gravity and Weight Factor Monitoring.

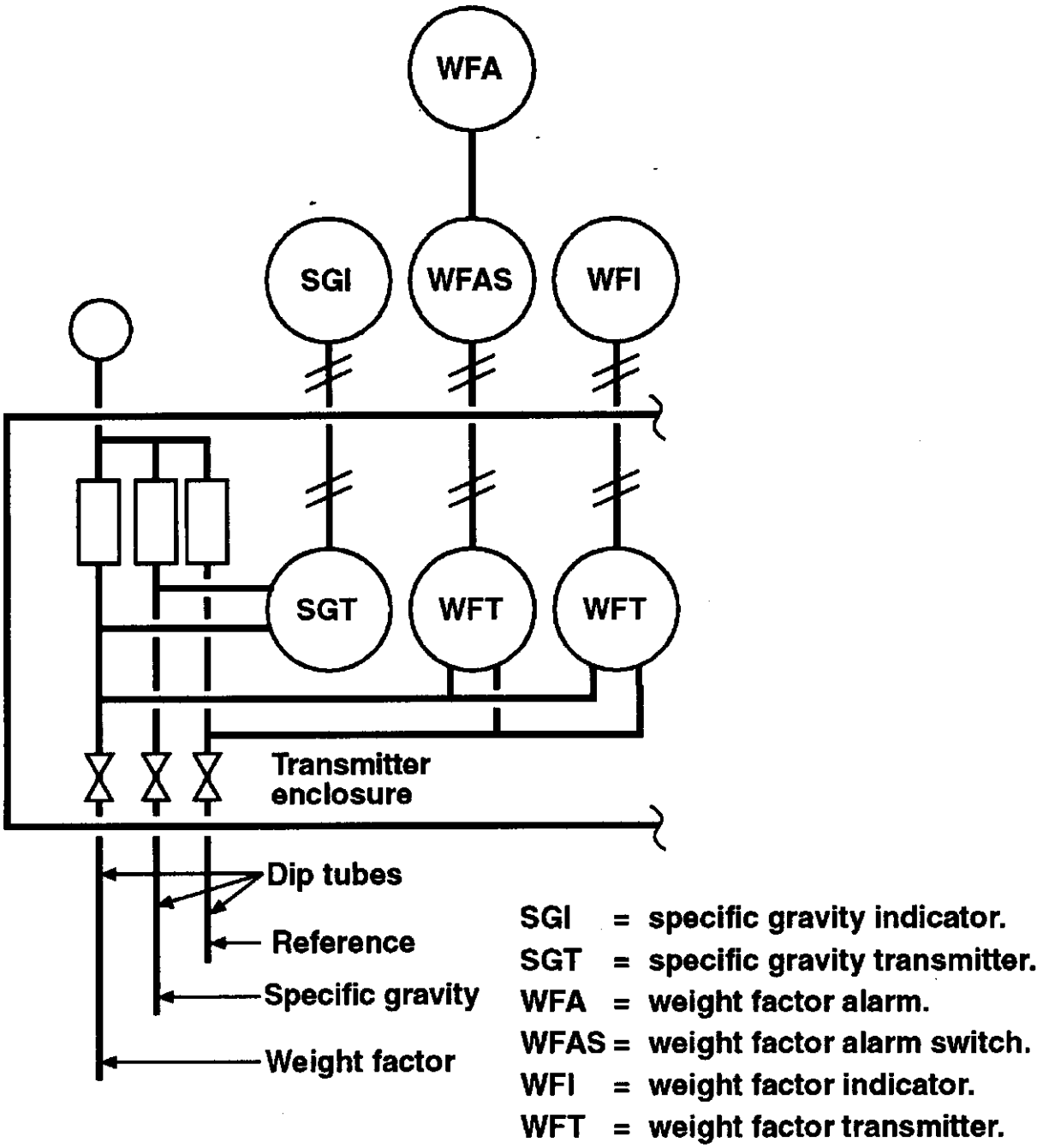

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Figure 2-51. Sludge-Level Measuring Assembly.

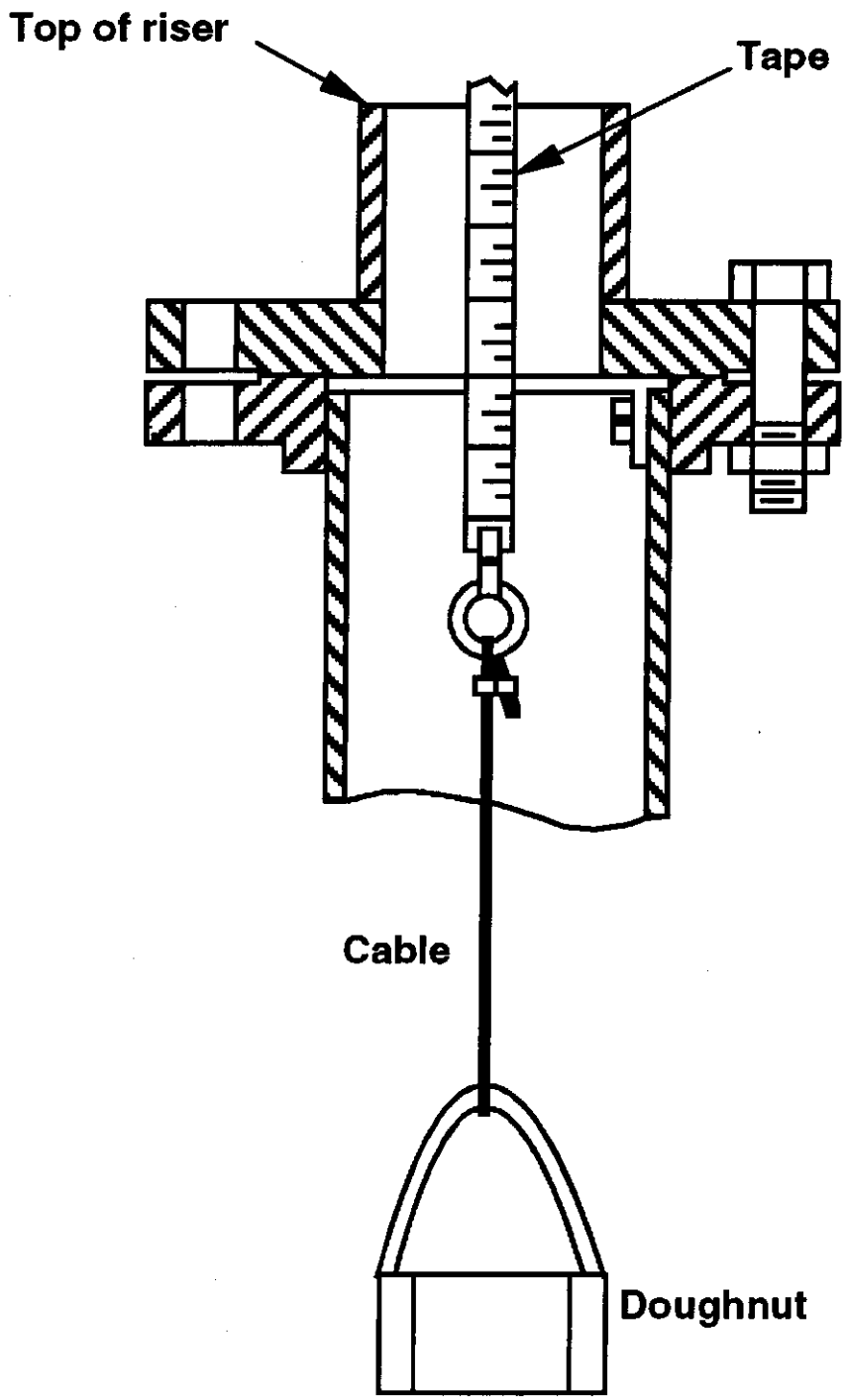

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Figure 2-52. Illustration of Double-Shell Tank and Transfer System Leak Detection Systems.

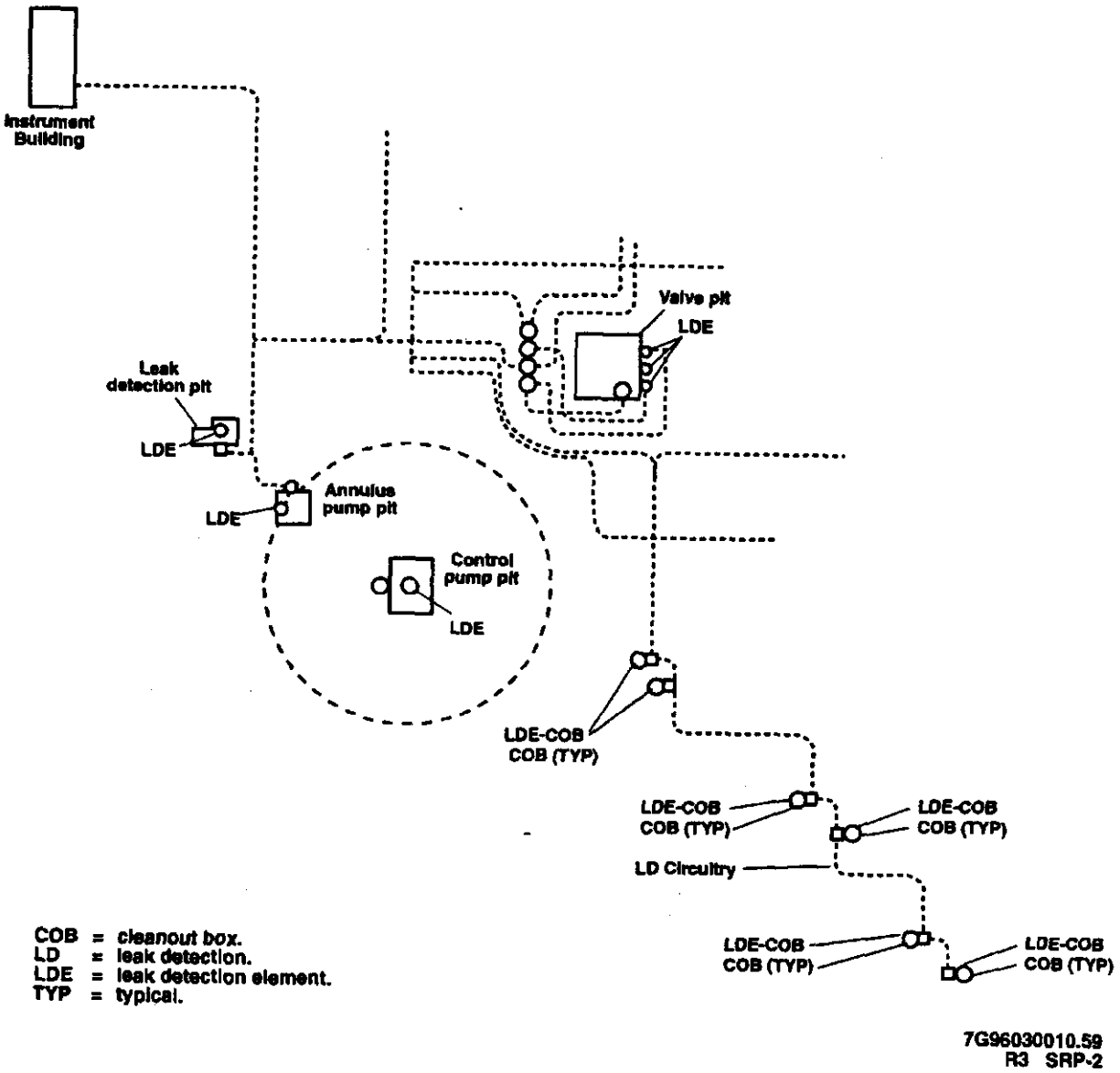
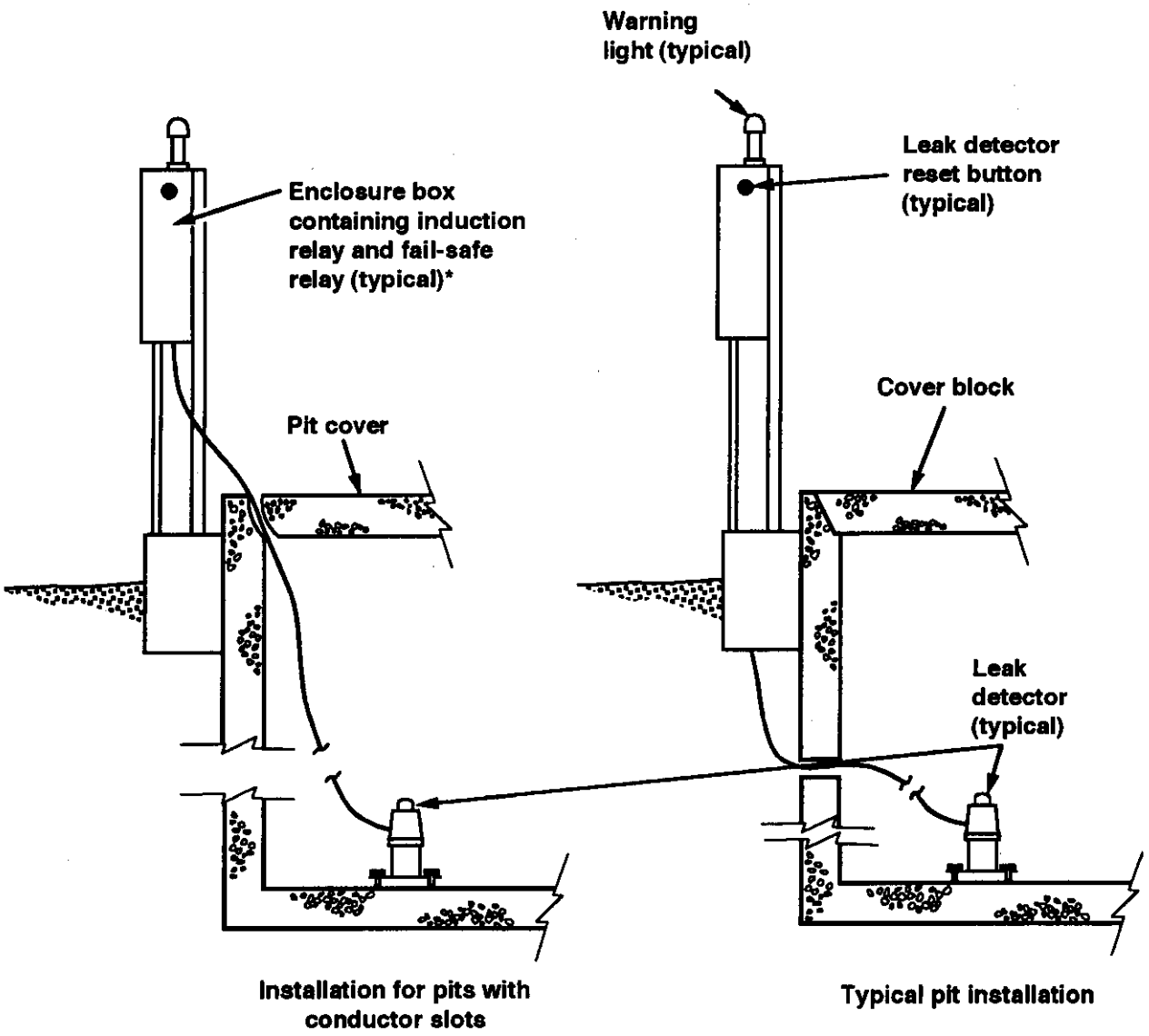


Figure 2-53. Typical Pit Leak Detection Installation.



* The induction relay functions on liquid level, and the fail-safe relay functions on loss of power.

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Figure 2-54. Schematic of a Typical Radiation Detection Pit with Sump (see Figure 2-19).

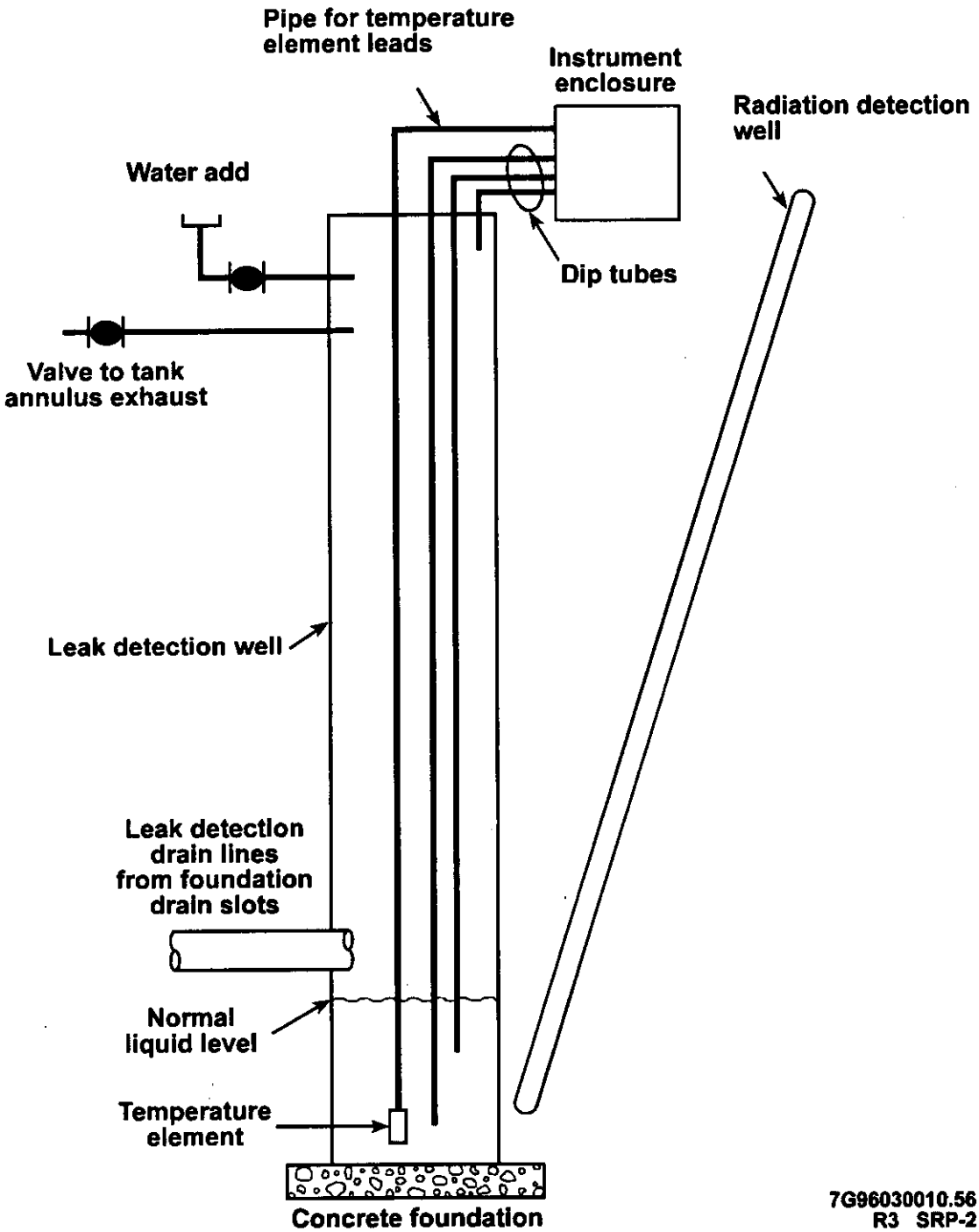


Figure 2-55. A Typical Leak Detection Transmitter Enclosure.

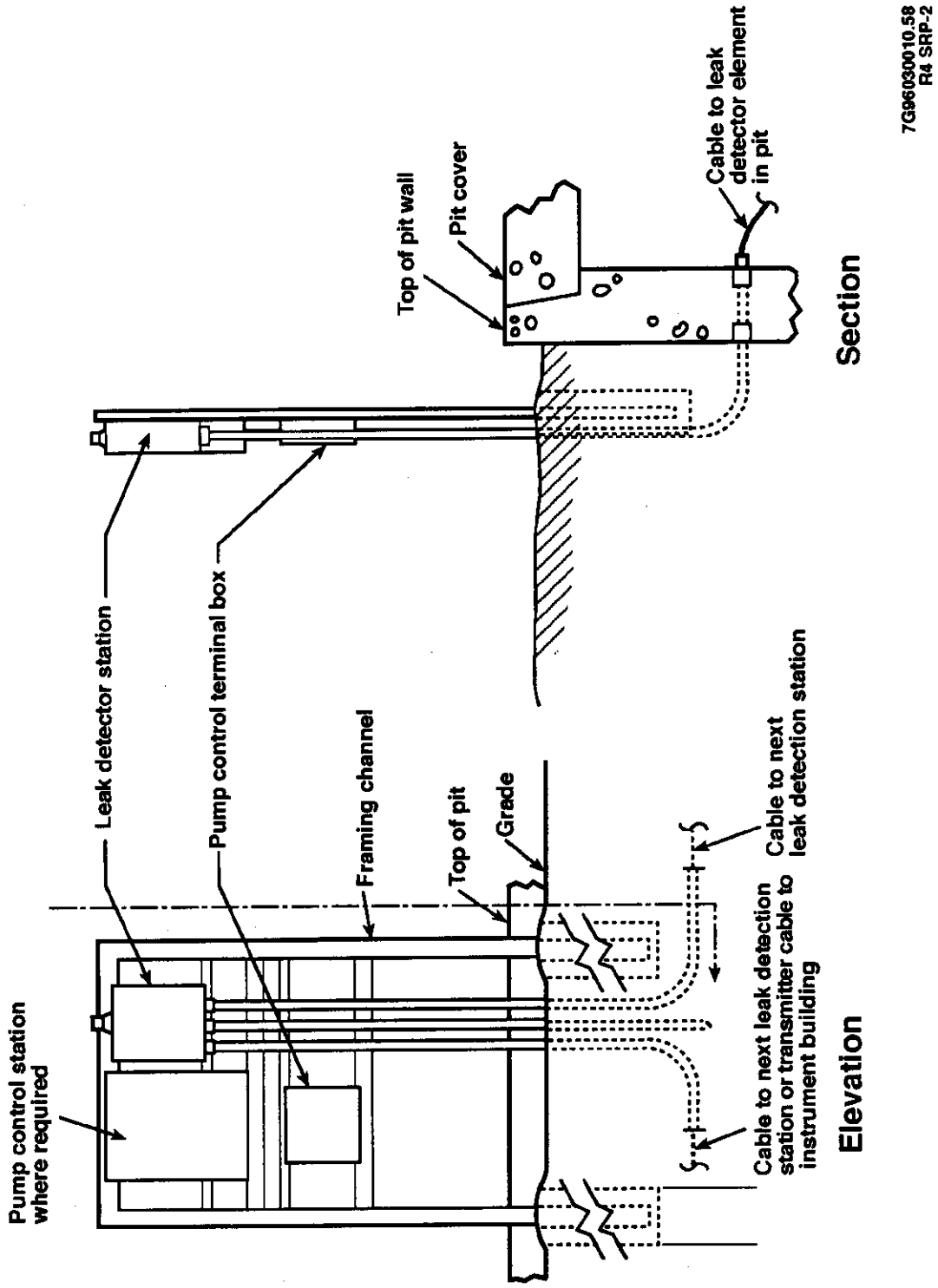
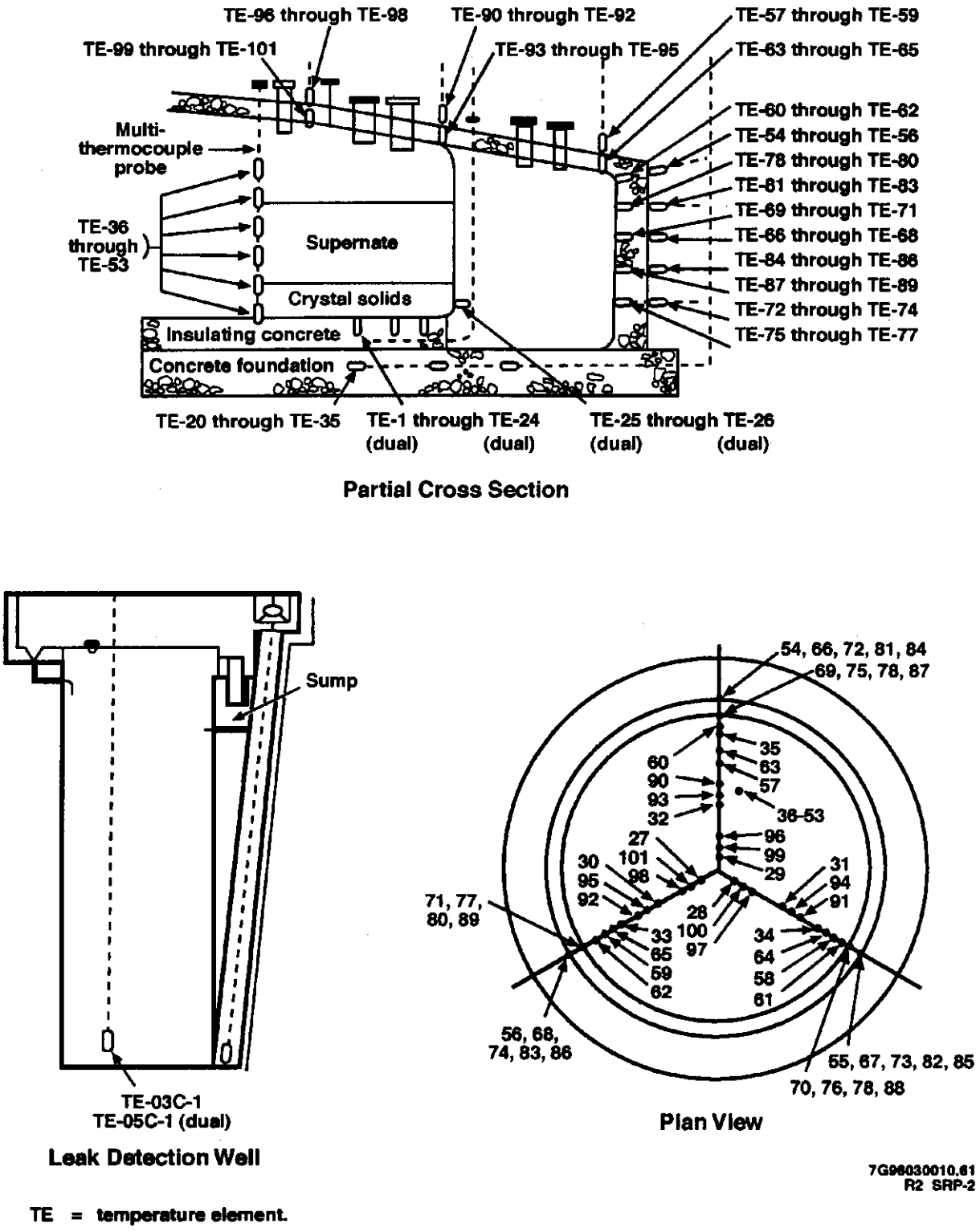


Figure 2-56. Typical Double-Shell Tank Thermocouple Element Location.



TE = temperature element.

Figure 2-57. Typical Double-Shell Tank Temperature Measurement Probe.

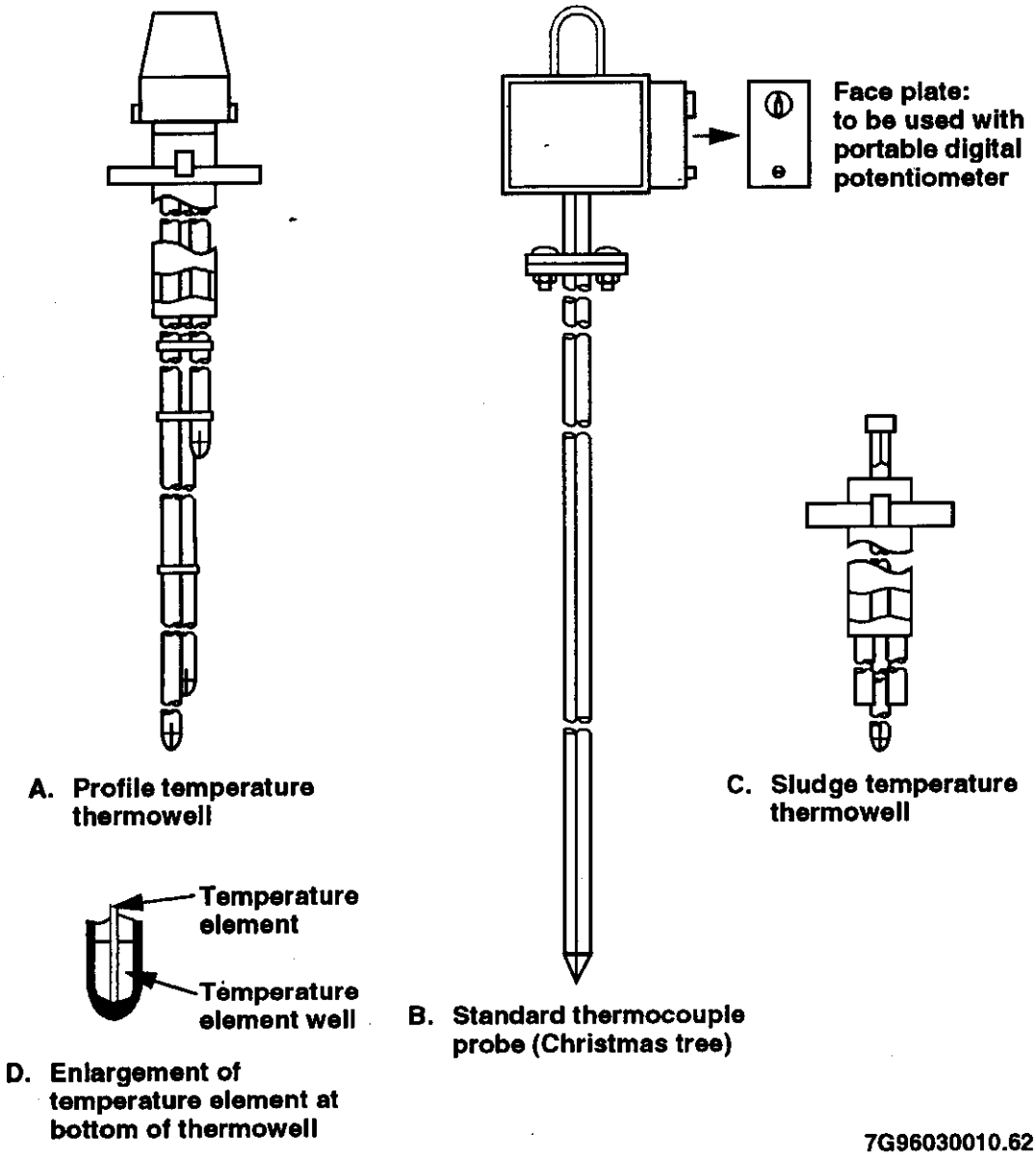


Figure 2-58. Typical Double-Shell Tank In-Tank Thermocouple Arrangement.

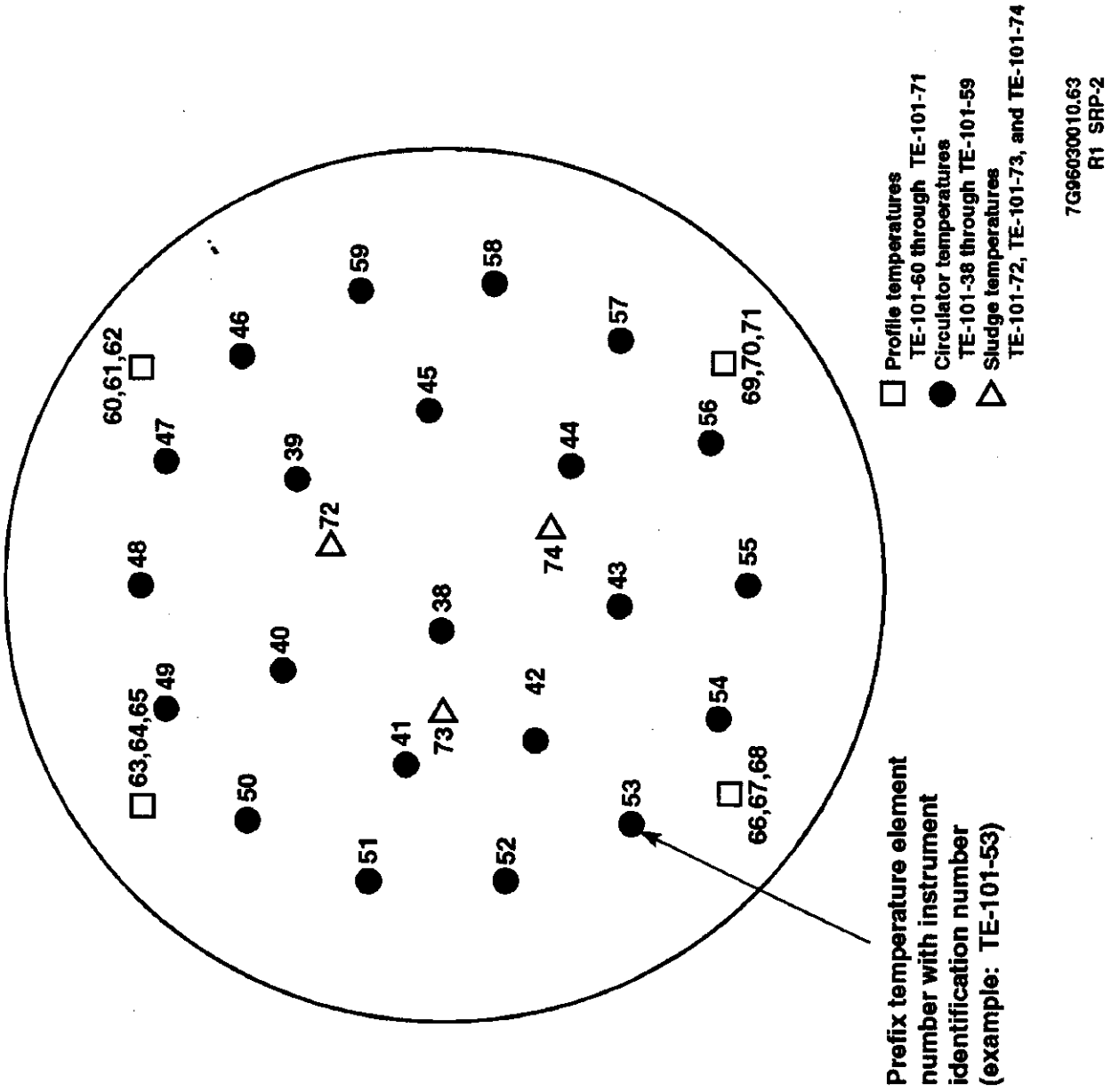


Figure 2-59. Typical Double-Shell Tank Terminal Box Locations.

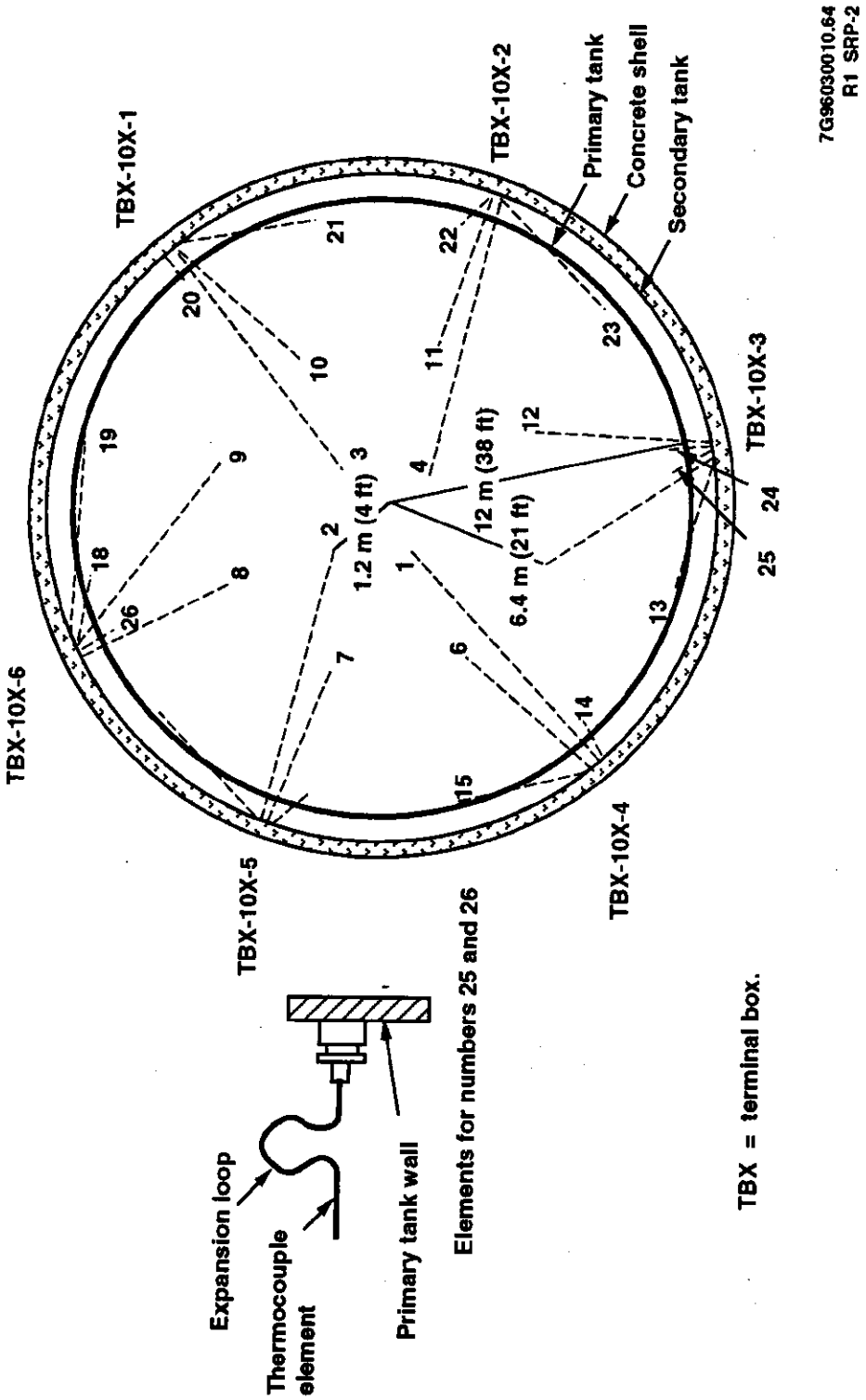


Figure 2-60. Core Sampler Assembly.

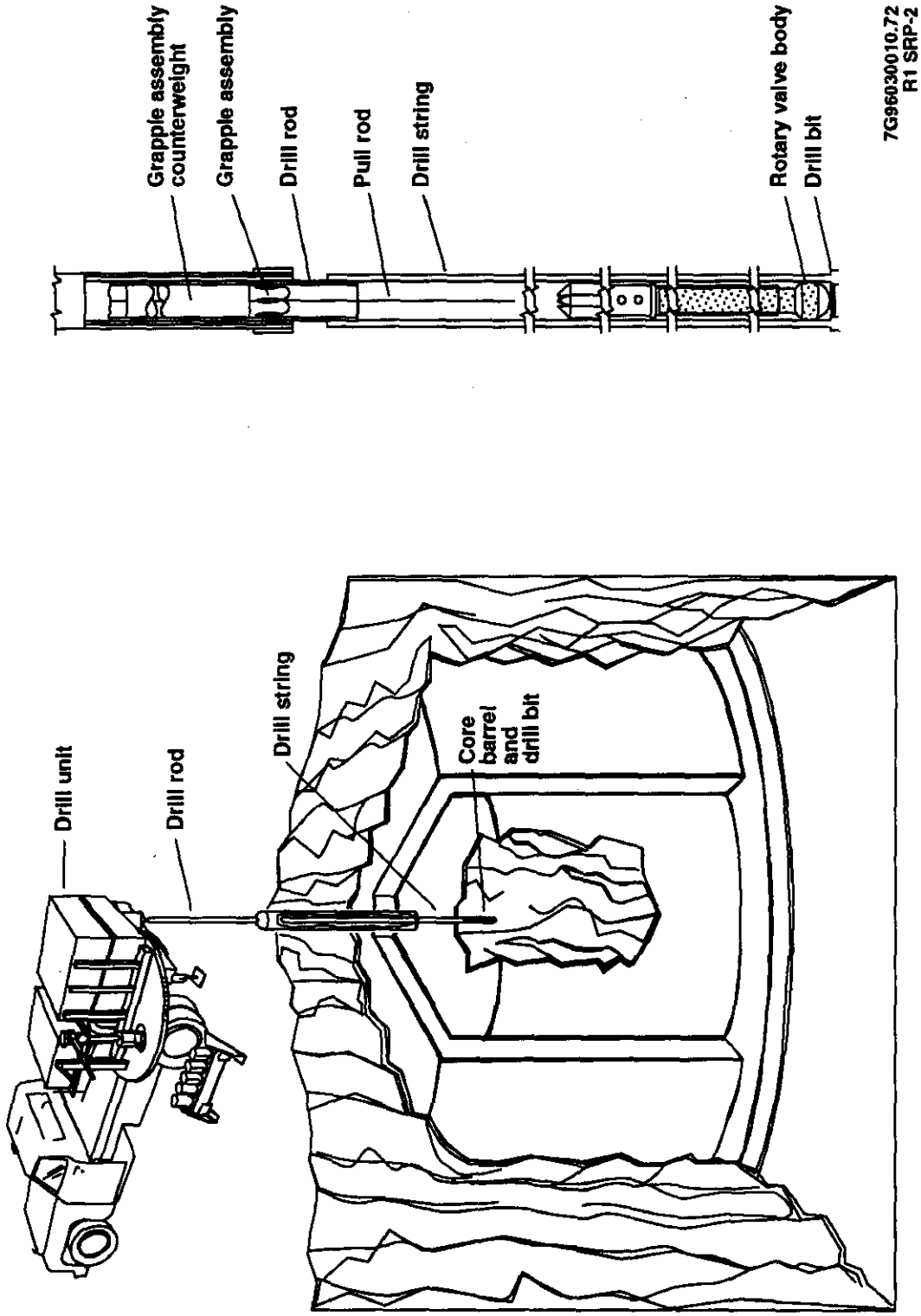


Figure 2-61. Schematic of the Standard Hydrogen Monitoring System.

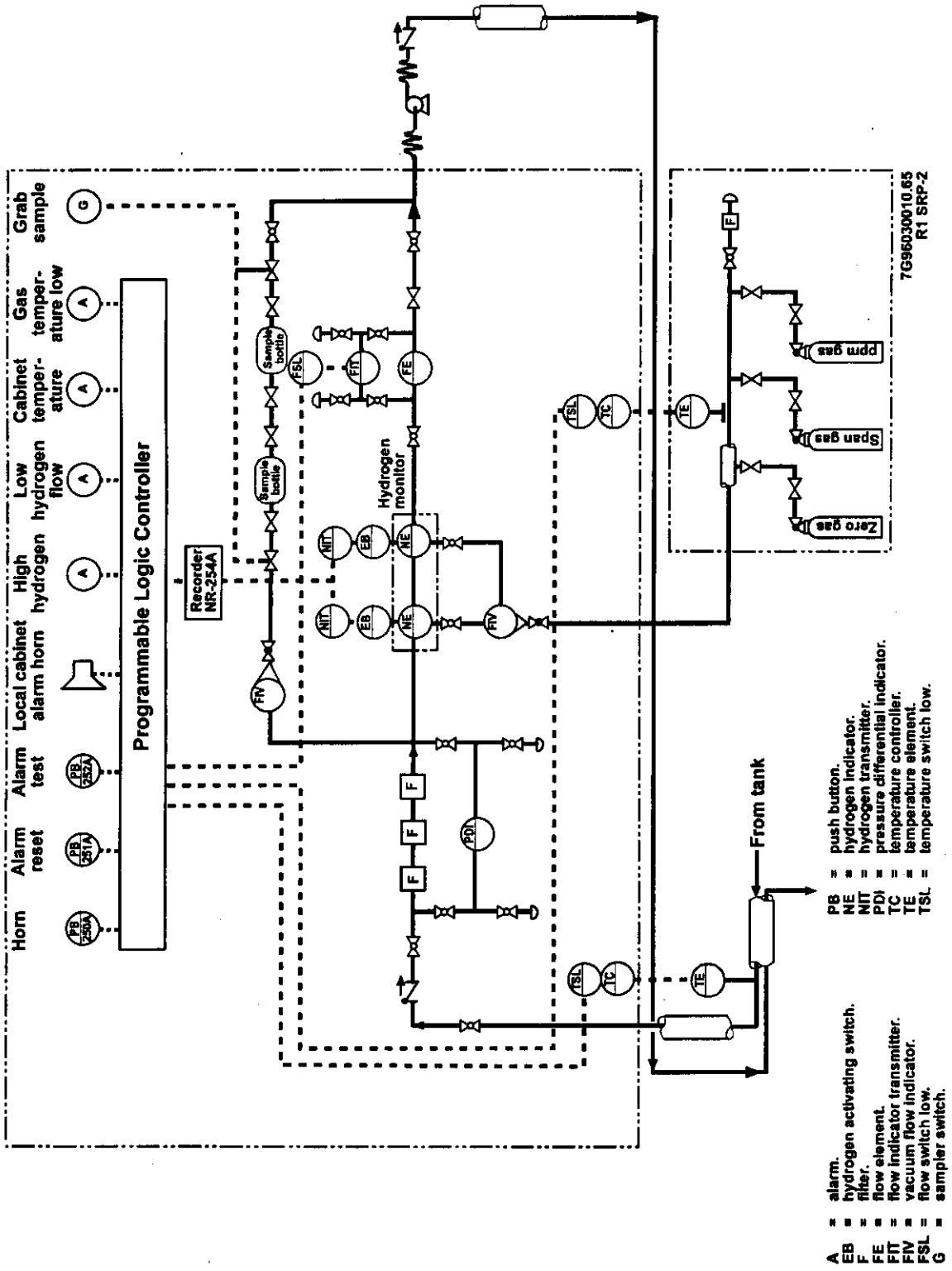


Figure 2-62. A Typical Mixer Pump.

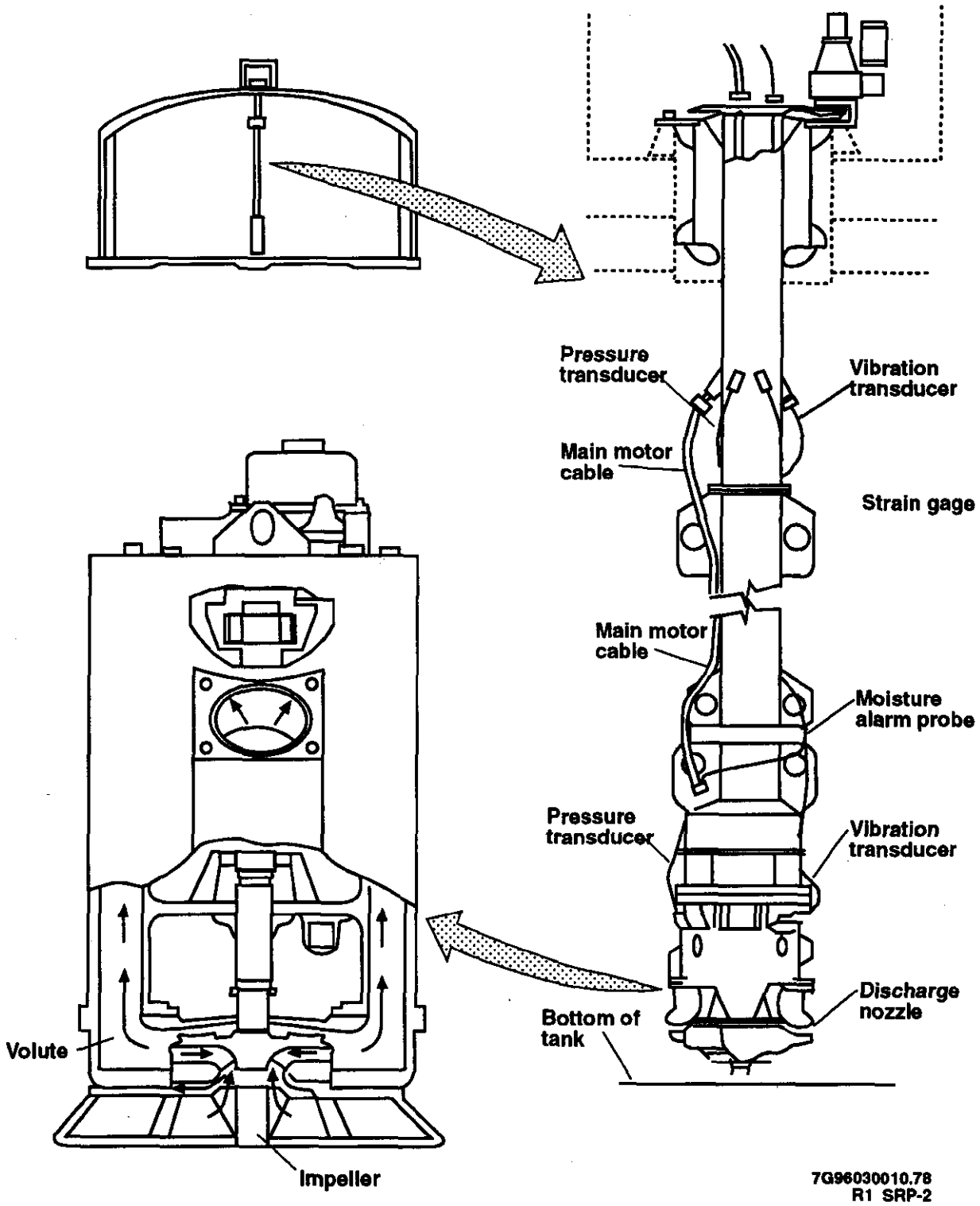


Figure 2-63. Typical Stack Sampling and Monitoring System.

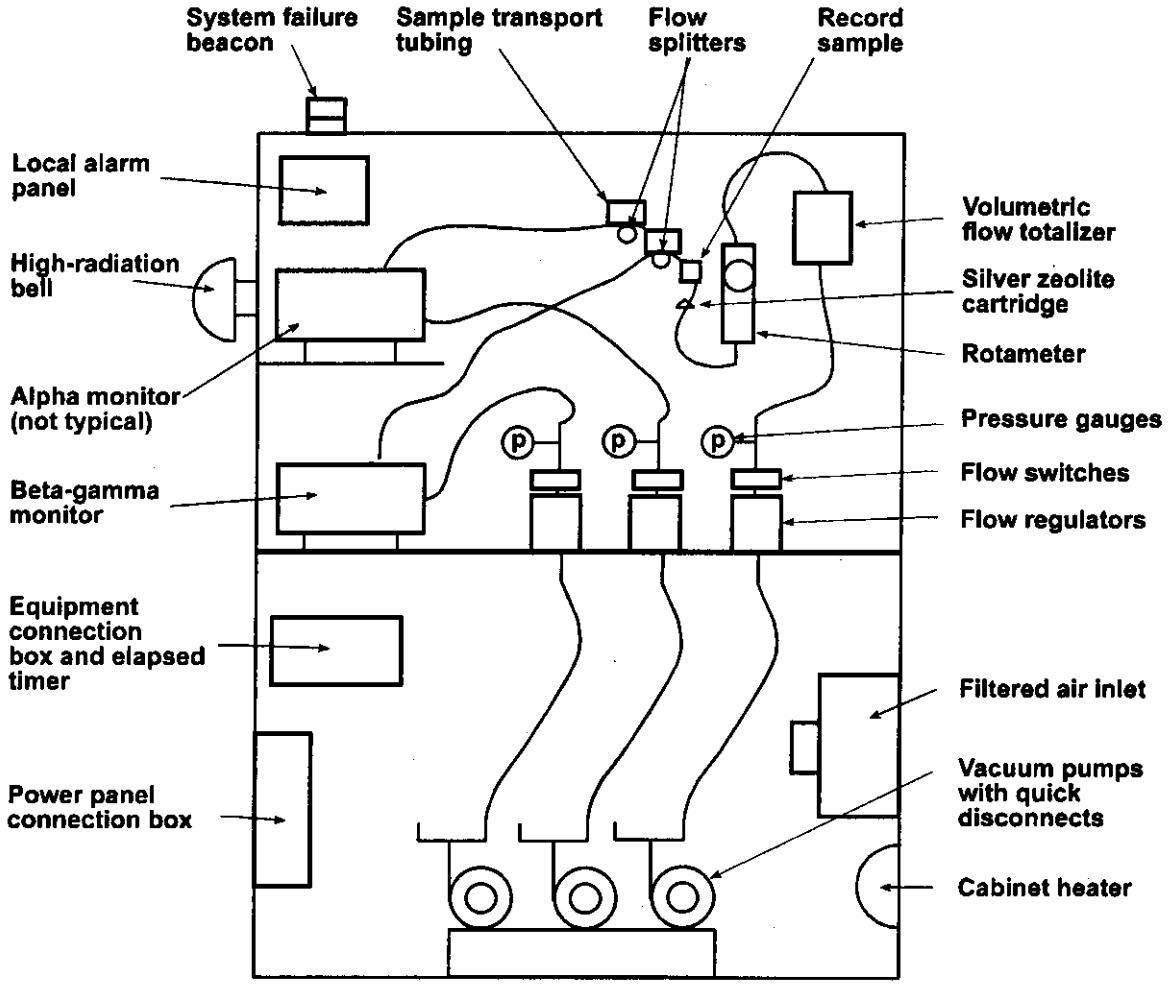


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Figure 2-64. Hanford Site Map Showing the 200 East and 200 West Areas Power Distribution System.

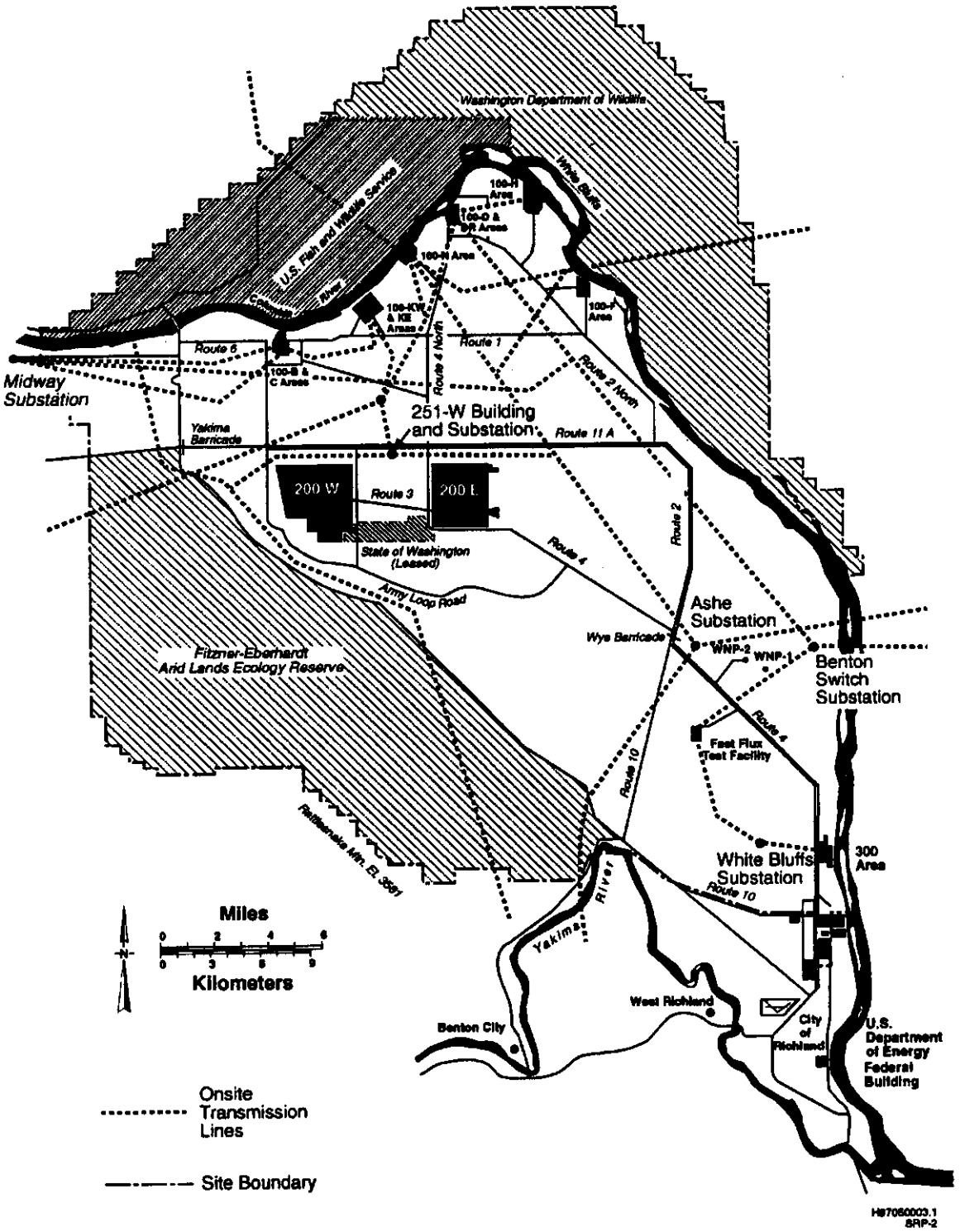
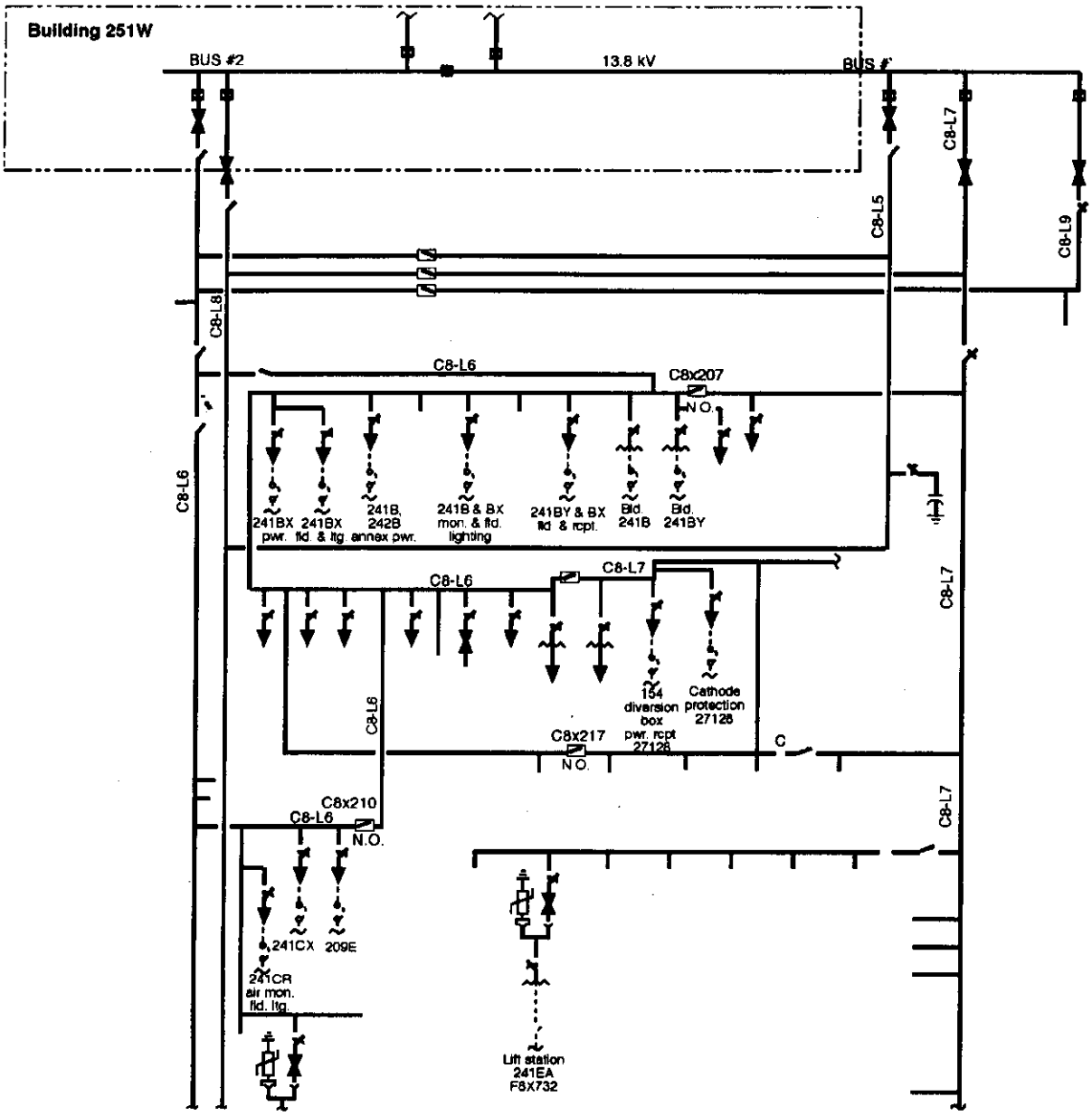


Figure 2-65. 200 East Area Electrical Distribution System. (2 sheets)



Bld. = **building.**
fld. = **flood.**
ltg. = **lighting.**
mon. = **monitor.**
N. O. = **normally open.**
pwr. = **power.**
rcpt. = **receptacle.**

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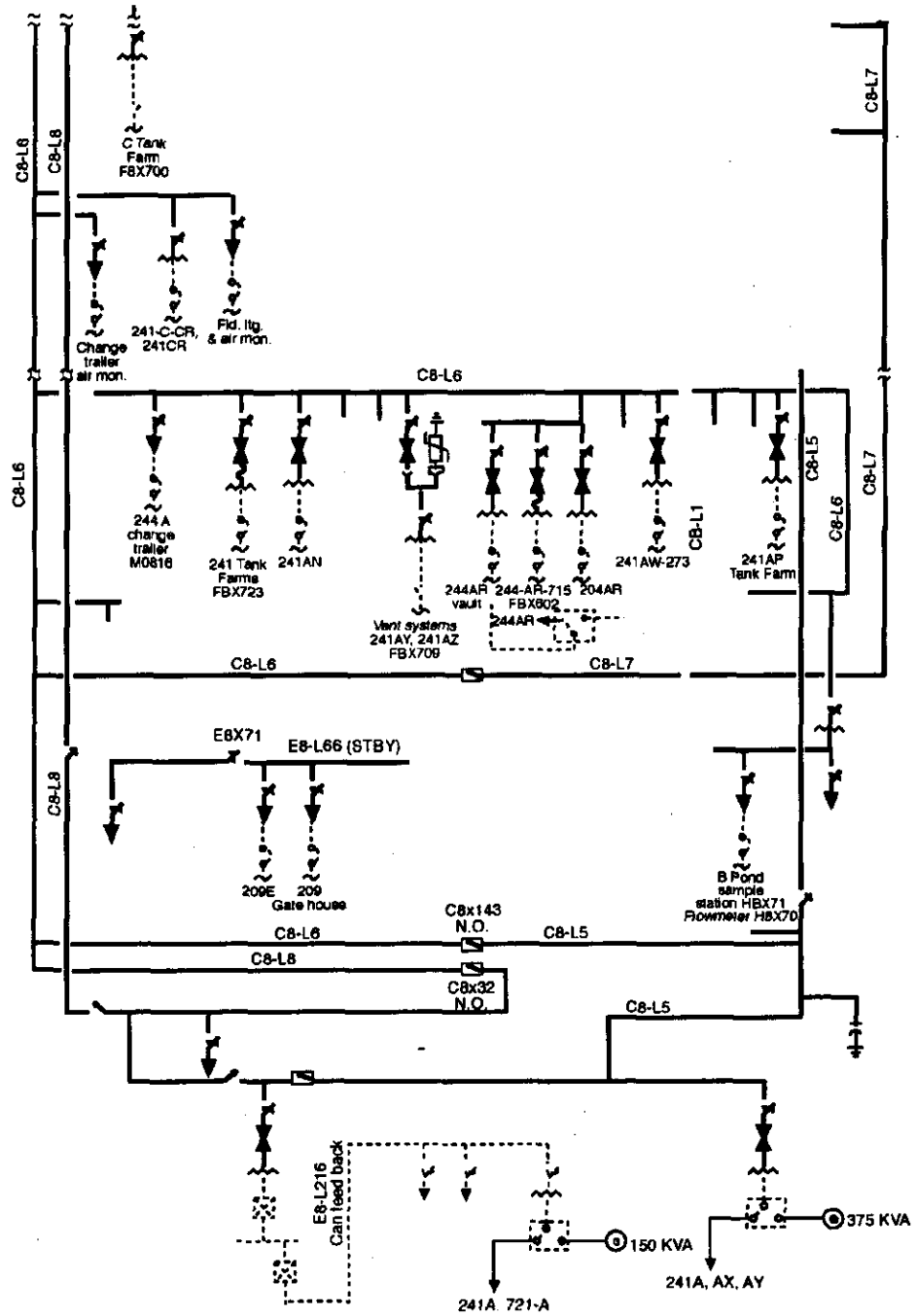
R1 SRP-2

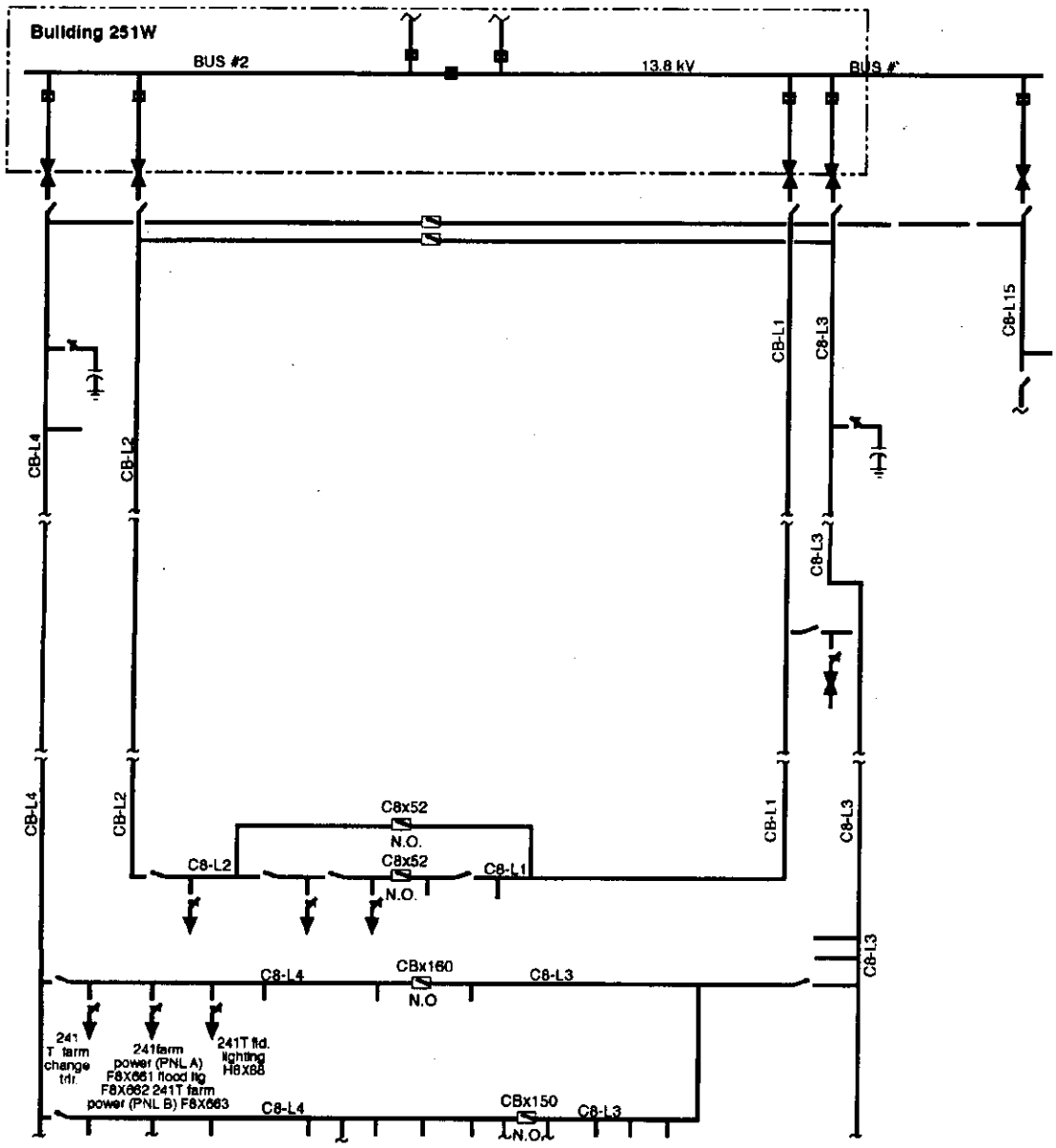
Figure 2-65. 200 East Area Electrical Distribution System. (2 sheets)



fld. = flood.
ltg. = lighting.
mon. = monitor.
N. O. = normally open.
ST BY = stand by.

7G96030010.71B2
R1 SRP-2

Figure 2-66. 200 West Area Electrical Distribution System. (2 sheets)

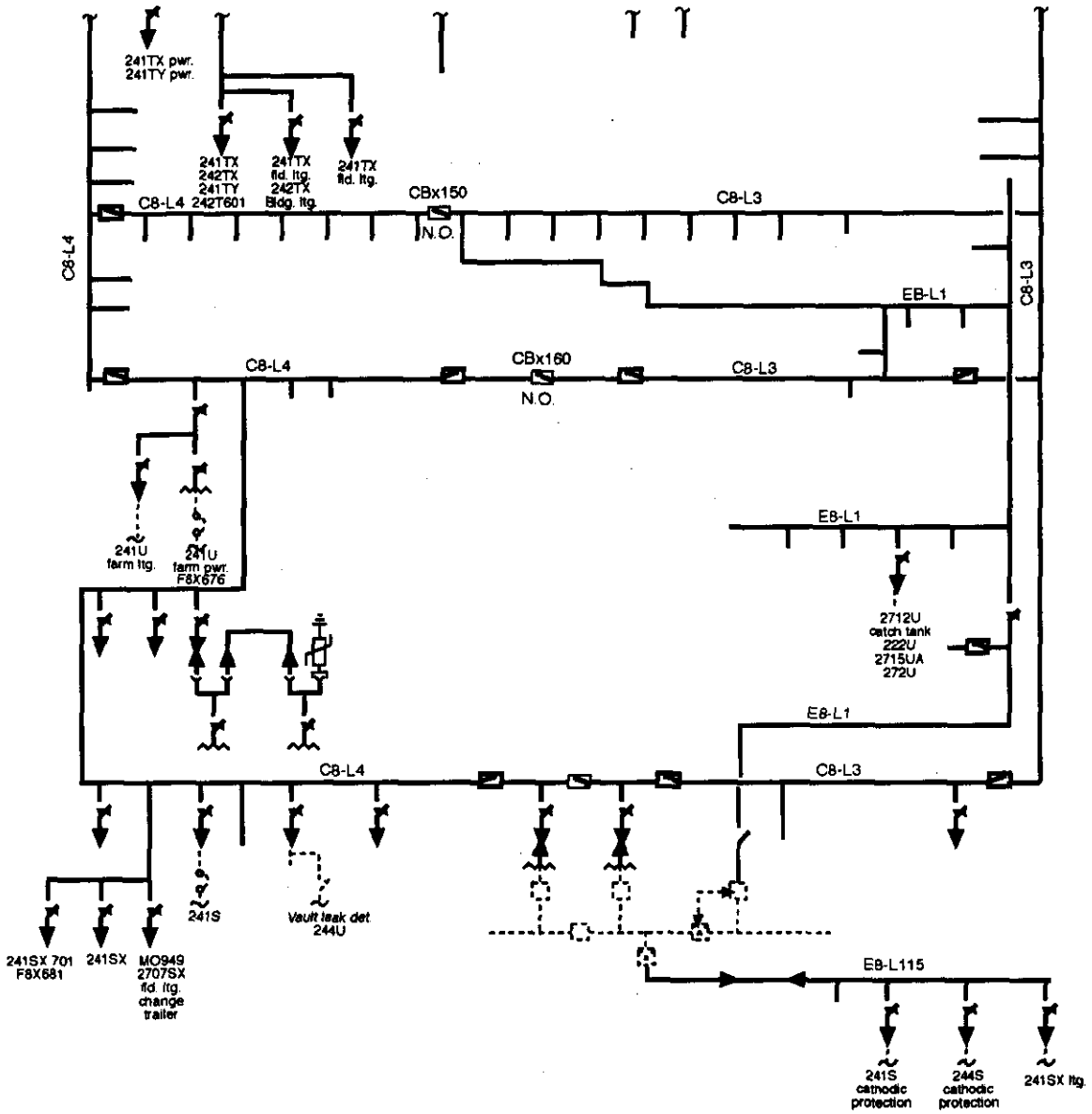


fld. = flood.
ltg. = lighting.
N. O. = normally open.
PNL = panel.
trlr = trailer.
TWRS = Tank Waste Remediation System.

Lines not terminating at facility are power leads to non-TWRS facilities.

7G96030010.71A1
R5 SRP-2

Figure 2-66. 200 West Area Electrical Distribution System. (2 sheets)



Lines not terminating at facility are power leads to non-TWRS facilities.

Bldg. = building.
det = detector.
fld. = flood.
ltg. = lighting.
N. O. = normally open.
pwr. = power.
TWRS = Tank Waste Remediation System.

7G96030010.71A2
R3 SRP-2

Figure 2-67. Jet Pump Unit and Foot Valve.

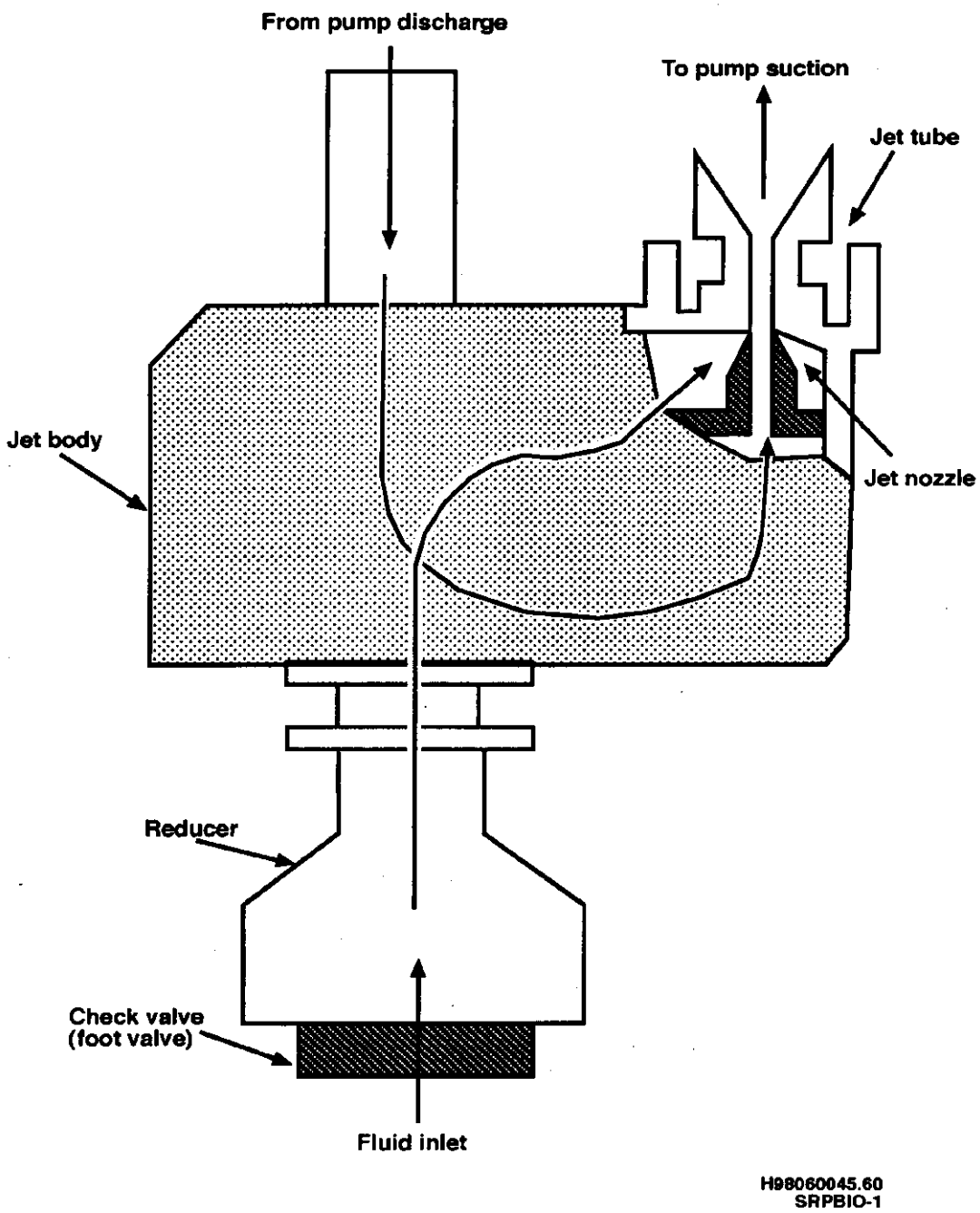
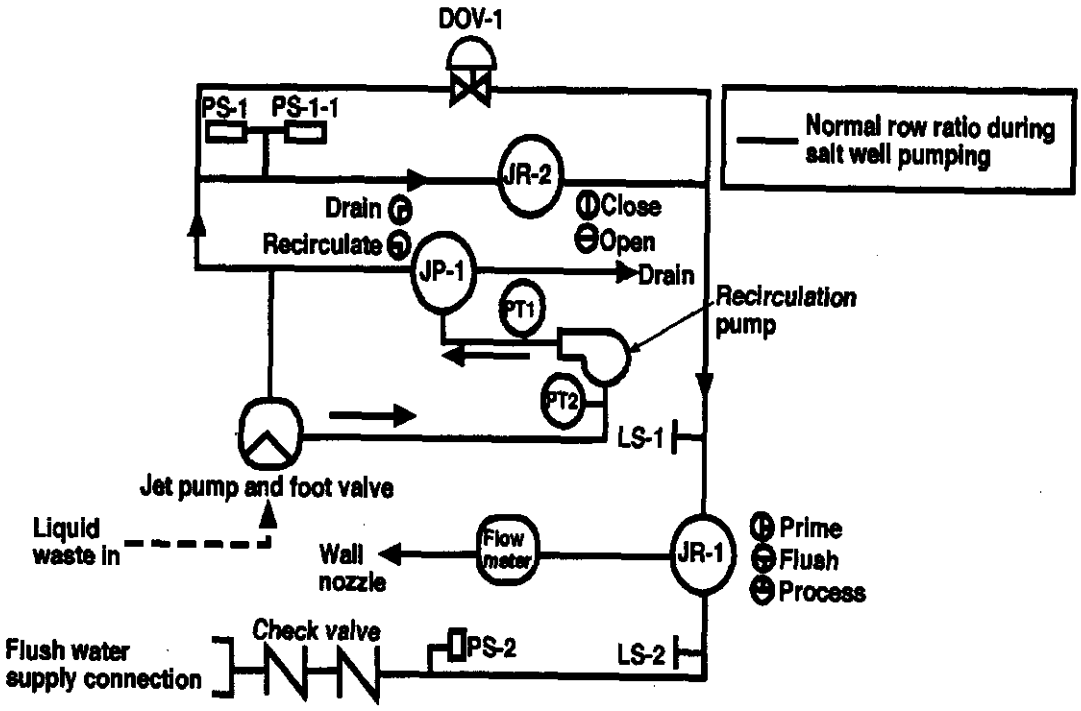


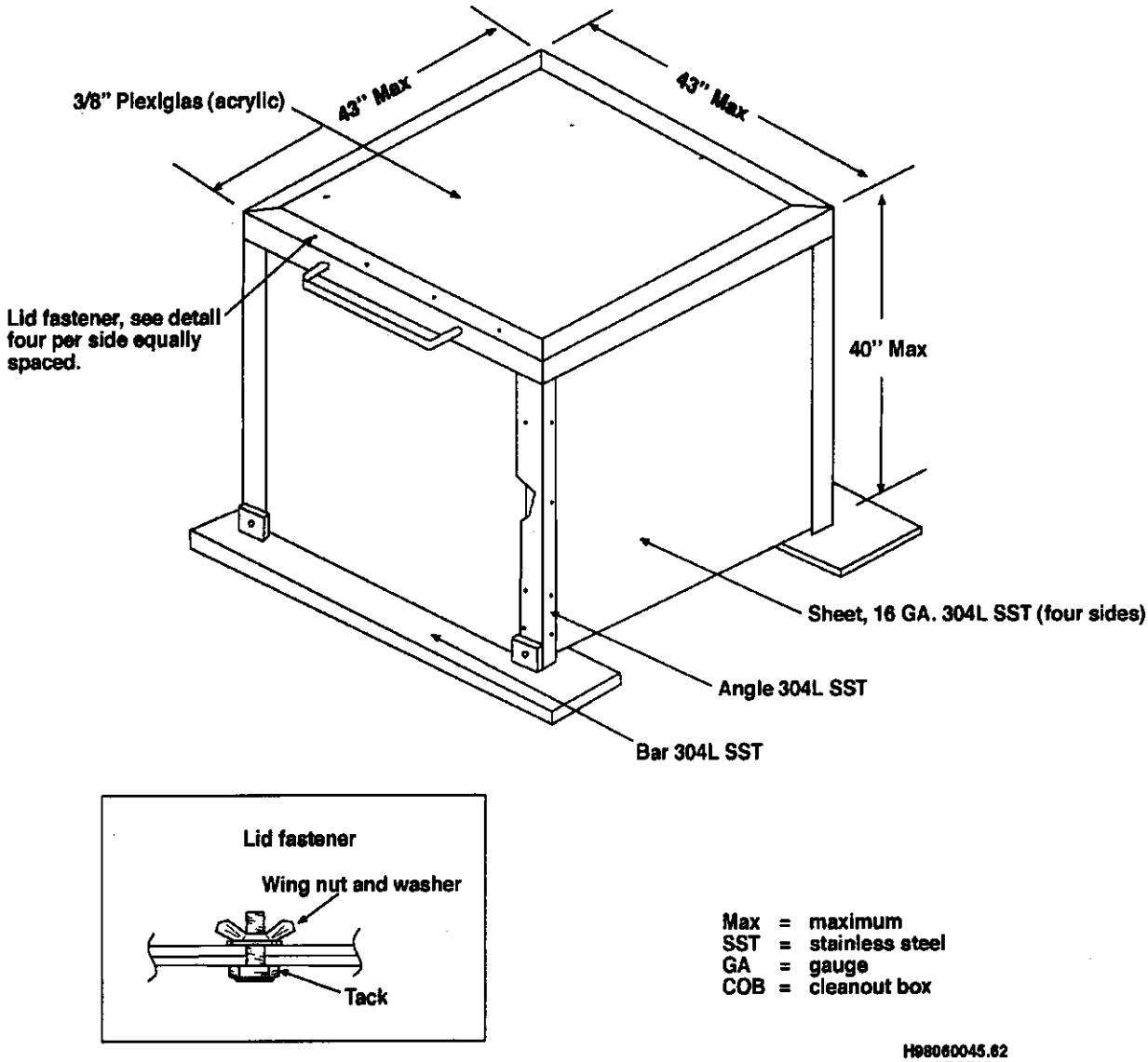
Figure 2-68. Salt Well Pump Piping and Instrument Diagram.



DOV = diaphragm-operated valve.
JB = jet booster.
JP = jet pump.
JR = foot valve.
LS = limit switch.
PS = pressure switch
PT = pressure transmitter.

H98060045.61R1
SRPBIO-1

Figure 2-69. Standard Supplemental COB Enclosure.



Max = maximum
SST = stainless steel
GA = gauge
COB = cleanout box

H98060045.62
SRPBIO-1

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Table 2-1. Facilities and Activities Not Included in the Tank Waste Remediation System Final Safety Analysis Report.

Facility/Activity	Existing or planned safety documentation*
Evaporator 242-S(hot side only)[1]	Existing safety documentation (WHC-SD-WM-SSP-002) Shutdown facility Single-use safety analysis report prepared in decontamination and decommissioning
Evaporator 242-T	Existing safety analysis report (WHC-SD-HS-SAR-009) Shutdown facility Single-use safety analysis report prepared in decontamination and decommissioning
Grout Treatment Facility	Existing safety analysis report (WHC-SD-WM-SAR-027) Standby facility Special-use safety analysis report if future mission developed
Rotary Mode Core Sampling	Existing safety documentation (WHC-SD-WM-SAD-035), with the exception of flammable gas hazards addressed in this FSAR.
241-SY-101 Mixer Pump Operations	Existing safety analysis report (LA-UR-92-3196) Level 1 controls from Section 6.0 of LA-UR-92-3196 identify authorization basis level controls for mixer pump operations in 241-SY-101.
Purgewater Treatment Facility (nonnuclear facility)	Existing safety documentation (*Liquid Level Monitoring Operations Manual*)

*See DOE 5480.23, 1992, *Nuclear Safety Analysis Reports*, Section 9, "Implementation Requirements," Paragraph b.(2) with Attachment 1, Section 4, "Interpretation," Paragraphs f.(10)(b),(c),(e),(f), and (i), U.S. Department of Energy, Washington, D.C.; and DOE-STD-3011-94, 1994, *Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans*, Change 0, Section 4.2.1 "The Need for the Upgrade," and Section 4.2.4.2 "BIO Scope and Level of Effort," paragraphs c, d, and e, U.S. Department of Energy, Washington, D.C.

[1]Only the "hot side" of this facility is excluded from the scope of the FSAR. The Plant Review Committee determined on December 3, 1998 that the "cold side" of this facility is within the scope of the FSAR. The "cold side" of the 242-S Evaporator includes the control room for the Replacement Cross-Site Transfer System (see Addendum 2), the 241-SY Tank Farm leak detection alarms, and other monitoring and alarm functions for the storage and transfer of waste.

LA-UR-92-3196, 1995, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, Rev. 14, Los Alamos National Laboratory, Los Alamos, New Mexico.

Liquid Level Monitoring Operations Manual, 1991, Course Number 3500050, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-HS-SAR-009, 1983, *242-T Evaporator Facility Standby/Shutdown to Condition V Safety Analysis Report*, Rev. 0, Rockwell Hanford Company, Richland, Washington.

WHC-SD-WM-SAD-035, 1996, *A Safety Assessment for Rotary Mode Core Sampling in Flammable Gas Single-Shell Tanks Hanford Site: Richland, Washington*, Rev. 0-a, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SAR-027, 1988, *Hazards Identification and Evaluation Report for the Operation of the Grout Facilities & Near Surface Disposal of Grouted Phosphate/Sulfate Low-Level Liquid Waste*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SSP-002, 1988, *242-S Facility Shutdown/Standby Plan*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE = U.S. Department of Energy.

FSAR = Final Safety Analysis Report.

Table 2-2. Authorized Projects Not Included in the Initial Tank Waste Remediation System Final Safety Analysis Report that have the Potential to Impact Existing Facility Design or Operations Descriptions.

Project number	Project description	Current status	
		Project	Safety documentation
	Authorized Projects		
B-604	Water System Reservoir Area Upgrades: Project upgrades raw and sanitary water reservoir in the 200 East. Raw and sanitary water tielines will connect the 200 East and 200 West Areas.	Construct	NI
W-211	Initial Tank Retrieval Systems: Provides mobilization and retrieval systems for 10 DSTs.	Design	Safety documentation prepared
W-369	Watch List Tank Standard Monitoring System, Phase II: Provides a standardized hydrogen monitoring system for the watch list tanks.	Construct	NI
W-451	Tank Farm Gas Characteristics.	Construct	NI
W-454	AW Jumper Manifold Upgrade: Provides valved manifolds with jumpers in the 241-AW tank farm valve pits AW-A and AW-B.	Design	NI
W-314	Tank Farm Restoration and Safe Operations: Provides capital upgrades to selected tank farm instrumentation/control, ventilation, waste transfer, and electrical systems. Phase I supports waste transfer systems for TWRS privatization with the exception of the TWRS privatization feed tanks. Phase II supports tank farm-wide ventilation, electrical, and in-tank instrumentation upgrades.	Design	Phase I: Safety documentation in preparation Phase II: NI

DST = double-shell tank.
NI = None identified.
TWRS = Tank Waste Remediation System.

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
Single-shell tanks													
241-A Tank Farm													
241-A-101	DSSF	SOUND	H/O	0	0	1,563	413	11	3	3,596	950	NA	Yes
241-A-102	DSSF	SOUND	NL	15	4	8	2	57	15	83	22	Aug-89	No
241-A-103	DSSF	ASMD LKR	NL	19	5	57	15	1,385	366	0	0	Jun-88	Yes
241-A-104	NCPLX	ASMD LKR	NL	0	0	0	0	106	28	0	0	Sep-78	Yes
241-A-105	NCPLX	ASMD LKR	NL	0	0	15	4	72	19	0	0	Jul-79	Yes
241-A-106	CP	SOUND	NL	0	0	26	7	473	125	0	0	Aug-82	Yes
241-AX Tank Farm													
241-AX-101	DSSF	SOUND	H	0	0	1,211	320	11	3	2,820	745	NA	No
241-AX-102	CC	ASMD LKR	O	11	3	53	14	26	7	110	29	Sep-88	Yes
241-AX-103	CC	SOUND	H	0	0	136	36	8	2	416	110	Aug-87	Yes
241-AX-104	NCPLX	ASMD LKR	NL	0	0	0	0	26	7	0	0	Aug-81	Yes
241-B Tank Farm													
241-B-101	NCPLX	ASMD LKR	NL	0	0	23	6	428	113	0	0	Mar-81	Yes
241-B-102	NCPLX	SOUND	NL	15	4	0	0	68	18	38	10	Aug-85	Yes
241-B-103	NCPLX	ASMD LKR	NL	0	0	0	0	223	59	0	0	Feb-85	Yes
241-B-104	NCPLX	SOUND	NL	4	1	174	46	1,139	301	261	69	Jun-85	Yes
241-B-105	NCPLX	ASMD LKR	NL	0	0	87	23	151	40	1,007	266	Dec-84	Yes
241-B-106	NCPLX	SOUND	NL	4	1	23	6	439	116	0	0	Mar-85	Yes
241-B-107	NCPLX	ASMD LKR	NL	4	1	45	12	621	164	0	0	Mar-85	Yes
241-B-108	NCPLX	SOUND	NL	0	0	15	4	356	94	0	0	May-85	Yes
241-B-109	NCPLX	SOUND	NL	0	0	30	8	481	127	0	0	Apr-85	Yes
241-B-110	NCPLX	ASMD LKR	NL	4	1	83	22	927	245	0	0	Dec-84	Yes
241-B-111	NCPLX	ASMD LKR	NL	4	1	79	21	893	236	0	0	Jun-85	Yes

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
241-B-112	NCPLX	ASMD LKR	NL	11	3	0	0	114	30	0	0	May-85	Yes
241-B-201	NCPLX	ASMD LKR	NL	4	1	11	3	106	28	0	0	Aug-81	Yes
241-B-202	NCPLX	SOUND	NL	0	0	11	3	102	27	0	0	May-85	Yes
241-B-203	NCPLX	ASMD LKR	NL	4	1	19	5	189	50	0	0	Jun-84	Yes
241-B-204	NCPLX	ASMD LKR	NL	4	1	19	5	185	49	0	0	Jun-84	Yes
241-BX Tank Farm													
241-BX-101	NCPLX	ASMD LKR	NL	4	1	0	0	159	42	0	0	Sep-78	Yes
241-BX-102	NCPLX	ASMD LKR	NL	0	0	15	4	363	96	0	0	Nov-78	Yes
241-BX-103	NCPLX	SOUND	NL	23	6	0	0	235	62	0	0	Nov-83	Yes
241-BX-104	NCPLX	SOUND	NL	11	3	114	30	363	96	0	0	Sep-89	Yes
241-BX-105	NCPLX	SOUND	NL	19	5	23	6	163	43	11	3	Mar-81	Yes
241-BX-106	NCPLX	SOUND	NL	0	0	0	0	144	38	0	0	Jul-95	No
241-BX-107	NCPLX	SOUND	NL	4	1	110	29	1,302	344	0	0	Sep-90	No
241-BX-108	NCPLX	ASMD LKR	NL	0	0	4	1	98	26	0	0	Jul-79	Yes
241-BX-109	NCPLX	SOUND	NL	0	0	49	13	731	193	0	0	Sep-90	No
241-BX-110	NCPLX	ASMD LKR	NL	11	3	61	16	738	195	34	9	Aug-85	No
241-BX-111	NCPLX	ASMD LKR	NL	4	1	4	1	197	52	413	109	Mar-95	No
241-BX-112	NCPLX	SOUND	NL	4	1	26	7	621	164	0	0	Sep-90	No
241-BY Tank Farm													
241-BY-101	NCPLX	SOUND	NL	0	0	19	5	413	109	1,052	278	May-84	Yes
241-BY-102	NCPLX	SOUND	NL	0	0	42	11	0	0	1,048	277	Apr-95	No
241-BY-103	NCPLX	ASMD LKR	NL	0	0	57	15	19	5	1,495	395	NA	No
241-BY-104	NCPLX	SOUND	NL	0	0	68	18	151	40	1,385	366	Jan-85	Yes
241-BY-105	NCPLX	ASMD LKR	NL	0	0	727	192	598	158	1,306	345	NA	No
241-BY-106	NCPLX	ASMD LKR	NL	0	0	757	200	360	95	2,070	547	NA	No

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
241-BY-107	NCPLX	ASMD LKR	NL	0	0	95	25	227	60	780	206	Jul-79	Yes
241-BY-108	NCPLX	ASMD LKR	NL	0	0	34	9	583	154	280	74	Feb-85	Yes
241-BY-109	NCPLX	SOUND	NL	0	0	102	27	314	83	1,287	340	NA	No
241-BY-110	NCPLX	SOUND	NL	0	0	34	9	390	103	1,117	295	Jan-85	Yes
241-BY-111	NCPLX	SOUND	NL	0	0	0	0	79	21	1,658	438	Jan-85	Yes
241-BY-112	NCPLX	SOUND	NL	0	0	30	8	19	5	1,083	286	Jun-84	Yes
241-C Tank Farm													
241-C-101	NCPLX	ASMD LKR	NL	0	0	11	3	333	88	0	0	Nov-83	Yes
241-C-102	DC	SOUND	O	0	0	114	30	1,196	316	0	0	Sep-85	No
241-C-103	NCPLX	SOUND	O	503	133	0	0	235	62	0	0	NA	No
241-C-104	CC	SOUND	NL	0	0	42	11	1,117	295	0	0	Sep-89	Yes
241-C-105	NCPLX	SOUND	NL	8	2	114	30	500	132	0	0	Oct-95	No
241-C-106	NCPLX	SOUND	HH	121	32	61	16	746	197	0	0	NA	No
241-C-107	DC	SOUND	NL	0	0	91	24	897	237	0	0	Sep-85	No
241-C-108	NCPLX	SOUND	NL	0	0	0	0	250	66	0	0	Mar-84	Yes
241-C-109	NCPLX	SOUND	NL	15	4	0	0	235	62	0	0	Nov-83	Yes
241-C-110	DC	ASMD LKR	NL	4	1	106	28	670	177	0	0	May-95	No
241-C-111	NCPLX	ASMD LKR	NL	0	0	0	0	216	57	0	0	Mar-84	Yes
241-C-112	NCPLX	SOUND	NL	0	0	121	32	394	104	0	0	Sep-90	No
241-C-201	NCPLX	ASMD LKR	NL	0	0	0	0	8	2	0	0	Mar-82	Yes
241-C-202	EMPTY	ASMD LKR	NL	0	0	0	0	4	1	0	0	Aug-81	Yes
241-C-203	NCPLX	ASMD LKR	NL	0	0	0	0	19	5	0	0	Mar-82	Yes
241-C-204	NCPLX	ASMD LKR	NL	0	0	0	0	11	3	0	0	Sep-82	Yes
241-S Tank Farm													
241-S-101	NCPLX	SOUND	NL	45	12	318	84	924	244	647	171	NA	No

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
241-S-102	DSSF	SOUND	H/O	0	0	871	230	15	4	2,063	545	NA	No
241-S-103	DSSF	SOUND	NL	64	17	322	85	38	10	836	221	NA	Yes
241-S-104	NCPLX	ASMD LKR	NL	4	1	106	28	1,109	293	0	0	Dec-84	Yes
241-S-105	NCPLX	SOUND	NL	0	0	132	35	8	2	1,718	454	Sep-88	Yes
241-S-106	NCPLX	SOUND	NL	15	4	704	186	106	28	1,692	447	NA	No
241-S-107	NCPLX	SOUND	NL	53	14	170	45	1,109	293	261	69	NA	No
241-S-108	NCPLX	SOUND	NL	0	0	15	4	15	4	1,688	446	NA	No
241-S-109	NCPLX	SOUND	NL	0	0	534	141	49	13	2,101	555	NA	No
241-S-110	NCPLX	SOUND	NL	0	0	114	30	496	131	980	259	NA	No
241-S-111	NCPLX	SOUND	H/O	38	10	738	195	526	139	1,692	447	NA	No
241-S-112	NCPLX	SOUND	H	0	0	416	110	19	5	1,961	518	NA	Yes
241-SX Tank Farm													
241-SX-101	DC	SOUND	H	4	1	549	145	424	112	1,298	343	NA	No
241-SX-102	DSSF	SOUND	H	0	0	693	183	443	117	1,612	426	NA	No
241-SX-103	NCPLX	SOUND	H/O	4	1	878	232	435	115	2,029	536	NA	No
241-SX-104	DSSF	ASMD LKR	H	0	0	761	201	515	136	1,809	478	NA	No
241-SX-105	DSSF	SOUND	H	0	0	988	261	276	73	2,309	610	NA	No
241-SX-106	NCPLX	SOUND	H/O	231	61	734	194	45	12	1,760	465	NA	No
241-SX-107	NCPLX	ASMD LKR	NL	0	0	19	5	394	104	0	0	Oct-79	Yes
241-SX-108	NCPLX	ASMD LKR	NL	0	0	19	5	329	87	0	0	Aug-79	Yes
241-SX-109	NCPLX	ASMD LKR	H	0	0	182	48	0	0	924	244	May-81	Yes
241-SX-110	NCPLX	ASMD LKR	NL	0	0	0	0	235	62	0	0	Aug-79	Yes
241-SX-111	NCPLX	ASMD LKR	NL	0	0	26	7	473	125	0	0	Jul-79	Yes
241-SX-112	NCPLX	ASMD LKR	NL	0	0	11	3	348	92	0	0	Jul-79	Yes
241-SX-113	NCPLX	ASMD LKR	NL	0	0	0	0	98	26	0	0	Nov-78	Yes

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
241-SX-114	NCPLX	ASMD LKR	NL	0	0	53	14	685	181	0	0	Jul-79	Yes
241-SX-115	NCPLX	ASMD LKR	NL	0	0	0	0	45	12	0	0	Sep-78	Yes
241-T Tank Farm													
241-T-101	NCPLX	ASMD LKR	NL	4	1	61	16	382	101	0	0	Apr-93	No
241-T-102	NCPLX	SOUND	NL	49	13	0	0	72	19	0	0	Mar-81	Yes
241-T-103	NCPLX	ASMD LKR	NL	15	4	0	0	87	23	0	0	Nov-83	Yes
241-T-104	NCPLX	SOUND	NL	0	0	159	42	1,393	368	0	0	NA	No
241-T-105	NCPLX	SOUND	NL	0	0	87	23	371	98	0	0	Jun-87	Yes
241-T-106	NCPLX	ASMD LKR	NL	8	2	0	0	72	19	0	0	Aug-81	Yes
241-T-107	NCPLX	ASMD LKR	NL	0	0	84	22	655	173	0	0	NA	No
241-T-108	NCPLX	ASMD LKR	NL	0	0	0	0	167	44	0	0	Nov-78	Yes
241-T-109	NCPLX	ASMD LKR	NL	0	0	0	0	220	58	0	0	Dec-84	Yes
241-T-110	NCPLX	SOUND	H	11	3	148	39	1,423	376	0	0	NA	No
241-T-111	NCPLX	ASMD LKR	O	0	0	129	34	1,688	446	0	0	Feb-95	No
241-T-112	NCPLX	SOUND	NL	26	7	0	0	227	60	0	0	Mar-81	Yes
241-T-201	NCPLX	SOUND	NL	4	1	11	3	106	28	0	0	Apr-81	Yes
241-T-202	NCPLX	SOUND	NL	0	0	8	2	79	21	0	0	Aug-81	Yes
241-T-203	NCPLX	SOUND	NL	0	0	15	4	132	35	0	0	Apr-81	Yes
241-T-204	NCPLX	SOUND	NL	0	0	15	4	144	38	0	0	Apr-81	Yes
241-TX Tank Farm													
241-TX-101	NCPLX	SOUND	NL	11	3	8	2	318	84	0	0	Feb-84	Yes
241-TX-102	NCPLX	SOUND	NL	0	0	83	22	0	0	821	217	Apr-83	Yes
241-TX-103	NCPLX	SOUND	NL	0	0	57	15	594	157	0	0	Aug-83	Yes
241-TX-104	NCPLX	SOUND	NL	4	1	53	14	0	0	242	64	Sep-79	Yes
241-TX-105	NCPLX	ASMD LKR	O	0	0	76	20	0	0	2,305	609	Apr-83	Yes

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
241-TX-106	NCPLX	SOUND	NL	0	0	38	10	0	0	1,715	453	Jun-83	Yes
241-TX-107	NCPLX	ASMD LKR	NL	4	1	4	1	0	0	132	35	Oct-79	Yes
241-TX-108	NCPLX	SOUND	NL	0	0	0	0	0	0	507	134	Mar-83	Yes
241-TX-109	NCPLX	SOUND	NL	0	0	38	10	0	0	1,453	384	Apr-83	Yes
241-TX-110	NCPLX	ASMD LKR	NL	0	0	57	15	0	0	1,749	462	Apr-83	Yes
241-TX-111	NCPLX	SOUND	NL	0	0	34	9	0	0	1,400	370	Apr-83	Yes
241-TX-112	NCPLX	SOUND	NL	0	0	91	24	0	0	2,456	649	Apr-83	Yes
241-TX-113	NCPLX	ASMD LKR	NL	0	0	61	16	0	0	2,297	607	Apr-83	Yes
241-TX-114	NCPLX	ASMD LKR	NL	0	0	57	15	0	0	2,025	535	Apr-83	Yes
241-TX-115	NCPLX	ASMD LKR	NL	0	0	72	19	0	0	2,422	640	Sep-83	Yes
241-TX-116	NCPLX	ASMD LKR	NL	0	0	87	23	0	0	2,388	631	Apr-83	Yes
241-TX-117	NCPLX	ASMD LKR	NL	0	0	30	8	0	0	2,369	626	Mar-83	Yes
241-TX-118	NCPLX	SOUND	O	0	0	102	27	0	0	1,313	347	Apr-83	Yes
241-TY Tank Farm													
241-TY-101	NCPLX	ASMD LKR	NL	0	0	0	0	447	118	0	0	Apr-83	Yes
241-TY-102	NCPLX	SOUND	NL	0	0	53	14	0	0	242	64	Sep-79	Yes
241-TY-103	NCPLX	ASMD LKR	NL	0	0	19	5	613	162	0	0	Feb-83	Yes
241-TY-104	NCPLX	ASMD LKR	O	11	3	45	12	163	43	0	0	Nov-83	Yes
241-TY-105	NCPLX	ASMD LKR	NL	0	0	0	0	874	231	0	0	Feb-83	Yes
241-TY-106	NCPLX	ASMD LKR	NL	0	0	0	0	64	17	0	0	Nov-78	Yes
241-U Tank Farm													
241-U-101	NCPLX	ASMD LKR	NL	11	3	0	0	83	22	0	0	Sep-79	Yes
241-U-102	NCPLX	SOUND	NL	68	18	477	126	163	43	1,185	313	NA	No
241-U-103	NCPLX	SOUND	H/O	49	13	666	176	121	32	1,601	423	NA	No
241-U-104	NCPLX	ASMD LKR	NL	0	0	26	7	462	122	0	0	Oct-78	Yes

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
241-U-105	NCPLX	SOUND	H/O	140	37	537	142	121	32	1,321	349	NA	No
241-U-106	NCPLX	SOUND	O	57	15	257	68	98	26	700	185	NA	No
241-U-107	DSSF	SOUND	H/O	117	31	556	147	57	15	1,363	360	NA	No
241-U-108	NCPLX	SOUND	H	91	24	651	172	110	29	1,571	415	NA	No
241-U-109	NCPLX	SOUND	H	72	19	617	163	182	48	1,499	396	NA	No
241-U-110	NCPLX	ASMD LKR	NL	0	0	57	15	704	186	0	0	Dec-84	No
241-U-111	DSSF	SOUND	O	0	0	462	122	98	26	1,147	303	NA	No
241-U-112	NCPLX	ASMD LKR	NL	15	4	0	0	170	45	0	0	Sep-79	Yes
241-U-201	NCPLX	SOUND	NL	4	1	0	0	15	4	0	0	Aug-79	Yes
241-U-202	NCPLX	SOUND	NL	4	1	0	0	15	4	0	0	Aug-79	Yes
241-U-203	NCPLX	SOUND	O	4	1	0	0	8	2	0	0	Aug-79	Yes
241-U-204	NCPLX	SOUND	O	4	1	0	0	8	2	0	0	Aug-79	Yes
Double-shell tanks													
241-AN Tank Farm													
241-AN-101	DN	SOUND	NL	318	84	0	0	125	33	0	0	NA	NA
241-AN-102	CC	SOUND	NL	3,732	986	11	3	337	89	0	0	NA	NA
241-AN-103	DSS	SOUND	H	2,063	545	0	0	1,552	410	0	0	NA	NA
241-AN-104	DSSF	SOUND	H	2,294	606	182	48	1,700	449	0	0	NA	NA
241-AN-105	DSSF	SOUND	H	2,419	639	201	53	1,851	489	0	0	NA	NA
241-AN-106	DSSF	SOUND	NL	765	202	0	0	64	17	0	0	NA	NA
241-AN-107	CC	SOUND	NL	3,058	808	87	23	935	247	0	0	NA	NA
241-AP Tank Farm													
241-AP-101	DSSF	SOUND	NL	4,220	1,115	0	0	0	0	0	0	NA	NA
241-AP-102	CP	SOUND	NL	4,145	1,095	0	0	0	0	0	0	NA	NA
241-AP-103	DN	SOUND	NL	83	22	0	0	4	1	0	0	NA	NA

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
241-AP-104	DN	SOUND	NL	98	26	0	0	0	0	0	0	NA	NA
241-AP-105	DSSF	SOUND	NL	45	12	42	11	583	154	0	0	NA	NA
241-AP-106	DN	SOUND	NL	1,238	327	0	0	0	0	0	0	NA	NA
241-AP-107	DN	SOUND	NL	110	29	0	0	0	0	0	0	NA	NA
241-AP-108	DN	SOUND	NL	969	256	0	0	0	0	0	0	NA	NA
241-AW Tank Farm													
241-AW-101	DSSF	SOUND	H	3,104	820	114	30	1,158	306	0	0	NA	NA
241-AW-102	DN	SOUND	NL	163	43	0	0	137	36	0	0	NA	NA
241-AW-103	DN/PD	SOUND	NL	564	149	140	37	1,374	363	0	0	NA	NA
241-AW-104	DN	SOUND	NL	3,138	829	185	49	678	179	420	111	NA	NA
241-AW-105	DN/PD	SOUND	NL	598	158	102	27	1,060	280	0	0	NA	NA
241-AW-106	DN	SOUND	NL	2,453	648	76	20	852	225	0	0	NA	NA
241-AY Tank Farm													
241-AY-101	DC	SOUND	NL	3,073	812	15	4	356	94	0	0	NA	NA
241-AY-102	DN	SOUND	NL	3,039	803	0	0	114	30	0	0	NA	NA
241-AZ Tank Farm													
241-AZ-101	AGING	SOUND	NL	3,225	852	0	0	132	35	0	0	NA	NA
241-AZ-102	AGING	SOUND	NL	3,085	815	15	4	360	95	0	0	NA	NA
241-SY Tank Farm													
241-SY-101	CC	SOUND	H	4,061	1,073	0	0	155	41	0	0	NA	NA
241-SY-102	DN/PT	SOUND	NL	2,127	562	0	0	269	71	0	0	NA	NA
241-SY-103	CC	SOUND	H	1,427	377	0	0	1,370	362	15	4	NA	NA
Column subtotals for single-shell underground waste storage tanks	NA	NA	NA	2,074	548	22,157	5,854	45,560	12,037	86,957	22,974	NA	NA

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		
Column subtotals for double-shell underground waste storage tanks	NA	NA	NA	55,613	14,693	1,170	309	13,611	3,596	435	115	NA	NA
Column totals	NA	NA	NA	57,687	15,241	23,327	6163	59,171	15,633	87,392	23,089	NA	NA
Total waste volume in Hanford Site underground waste storage tanks: 227,577 kL (60,126 kgal)													

Note: Source information used in developing this table is updated monthly in HNF-EP-0182, 1997, *Tank Farm Surveillance and Waste Status Summary Report For Month Ending March 31, 1997*, Rev. 108, Fluor Daniel Hanford, Inc., Richland, Washington.

[a]Types of waste known to be in the underground waste storage tank. Classifications are as follows:

- AGING = Aging waste: High-level, first-cycle solvent extraction waste from the PUREX Facility (NCAW).
- CC = Concentrated complexant: Concentrated product from the evaporation of dilute complexed waste.
- CP = Concentrated phosphate waste: Waste originating from the decontamination of the N Reactor in the 100-N Area. Concentration of this waste produces concentrated phosphate waste.
- DC = Dilute complexed waste: Characterized by a high content of organic carbon including organic complexants: ethylenediaminetetraacetic acid (EDTA), citric acid, and hydroxylethylethylenediaminetetriacetic acid (HEDTA), being the major complexants used. Main sources of this waste in the DST system are salt well liquid inventory (from single-shell tanks).
- DN = Dilute noncomplexed waste: Low-activity waste originating from T and S Plants, the 300 and 400 Areas, PUREX Facility (decladding supernate and miscellaneous wastes), 100-N Area (sulfate waste), B Plant, salt wells, and Plutonium Finishing Plant (supernate).
- DSS = Double-shell slurry: Waste that exceeds the sodium aluminate saturation boundary in the evaporator without exceeding receiver tank composition limits. For reporting purposes, this waste is considered a solid.
- DSSF = Double-shell slurry feed: Waste concentrated just before reaching the sodium aluminate saturation boundary in the evaporator without exceeding receiver tank composition limits. This form is not as concentrated as double-shell slurry.
- NCAW = neutralized current acid waste
- NCPLX = Noncomplexed waste. Dilute wastes that can be treated by the 242-A Evaporator.
- PD = PUREX decladding: PUREX neutralized cladding removal waste is the solids portion of the PUREX Facility neutralized cladding removal waste stream; received in tank farms as a slurry. Neutralized cladding removal waste solids are classified as transuranic waste.
- PT = Plutonium Finishing Plant transuranic solids—transuranic solids fraction from Plutonium Finishing Plant operations.

[b]SOUND = The integrity classification of a waste storage tank for which surveillance data includes no loss of liquid attributed to a breach of integrity; 28 double-shell and 82 single-shell tanks are classified as sound. ASMD LKR (assumed leaker) = Surveillance data indicated a loss of liquid attributed to a breach of integrity; 67 single-shell tanks are assumed to be leaker tanks.

Table 2-3. Current Status of Single-Shell and Double-Shell Underground Waste Storage Tanks (as of March 31, 1997). (10 sheets)

Tank or facility	Waste material classification[a]	Integrity category[b]	"Watch list" designation[c]	Supernate volume[d]		Drainable interstitial liquid volume[e]		Sludge volume[f]		Salt cake volume[g]		Interim stabilized date[h]	Intrusion prevention complete[i]
				kL	kgal	kL	kgal	kL	kgal	kL	kgal		

Notes Cont'd:

[c]A "watch list" tank is an underground waste storage tank containing waste that requires special safety precautions because it may have a serious potential for release of high-level radioactive waste because of uncontrolled increases in temperature or pressure. Special restrictions have been placed on these tanks by *National Defense Authorization Act for Fiscal Year 1991*, Public Law 101-510, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 (also known as the Wyden Amendment). Six double-shell and 32 single-shell tanks are "watch list" tanks. The following designations are used to denote the reason or reasons that a tank may be included on the "watch list":

- H = A tank with the potential for hydrogen or flammable gas accumulation above the flammability limit.
- HH = A tank with a high heat load (greater than 40,000 Btu/h). No double-shell underground waste storage tanks are included in this category.
- H/O = A tank with the potential for hydrogen or flammable gas accumulation above the flammability limits.
- NL = A tank that is not listed on the "watch list."
- O = A tank that may contain concentrations of organic salts greater than 3 wt% total organic carbon. No double-shell underground waste storage tanks are included in this category.

[d]Supernate volume is the volume of the liquid that is above the solids in the waste storage tanks.

[e]Drainable interstitial liquid volume is the volume of the drainable interstitial liquids in the waste storage tank. Drainable interstitial liquid is defined as the liquid that is not held in place by capillary forces and will therefore migrate or move by gravity. The amount of drainable interstitial liquid is calculated based on the salt cake and sludge volumes, using average porosity values or actual data for each tank, when available.

[f]Sludge volume is the volume of the sludge in the waste storage tank. Solids or sludge wastes are formed during sodium hydroxide additions to waste. Sludge usually was in the form of suspended solids when the waste was originally received in the tank from the waste generator. In-tank photographs may be used to estimate the sludge volume. Double-shell slurry waste in tanks 241-AN-103, 241-SY-101, and 241-SY-103 is represented as sludge waste in this table.

[g]Salt cake volume is the volume of the salt cake in the waste storage tank. Salt cake results from crystallization and precipitation after concentration of liquid waste, usually in an evaporator. If salt cake is layered over sludge, it is only possible to measure the total solids volume. In-tank photographs may be used to estimate the salt cake volume.

[h]This column includes the date that interim stabilization was actually completed. In some instances, official interim stabilization documents were issued at a later date. Interim stabilization does not apply to the double-shell underground waste storage tanks. The interim stabilization process applies to the 149 out of service single-shell underground waste storage tanks. The purpose of interim stabilization is to prevent or reduce leaks to the environment by removal of as much liquid as is reasonable achievable. Single-shell tank interim stabilization is achieved by either pumping (technically stabilized) or through measurement and analysis of stored liquid (administratively stabilized). Pumping is performed by either jet or submersible pumps. A single-shell underground waste storage tank is considered interim stabilized when it contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) of supernate (or jet pumped to less than 0.19 L [0.05 gal] per minute; submersible pumped to an estimated 45% waste porosity). Investigative studies indicate that tanks 241-B-104, 241-BX-103, 241-T-102, and 241-T-112 do not meet the current interim stabilization criteria (but did meet the criteria in existence when they were declared interim stabilized). A total of 114 single-shell tanks have been interim stabilized.

[i]Intrusion prevention is defined as the completion of the physical effort required to prevent the addition of liquids into an interim stabilized single-shell tank via risers, process vaults, sumps, catch tanks, or diversion boxes and the installation of the necessary monitoring equipment to ensure single-shell tank wastes remain stable. Intrusion prevention does not apply to the double-shell underground waste storage tanks. Before June 1993, tanks were referred to as having been partially interim isolated or interim isolated. In June 1993, the term interim isolation was replaced by intrusion prevention with the definition further refined. The prior use terms were defined as follows:

- Partially Interim Isolated = The administrative designation reflecting the completion of the physical effort required for interim isolation except for isolation of risers and piping that is required for jet pumping or for other methods of stabilization.
- Interim Isolated = The administrative designation reflecting the completion of the physical effort required to minimize the addition of liquids into an inactive storage tank, process vault, sump, catch tank, or diversion box. To date, a total of 98 single-shell tanks have had intrusion prevention completed.

DST = double-shell tank.
NA = not applicable.
PUREX = Plutonium Uranium Extraction (Facility).

Table 2-4. Typical Compounds Generated by Production Processes at the Hanford Site.

Process	Typical compounds
Bismuth phosphate	$NaOH$, $NaNO_3$, $NaAlO_2$, Na_2SiO_3, $NaNO_2$, Na_2CO_3, Na_2SO_4, Na_3PO_4, $Fe_2(SO_4)_3$, $(NH_4)_2SiF_6$, $(NH_4)_2SO_4$, $Cr(NO_3)_3$, NH_4NO_3
Reduction oxidation (REDOX)	$NaAlO_2$, $NaOH$, $NaNO_3$, $NaNO_2$, Na_2SiO_3, $Na_2Cr_2O_7$, Na_2SO_4, $Cr(OH)_3$, $Fe(OH)_3$
Plutonium uranium extraction (PUREX)	KOH, $NaOH$, $NaNO_3$, $NaPO_4$, $NaSiO_3$, KF, NaF, Na_2SO_4, $Fe(OH)_3$, $Cr(OH)_3$, $Ni(OH)_2$, $NaNO_2$, ZrO_2-$2H_2O$, Sn, $NaAlO_2$, Na_2CO_3, MnO_2
Uranium recovery	SO_4^{-2}, PO_4^{-3}, NO_3^-, Cl^-, Na^+, $Fe(OH)_3$
B Plant Waste Fractionation Process	$H^3[P(W3O^{10})^4]$-$14H_2O$ phosphotungstic acid, 2-hydroxyethylethylenediamine-triacetic acid (HEDTA), ethylenediaminetetraacetic acid (EDTA), hydroxyacetic acid, citric acid, Na_2SO_4

Table 2-5. Major Facilities that Interface with Tank Waste Remediation System. (2 sheets)

Facility of origin[a,b]	Mode	Junction	Destination[b]	Waste stream
200 East Area				
WESF/B Plant	Transfer line	Diversion box 241-ER-152[c]	241-AW Tank Farm, 241-AP Tank Farm	Facility decontamination solutions
242-A Evaporator[d]	Transfer line (steam transfer)	Valve pit 241-AW-A, 241-AW-B	241-AW (dedicated transfer, dump, and diversion lines)	Evaporator product (double-shell slurry feed)
PUREX Facility (no longer active)	Transfer line	Diversion box 241-A-151[c]	241-AW Tank Farm	Facility decontamination solutions
Transition facilities	Tanker trailer or transfer line	NA	Unspecified tank farm	Flush solutions and other radioactive waste water
Tank farms	Truck	NA	Solid waste facilities	Solid waste, low- and high-level radioactive waste
TWRS facilities	Truck	NA	Solid waste facilities	Solid waste
200 West Area				
219-S Building	Transfer line	NA	244-S DCRT	Laboratory waste 222-S
T Plant	Railcar	204-AR Waste Unloading Facility[e]	241-A Tank Farm	Facility decontamination solutions
Z Plant (PFP)	Transfer line (steam transfer)	Double-contained receiver tank 244-TX[e]	Tank SY-102	Facility decontamination solutions
U Plant	Transfer line	Diversion box 154-UX[e]	Tank SY-102	Facility decontamination solutions (Line is still connected, but there are no operations ongoing at U Plant that would send waste down this transfer line.)
Transition facilities	Tanker trailer, transfer line, or railcar	NA	Unspecified tank farm	Flush solutions and other radioactive waste water
Tank farms	Truck	NA	Solid waste facilities	Solid waste, low- and high-level radioactive waste
Tank farms	Cross-site transfer line	Valve pits 241-SY-A, 241-SY-B, 241-UX-154[e]	Valve pit 241-ER-151	Low- and high-level waste solution
TWRS facilities	Truck	NA	Solid waste facilities	Solid waste

Table 2-5. Major Facilities that Interface with Tank Waste Remediation System. (2 sheets)

Facility of origin[a,b]	Mode	Junction	Destination[b]	Waste stream
300 Area				
340 Building	Railcar	204-AR Waste Unloading Facility[c]	Unspecified DST Tank Farm	Radioactive waste water

[a]Other facilities, not identified in this table, are in transition and may transfer liquid wastes to tank farm facilities or hazardous wastes to 209-E Complex.

[b]See Figures 2-1 and 2-2 for facility locations.

[c]TWRS is responsible for valving, piping, and jumpers within diversion box on valve pit and transfer lines exiting diversion box or valve pit.

[d]The following 242-A Evaporator transfer lines (1) interface with Tank 241-AW-102 drain and pump pits and TWRS valve pits 241-AW-A and 241-AW-B and (2) are outside of the scope of this Final Safety Analysis Report:

SN-269, -270: double-shell slurry feed lines to 242-A
DR-335: 242-A drop out line
DR-334, -343, -338: 242-A drain lines
SL-167, 168, -113, -114: slurry out lines to valve pits.

[e]TWRS is responsible for in-facility operations and transfer lines from facility.

DCRT = double-contained receiver tank.
DST = double-shell tank.
NA = not applicable.
PFP = Plutonium Finishing Plant.
PUREX = Plutonium Uranium Extraction (Facility).
REDOX = Reduction Oxidation (Facility).
TWRS = Tank Waste Remediation System.
WESF = Waste Encapsulation and Storage Facility.

Table 2-6. Single-Shell Tanks Within the Hanford Site.

Tank farm	Year constructed	Number of tanks	Operating volume (per tank)		Diameter		Height (top of dome)		Liner height		Operating depth	
			L	gal	m	ft	m	ft	m	ft	m	ft
200 East Area												
B	1943-44	12	2.0 E+06	5.3 E+05	23	75	9.1	29.8	5.5	18	5.2	17
		4	2.1 E+05	5.5 E+04	6.1	20	8	26.3	7.6	25	7.3	24
C	1943-44	12	2.0 E+06	5.3 E+05	23	75	9.1	29.8	5.5	18	5.2	17
		4	2.1 E+05	5.5 E+04	6.1	20	8	26.3	7.6	25	7.3	24
BX	1946-47	12	2.0 E+06	5.3 E+05	23	75	9.1	29.8	5.5	18	5.2	17
BY	1948-49	12	2.9 E+06	7.6 E+05	23	75	11	37.3	7.3	24	7	23
A	1954-55	6	3.8 E+06	1.0 E+06	23	75	14	46	9.7	32	9.4	31
AX	1963-64	4	3.8 E+06	1.0 E+06	23	75	14	46	9.7	32	9.4	31
200 West Area												
T	1943-44	12	2.0 E+06	5.3 E+05	23	75	9.1	29.8	5.5	18	5.2	17
		4	2.1 E+05	5.5 E+04	6.1	20	8	26.3	7.6	25	7.3	24
U	1943-44	12	2.0 E+06	5.3 E+05	23	75	9.1	29.8	5.5	18	5.2	17
		4	2.1 E+05	5.5 E+04	6.1	20	8	26.3	7.6	25	7.3	24
S	1950-51	12	2.9 E+06	7.6 E+05	23	75	11	37.3	7.3	24	7	23
TX	1947-48	18	2.9 E+06	7.6 E+05	23	75	11	37.3	7.3	24	7	23
TY	1951-52	6	2.9 E+06	7.6 E+05	23	75	11	37.3	7.3	24	7	23
SX	1953-54	15	3.8 E+06	1.0 E+06	23	75	13	44	9.7	32	9.4	31

Table 2-7. Summary of Single-Shell Tank Active Ventilation Systems Equipment.

Facility	Area vented	Stack description			Exhaust fan description		Ventilation systems	
		Number	Height		Number	Design capacity (ft^3/min)[a]	Equipment	Filters
			m	ft				
241-C-105/106	Portable	296-P-16	3.0	10	NA	7,000 (@70 °F)	Deentrainer	HEPAs - 2 in series
241-SX	Primary	296-S-15	4.6	15	K1-3-2 N[b] K1-3-1 S	6100	None	PF - 1 per fan HEPAs - 2 per fan in series, 2 parallel banks

Source: WHC-SD-WM-ES-291, 1994, *Tank Farm Sampling System Configuration and Efficiency Study*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[a]To convert ft^3/min to m^3/s, multiply by 4.72×10^{-4}.

[b]Only one fan operates at a time; flow is for each fan.

HEPA = high-efficiency particulate air (filter).

NA = not applicable.

PF = prefilter.

Table 2-8. Dimensions and Capacities of Double-Shell Tanks.

Tanks	Diameter		Height at crown		Nominal capacity				Maximum capacity			
					Height		Amount		Height		Amount	
	m	ft	m	ft	m	ft	L	gal	m	ft	L	gal
200 East Area												
241-AY-101 and 241-AY-102	23	75	14.25	46.75	9.1	30	3,750,000	991,500	9.2	30.3	3,790,000	1,000,000
241-AZ-101 and 241-AZ-102	23	75	14.25	46.75	9.1	30	3,750,000	991,500	9.2	30.3	3,790,000	1,000,000
241-AW-101 through 241-AW-106	23	75	14.25	46.75	10.6	34.9	4,370,000	1,154,000	10.7	35.2	4,400,000	1,162,000
241-AN-101 through 241-AN-107	23	75	14.25	46.75	10.6	34.9	4,370,000	1,154,000	10.7	35.2	4,400,000	1,162,000
241-AP-101 through 241-AP-108	23	75	14.25	46.75	10.6	34.9	4,370,000	1,154,000	10.7	35.2	4,400,000	1,162,000
200 West Area												
241-SY-101 through 241-SY-103	23	75	14.25	46.75	10.6	34.9	4,370,000	1,154,000	10.7	35.2	4,400,000	1,162,000

Table 2-9. Design Parameters Common to the Double-Shell Tanks. (2 sheets)

Parameter	Tank Farm					
	241-AN[a]	241-AP[b]	241-AW[c]	241-AY[d]	241-AZ[e]	241-SY[f]
Design life (yr)	50	50	50	30	30	50
Live loading on backfill (lb/ft^2)	40 plus 50 ton concentrated	40 plus 50 ton concentrated	40 plus 50 ton concentrated	40 plus 50 ton concentrated	40 plus 50 ton concentrated	40 plus 50 ton concentrated
Maximum internal vacuum kPa in. H_2O	1.56	312	1.56	1.56	1.56	1.56
Maximum internal pressure kPa in. H_2O	14.906	14.96	14.906	14.906	14.906	14.906
Maximum temperature °C °F	177350	177350	177350	177 sludge 350 sludge	177 sludge 350 sludge	121250
Maximum HGR W Btu/h	29,300/tank 100,000/tank	29300100000	29300100000	11720004000000	11720004000000	1470050000
pH range	8 to 14	8 to 14	8 to 14	8 to 14	8 to 14	8 to 14
Maximum SPG	2	2	2	1.6 2.5 sludge	1.6 2.5 sludge	1.7
Seismic acceleration	0.25 g horizontal, 0.17 g vertical	0.25 g horizontal, 0.17 g vertical	0.25 g horizontal, 0.17 g vertical	0.25 g horizontal, 0.17 g vertical	0.25 g horizontal, 0.17 g vertical	0.25 g horizontal, 0.17 g vertical
Wind loads	UBC[g]	UBC[h]	UBC[i]	UBC[j]	UBC[j]	UBC[i]
Maximum tank wall temperature °C °F	93.32	149300	93.32	204400	204400	121250
Maximum annulus ventilation L/s ft^3/min	28906125	40598600	22664800	16503500	16503500	35407500

Table 2-9. Design Parameters Common to the Double-Shell Tanks. (2 sheets)

Parameter	Tank Farm					
	241-AN[a]	241-AP[b]	241-AW[c]	241-AY[d]	241-AZ[e]	241-SY[f]
Maximum primary ventilation m^3/s ft^3/min	4721000	4721000	4721000	19004000	19004000	4721000
Radiation exposure mSv/h mrem/h	≤0.01 ≤0.005 (241-AN-107) ≤1 ≤0.5 (241-AN-107)	≤0.005 ≤0.5	≤0.01 ≤1	≤0.01 ≤1	≤0.01 ≤1	NA NA

[a]ARH-CD-549, 1978, *Functional Design Criteria: Additional High Level Waste Handling and Storage Facilities*, Rev. 1, Atlantic Richfield Hanford Company, Richland, Washington.

[b]SD-340-FDC-001, 1982, *Functional Design Criteria: Project B-340, 241-AP Tank Farm*, Rockwell Hanford Operations, Richland, Washington.

[c]ARH-CD-362, 1973, *Functional Design Criteria: Additional High Level Waste Storage Facilities*, Rev. 2, Atlantic Richfield Hanford Company, Richland, Washington.

[d]ARH-205, 1967, *Design Criteria: PUREX AY Tank Farm*, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-1437, 1970, *Design Criteria: PUREX AY Tank Farm*, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

[e]FDM-T-200-00003, 1983, *Aging Waste Tank Facility Description Manual*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[f]ARH-2930, 1973, *Functional Design Criteria: Salt Cake Storage Facility, 241-SY Tank Farm*, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

[g]UBC, 1974, *Uniform Building Code*, International Conference of Building Officials, Whittier, California.

[h]UBC, 1978, *Uniform Building Code*, International Conference of Building Officials, Whittier, California.

[i]UBC, 1970, *Uniform Building Code*, International Conference of Building Officials, Whittier, California.

[j]UBC, 1966, *Uniform Building Code*, International Conference of Building Officials, Whittier, California.

100 rem = 1 sievert.

HGR = heat generation rate.

NA = original design values not available from existing facility documentation.

SPG = specific gravity.

UBC = Uniform Building Code.

Table 2-10. Summary of Ventilation Systems Equipment for Double-Shell Tanks. (2 sheets)

Facility	Area vented	Stack description			Exhaust fan description		Ventilation systems	
		Number	Height		Number	Design capacity (ft^3/min)[a]	Equipment	Filters
			m	ft				
241-AY/AZ	Primary Isolated	296-A-17	15.2	50	K1-1-1[b] K1-1-2	4,000	Condenser Deentrainer	HEPAs — 2 in series per bank, 6 banks in parallel
241-AY/AZ	Primary backup Isolated	296-P-26	3.0	10	Not available	4,000	Condenser Deentrainer	HEPAs — 2 in series
241-AZ-702	Primary	296-A-42	16.8	55	K1-5-1A K1-5-1B	1000	Condenser Moisture Separator	HEPAs - 1 per fan
241-AY-101	Annulus	296-A-18	4.0	13	K1-3-2	3,520 (@350 °F)	None	HEPAs — 2 in series
241-AY-102	Annulus	296-A-19	4.0	13	K2-3-2	3,520 (@350 °F)	None	HEPAs — 2 in series
241-AZ	Annulus	296-A-20	4.9	16	K1-3-2	7,040 (@350 °F)	None	HEPAs — 2 in series per bank, 1 bank per tank
241-AW	Primary	296-A-27	4.9	16	K1-5-1[b] K1-5-2	1,000 (@70 °F)	Moisture separator	PF — 1 per fan HEPAs — 2 in series per fan
241-AW	Annulus	296-A-28	7.0	23	K2-5-1[c] K2-5-2	5,250 (@350 °F)	Moisture separator	HEPAs — 2 in series per fan
241-AN	Primary	296-A-29	4.6	15	K1-5-1[b] K1-5-2	600 (@70 °F)	Deentrainer	PF — 1 per fan HEPAs — 2 in series per fan
241-AN	Annulus	296-A-30	7.0	23	K2-5-1[c] K2-5-2	6,125 (@120 °F)	Moisture separator per fan	HEPAs — 2 in series per fan
241-AP	Primary	296-A-40	4.0	13	K1-5-1[b] K1-5-2	1,170 (@70 °F)	Deentrainer per fan	PF — 1 per fan HEPAs — 2 in series per fan
241-AP	Annulus	296-A-41	8.8	29	K2-5-1[b] K2-5-2	8,600 (@70 °F)	None	HEPAs — 2 in series per fan
241-SY	Annulus	296-P-22	3.0	10	K2-4-1	750 (@150 °F)	Moisture separator	PF — 1 HEPAs — 2 in series
241-SY	Primary	296-P-23	4.0	13	K1-4-1	700 (@200 °F)	Moisture separator	PF — 1 HEPAs — 2 in series

Table 2-10. Summary of Ventilation Systems Equipment for Double-Shell Tanks. (2 sheets)

Facility	Area vented	Stack description			Exhaust fan description		Ventilation systems	
		Number	Height		Number	Design capacity (ft^3/min)[a]	Equipment	Filters
			m	ft				
241-SY	Primary backup	296-P-28	3.4	11	P-28	1,000	Deentrainer	HEPAs — 2 in series

Source: WHC-SD-WM-ES-291, 1994, *Tank Farm Sampling System Configuration and Efficiency Study*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[a]To convert ft^3/min to L/s, multiply by 0.472; to convert Fahrenheit to Celsius, subtract 32 degrees and multiply by 5/9.

[b]Only one fan operates at a time; flow is for each fan.

[c]Both fans operate together; flow is total flow for both fans.

HEPA = high-efficiency particulate air (filter).

PF = prefilter.

Table 2-11. Summary of Double-Contained Receiver Tank Active Ventilation Systems Equipment.

Facility	Area vented	Stack description			Exhaust fan description		Ventilation systems
		Number	Height		Number	Design capacity (ft^3/min)[a]	Prefilters
			m	ft			
200 East Area							
244-A DCRT	Primary/ annulus	296-A-25	3.0	10	K1-5-1	150 (@350 °F)	PF — 1 per bank HEPAs — 2 in series per bank, 2 banks in parallel
244-BX DCRT	Primary/ annulus	296-B-28	3.4	11	EF-1	250	PF — 1 per bank HEPAs — 2 in series per bank, 3 banks in parallel, 1 bank in standby
244-CR Vault	Primary	296-C-5	15.2	50	291-CR-923-1[b] 291-CR-923-2	4,200	HEPAs — 2 stages
200 West Area							
244-S DCRT	Primary/ annulus	296-S-22	3.4	11	K1-5-1	165 (@240 °F)	PF — 1 per fan HEPAs — 2 per bank in series, 2 parallel banks
244-TX DCRT	Primary/ annulus	296-T-18	3.4	11	K1-5-1	250	PF — 1 per bank HEPAs — 2 in series per bank, 3 banks in parallel, 1 bank in standby
244-U DCRT	Primary/ annulus	296-U-11	3.4	11	K1-5-1 (not operational)	250	PF — 1 per bank HEPAs 2 in series per bank, 3 banks in parallel, 1 bank in standby

Source: WHC-SD-WM-ES-291, 1994, *Tank Farm Sampling System Configuration and Efficiency Study*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[a]To convert ft^3/min to m^3/s, multiply by 0.472; to convert Fahrenheit to Celsius, subtract 32 degrees and multiply by 5/9.

[b]Only one fan operates at a time; flow is for each fan.

DCRT = double-contained receiver tanks.

HEPA = high-efficiency particulate air (filter).

PF = prefilter.

Table 2-12. Catch Tank Capacity and Use.

Catch tank	Maximum capacity		Use
	L	gal	
200 East Area			
241-A-302A	31940	8438	Drainage from DB-241-A-151
241-A-350	2940	776	Receives drainage from 241-A-A and 241-A-B valve pits.
241-A-417	167315	44200	Drainage from 214-AY/241-AZ ventilation condensate system and possibly steam condensate from 241-AX-501 valve pit and 241-AZ-154
241-AX-152	41640	11000	Drainage from 241-AX-152 diverter station, DB-241-AX-155, AY-501 and 702-A seal pot
241-AZ-151	45046	11900	Drainage from DB-241-AZ-152, AZ loop seals, leak detection pits, 801-AZ Instrumentation Building, and precipitation and runoff
241-AZ-154	3290	869	Drainage from TK-241-AZ-101 and TK-241-AZ-102 steam coils and precipitation and runoff
241-ER-311	66934	17682	Drainage from DB-241-ER-151 and DB-241-ER-152
200 West Area			
241-S-304	23850	6300	Drainage from DB-241-S-151 and precipitation and runoff
241-TX-302C	66930	17681	Drainage from DB-241-TX-154 and precipitation and runoff
241-U-301B	133530	35275	Drainage from DB-241-U-151, DB-241-U-152, DB-241-U-153, and DB-241-U-252
241-UX-302A	66934	17682	Drainage from DB-241-UX-154, 291-U stack, and precipitation and runoff
600 Area			
241-EW-151	2940	776	Receives drainage from cross-site transfers vent station.

DB = diversion box.
TK = tank.

Table 2-13. Summary of Catch Tank Dimensions. (2 sheets)

Catch tank	Material	Inside dimensions	
		Meters	Feet
200 East Area			
241-A-302A Pump pit Catch tank	 RC Carbon steel	 1.5 x 1.5 x 1.3 3 dia x 5.03	 5 x 5 x 4.33 9 dia x 16.5
241-A-350 Pump pit Catch tank	 Concrete Stainless steel	 3 x 3 x 2.82 1.35 dia x 2.11	 9 x 9 x 9.25 4.44 dia x 6.91
241-A-417 Pump pit Catch tank	 RC RC/steel liner (liner material unknown)	 4.9 x 2.4 x 3.7 7.47 dia x 4.17	 16 x 8 x 12 24.52 dia x 13.67
241-AX-152 Pump pit Catch tank	 3 ksi RC 3 ksi RC/steel liner: ASTM A240-61T, type 304L stainless steel	 1.8 x 1.8 x 2.41 6.76 x 1.8 x 3.48	 6 x 6 x 7.92 22.17 x 6 x 11.42
241-AZ-151 Pump pit Catch tank	 RC RC/steel liner: ASTM A569 carbon steel	 1.8 x 1.8 x 3.33 7.3 x 1.8 x 3.4	 6 x 6 x 10.92 24 x 6 x 11
241-AZ-154 Pump pit Catch tank	 RC RC/steel liner: ASTM A569 carbon steel	 1.5 x 1.5 x 2.25 1.5 x 1.5 x 1.5	 5 x 5 x 7.38 5 x 5 x 5
241-ER-311 Pump pit Catch tank	 Metal pipe Carbon steel	 1.5 dia x 1.4 2.9 dia x 12	 5 dia x 4.5 9.5 dia x 40
200 West Area			
241-S-304 Pump pit Catch tank	 4 ksi RC, ASTM A-615 reinforced ASME SA 516 carbon steel	 3.0 x 3.0 x 1.78 2.7 dia x 4.6	 10 x 10 x 5.83 8.9 dia x 15
241-TX-302C Pump pit Catch tank	 Culvert pipe Carbon steel	 1.5 dia x 1.4 2.72 dia x 11.99	 5 dia x 4.5 8.91 dia x 39.35

Table 2-13. Summary of Catch Tank Dimensions. (2 sheets)

Catch tank	Material	Inside dimensions	
		Meters	Feet
241-U-301B Pump pit Catch tank	 Culvert pipe Concrete	 1.5 dia x 1.5 6 dia x 4.72	 5 dia x 5 20 dia x 15.5
241-UX-302A Pump pit Catch tank	 Culvert pipe Carbon steel	 1.5 dia x 1.4 2.72 dia x 11.99	 5 dia x 4.5 8.91 dia x 39.35
600 Area			
241-EW-151 Pump pit, no pump Catch tank	 NA Carbon steel	 NA 1.35 dia x 2.11	 NA 4.44 dia x 6.91

ASME = American Society of Mechanical Engineers
ASTM = American Society of Testing and Materials.
ksi = kips (kilopounds) per square inch.
NA = not applicable.
RC = reinforced concrete.

Table 2-14. Additional Catch Tank Attributes. (2 sheets)

Catch tank	Cover			Bottom (applicable to lined concrete tanks only)		Walls
	Approximate depth		Material	Thickness (concrete thickness approximate)	Material	
	m	ft				
200 East Area						
241-A-302A	5 = 2	17	Soil over top	NA	NA	14.2 mm (0.56 in.)
241-A-350	5 = 2	17	Soil/pits	NA	NA	9.53 mm (0.375 in.)
241-A-417	4 = 3	14	Soil/pits	152 mm (6 in.) RC, 9.53 mm (0.375 in.) liner	RC, liner (liner unknown)	254 mm (10.00 in.) RC, 9.53 mm (0.375 in.) liner
241-AX-152	5 = 2	17	Pits	0.61 m (2 ft) RC, 3.18 mm (0.125 in.) liner	RC/ASTM A240, type 304L	0.76 m (2.5 ft) RC, 3.2 mm (0.125 in.) liner
241-AZ-151	5 = 2	17	Soil/pits	0.46 m (1.5 ft) RC, 10-Ga liner	RC/ASTM A569 CS	0.3 m (1 ft) RC, 10-Ga liner
241-AZ-154	3 = 4	11	Pit	0.46 m (1.5 ft) RC, 10-Ga liner	RC/ASTM A569 CS	0.46 m (1.5 ft) RC, 10-Ga liner
241-ER-311	6 = 1	20	Soil over top	NA	NA	14.2 mm (0.56 in.)
200 West Area						
241-S-304	7 = 9	26	Soil/pit	NA	NA	16.0 mm (0.63 in.)
241-TX-302C	8 = 8	29	Soil over top	NA	NA	14.2 mm (0.56 in.)
241-U-301B	1 = 8	6	Soil over top	NA	NA	15.24 cm (6 in.)
241-UX-302A	6 = 1	20	Soil over top	NA	NA	14.2 mm (0.56 in.)

Table 2-14. Additional Catch Tank Attributes. (2 sheets)

Catch tank	Cover			Bottom (applicable to lined concrete tanks only)		Walls
	Approximate depth		Material	Thickness (concrete thickness approximate)	Material	
	m	ft				
600 Area						
241-EW-151	2 = 4	8	Soil/pits	NA	NA	9.53 mm (0.375 in.)

ASTM = American Society of Testing and Materials
CS = carbon steel.
Ga = gauge thickness.
NA = not applicable.
RC = reinforced concrete.

Table 2-15. Double-Contained Receiver Tanks.

Double-contained receiver tank	Use
200 East Area	
244-A	Cross-site, B Plant, and some evaporator feed transfers. Drain for transfer lines.
244-BX	Receives 241-B and 241-BY tank farm salt well liquids.
244-CR TK-003	Receives salt well waste from the 241-C Tank Farm.
200 West Area	
244-S	Receives 241-S and 241-SX tank farms salt well waste and miscellaneous plant wastes. Drain for cross-site transfer line. Contains jumpers for Tank 241-SY-102.
244-TX	Receives 241-T Tank Farm salt well waste and miscellaneous Plutonium Finishing Plant wastes. Serves as the Plutonium Finishing Plant transfer line drain.
244-U	Will receive 241-U Tank Farm salt well wastes. Drain for transfer line to 241-SY Tank Farm.

Table 2-16. Tank Waste Remediation System-Owned Inactive Miscellaneous Underground Storage Tanks that are Radioactively Contaminated. (2 sheets)

Tank	Tank type	Tank characteristics		Current status	Operating volume		Sludge volume		Liquid volume		Total volume	
		Construction	Containment		L	gal	L	gal	L	gal	L	gal
200 East Area												
216-BY-201	FT	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
241-A-302B	C	SU	No	IS	51,103	13,500	No data	No data	No data	No data	13,627	3,600
241-AX-151	DV	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
241-B-301B	C	SU	No	I	136,275	36,000	81,992	21,660	2,233	590	84,225	22,250
241-B-302B	C	SU	No	I	66,941	17,684	2,612	690	16,050	4,240	18,662	4,930
241-BX-302A	C	SU	No	I	66,941	17,684	3,180	840	0	0	3,180	840
241-BX-302B	C	SU	No	I	43,112	11,389	3,596	950	341	90	3,937	1,040
241-BX-302C	C	SU	No	I	43,070	11,378	2,423	640	871	230	3,293	870
241-C-301C	C	SU	No	I	136,275	36,000	34,069	9,000	5,565	1,470	39,633	10,470
241-ER-311A	C	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
244-BXR-001	VT	CS	Yes, vault	IS	189,271	50,000	27,255	7,200	0	0	27,255	7,200
244-BXR-002	VT	SS	Yes, vault	IS	56,781	15,000	6,814	1,800	1,438	380	8,252	2,180
244-BXR-003	VT	SS	Yes, vault	IS	56,781	15,000	5,489	1,450	1,363	360	6,852	1,810
244-BXR-011	VT	SS	Yes, vault	IS	189,271	50,000	26,498	7,000	379	100	26,876	7,100
200 West Area												
213-W-TK-1	DT	No data	No data	No data	No data	No data	No data	No data	No data	No data		
216-TY-201	FT	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
231-W-151-001	S	SS	Yes, vault	No data	15,142	4,000	0	0	5,413	1,430	5,413	1,430
231-W-151-002	S	SS	Yes, vault	No data	3,785	1,000	38	10	3,596	950	3,634	960
240-S-302	C	SU	No	AL	66,941	17,684	No data	No data	No data	No data	8,616	2,276
241-S-302A	C	SU	No	AL	66,941	17,684	No data	No data	No data	No data	19,419	5,130
241-S-302B	C	SU	No	I	54,184	14,314	0	0	0	0	0	0
241-SX-302	C	SU	No	I	66,941	17,684	3,975	1,050	1,136	300	5,110	1,350
241-T-301	C	RC*	No	No data	136,275	36,000	81,992	21,660	2,233	590	84,225	22,250
241-TX-302A	C	SU	No	I	66,941	17,684	9,274	2,450	114	30	9,388	2,480
241-TX-302B	C	SU	No	I	66,941	17,684	No data	No data	No data	No data	4,998	1,320
241-TX-302B(R)	C	SU	No	I	45,425	12,000	No data	No data	No data	No data	No data	No data

Table 2-16. Tank Waste Remediation System-Owned Inactive Miscellaneous Underground Storage Tanks that are Radioactively Contaminated. (2 sheets)

Tank	Tank type	Tank characteristics		Current status	Operating volume		Sludge volume		Liquid volume		Total volume	
		Construction	Containment		L	gal	L	gal	L	gal	L	gal
241-TX-302X	C	SU	No	I	54,184	14,314	416	110	946	250	1,363	360
241-TY-302A	C	SU	No	I	66,941	17,684	1,703	450	0	0	1,703	450
241-TY-302B	C	SU	No	I	54,184	14,314	0	0	0	0	0	0
241-Z-8	S	SU	No	No data	58,428	15,435	1,893	500	0	0	1,893	500
242-T-135	DT	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
242-TA-R1	R	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
243S-TK-1	DT	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
244-TXR-001	VT	SU	Yes, vault	IS	189,276	50,000	8,706	2,300	189	50	8,896	2,350
244-TXR-002	VT	SS	Yes, vault	IS	56,781	15,000	11,167	2,950	0	0	11,167	2,950
244-TXR-003	VT	SS	Yes, vault	IS	56,781	15,000	24,605	6,500	0	0	24,605	6,500
270-W	N	SU	No	No data	14,309	3,780	No data	No data	No data	No data	No data	No data

Note: Tank identification taken from WHC-SD-WM-PD-046, 1995, *Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tanks Program Plan*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Information in this table except tank characteristics and current status is taken from WHC-EP-0681, 1993, *Interim Criteria for Organic Watch List Tanks at the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Tank characteristics are from WHC-SD-EN-ES-040, 1994, *Engineering Study of 50 Miscellaneous Inactive Underground Radioactive Waste Tanks Located at the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Current status is from WHC-SD-EN-ES-040 and HNF-EP-0182, March 31, 1997, *Waste Tank Summary Report for Month Ending March 31, 1997*, Rev. 108, Fluor Daniel Hanford, Inc., Richland, Washington.

*Reinforced concrete is steel lined.

AL = assumed leaker.
C = catch tank.
CS = carbon steel.
DT = decontamination tank.
DV = diverter station.
FT = flush tank.
I = isolated.
IS = interim stabilized.
N = neutralization tank.
R = receiver tank.
RC = reinforced concrete.
S = settling tank.
SS = stainless steel.
SU = steel unspecified.
VT = vault tank.

Table 2-17. Tank Waste Remediation System-Owned Active Miscellaneous Underground/Aboveground Storage Tanks Containing Nonradioactive Material. (3 sheets)

Common name	Hanford Site authorized name
200 East Area	
211A	Chemical makeup tank farm, pump house
211B	Cold chemical makeup tank farm
215A	Sodium hydroxide tank farm instrument house
222EC	Laboratory waste tank and emergency generator building
241HN701-66	Vault diesel fuel storage tank
270A	Underground condensate neutralization tank
2607EA	Septic tank
2607EB	Septic tank
2607EC	Septic tank
2607ED	Septic tank
2607EE	Septic tank
2607EF	Septic tank
2607EG	Septic tank
2607EH	Septic tank and drain field Multi-Function Waste Tank Facility
2607EHV	Dosing septic tank structure
2607EK	Septic tank
2607EL	Septic tank
2607EM	Septic tank
2607EN	Septic tank
2607EO	Septic tank
2607EP	Septic tank
2607EQ	Septic tank
2607ER	Septic tank
2607E1	Septic tank
2607E2	Septic tank
2607E3	Septic tank

Table 2-17. Tank Waste Remediation System-Owned Active Miscellaneous Underground/Aboveground Storage Tanks Containing Nonradioactive Material. (3 sheets)

	Common name	Hanford Site authorized name
1	2607E4	Septic tank
2	2607E5	Septic tank
3	2607E6	Septic tank
4	2607E7	Septic tank
5	2607E8	Septic tank
6	2607E9	Septic tank
7	2607E10	Septic tank
8	2607E11	Septic tank
9	2607E12	Septic tank
10	2607E13	Septic tank
11	2607E14	Septic tank
12	2607HV	Septic tank and dosing tank
13	2711E66	Tank, petroleum (waste oil)
14	2711E66A	Tank, petroleum (waste oil)
15	2721E66	Tank, petroleum (diesel)
16	200 West Area	
17	TR31-ST-T1	Leachate storage tank - Trench 31
18	TR34-ST-T1	Leachate storage tank - Trench 34
19	211S	Cold chemical make up tank farm
20	211T	Cold chemical makeup tank farm
21	211U	Cold chemical makeup tank farm
22	211UA	Cold chemical makeup tank farm addition
23	241S303	Dump waste tank
24	276U	Solvent recovery tanks
25	284WA	Salt/brine storage tank
26	2607WA	Septic tank
27	2607WB	Septic tank

Table 2-17. Tank Waste Remediation System-Owned Active Miscellaneous Underground/Aboveground Storage Tanks Containing Nonradioactive Material. (3 sheets)

Common name	Hanford Site authorized name
2607WC	Septic tank
2607WL	Septic tank
2607WN	Septic tank and drain field Multi-Function Waste Tank Facility
2607W1	Septic tank
2607W2	Septic tank
2607W3	Septic tank
2607W4	Septic tank
2607W5	Septic tank
2607W6	Septic tank
2607W7	Septic tank
2607W8	Septic tank
2607W9	Septic tank
2607W10	Septic tank
2607W11	Septic tank
2607W12	Septic tank
2607Z	Septic tank
2607Z1	Septic tank
2706T201	Tank, decontamination waste liquid storage
2706T202	Tank, decontamination waste liquid storage

Table 2-18. Summary of 204-AR Waste Unloading Facility Ventilation Systems Equipment.

Facility	Area vented	Stack description			Exhaust fan description		Ventilation systems	
		Number	Height		Number	Design capacity (ft^3/min)*	Equipment	Filtration
			m	ft				
204-AR Waste Unloading Facility	Primary	296-A-26	8.2	27	EF-1	2,000	Moisture separator	PF - 1 HEPAs - 2 in series per bank, 2 banks one on each side of the moisture separator

Source: WHC-SD-WM-ES-291, 1994, *Tank Farm Sampling System Configuration and Efficiency Study*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

*To convert ft^3/min to L/s, multiply by 0.472.

HEPA = high-efficiency particulate air (filter).

PF = prefilter.

Table 2-19. Summary of 244-AR Vault Ventilation Systems Equipment (as Designed).

Facility	Area vented	Stack description			Exhaust fan description		Ventilation systems
		Number	Height		Number	Design capacity (ft^3/min)[a]	Filtration
			m	ft			
244-AR Vault	Vessel vent	296-A-12	45=7	150	K4-11-1	950	PF - 1 LEF - 1 per bank HEPAs - 2 in series per bank, 2 banks in parallel
244-AR Vault	Canyon/ cell	296-A-13	18=6	61	K-3-91[b] K-3-92	15000	HEPAs - 2 in series

Source: WHC-SD-WM-ES-291, 1994, *Tank Farm Sampling System Configuration and Efficiency Study*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[a]To convert ft^3/min to L/s, multiply by 0.472.

[b]Only one fan operates at a time; flow is for each fan.

HEPA = high-efficiency particulate air (filter).

LEF = low-efficiency filter.

PF = prefilter.

Table 2-20. Cribs, Ditches, and Ponds Currently Owned or Operated By Tank Waste Remediation System.

Type	Identification number
200 East Area	
Crib	216-A-8
Crib	216-A-16
Crib	216-A-17
Crib	216-A-23A
Crib	216-A-23B
Crib	216-A-30
Crib	216-A-37-2
Retention basin	216-A-40
Crib	216-A-45
Pond (first expansion pond)	216-B-3A
Pond (second expansion pond)	216-B-3B
Pond (third expansion pond)	216-B-3C
Crib	216-B-55
Crib	216-B-62
Ditch	216-B-63
Crib	216-C-8
200 West Area	
Crib	216-S-3
Crib	216-S-15
Crib	216-S-25
Crib	216-S-26
Ditch	216-T-01
Ditch	216-T-04-02
Ditch	216-U-14
Crib	216-U-17
Crib	216-W-LC
Crib	216-Z-20
Pond	216-Z-21

Table 2-21. Number and Diameter of Vertical Storage Units Associated with Single-Shell Tank Farms.

Tank Farm	Number	Diameter	
		mm	in.
241-S[a]	6	305	12
241-T[b]	6	305	12
241-TY[c]	6	305	12
241-U[a]	6	305	12
241-TX[c]	6	305	12
241-SX[a]	22 1	305 610	12 24

[a]In process of being closed.
[b]Most are open, not capped.
[c]All backfilled and buried.

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in²)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 East Area active transfer lines										
V244	L1, V1	76	3	Concrete	SSTL A312, 304L	100	221-B	241-ER-152	N	N
V244	L1, V1	76	3	Concrete	SSTL A312, 304L	100	241-ER-153	244-CR Vault	N	N
V244	L1, V1	76	3	Concrete	SSTL A312, 304L	100	241-ER-152	241-ER-153	N	N
4006/4918	L1, V1	102	4	Concrete/double	SSTL, Sch 40	100	244-AR Vault	241-AX-152	N	Y
4503	L1, V1	76-102	3-4	Concrete	Sch 40, SSTL	NA	241-AX-155	241-AY-101	N	N
4506	L1, V1	76	3	Concrete	Sch 40, SSTL	NA	241-AX-155	241-AY-102	N	Y
4608	L1, V1	76	3	Concrete	CS	NA	241-AZ-152	241-AY-101	N	Y
9219[d]	L1, V1	51	2	Direct buried	A53 CS, Sch 40	120	241-ER-152	225-B	N	Y
9220[d]	L1, V1	51	2	Direct buried	A53 CS, Sch 40	120	241-ER-152	225-B	N	Y
9221[d]	L1, V1	51	2	Direct buried	A53 CS, Sch 40	120	241-ER-152	225-B	N	Y
9253[d]	L1, V1	203	8	Direct buried	SSTL A312, 304L	NA	241-ER-152	225-B	N	Y
9808	L1, V1	76	3	Concrete	Sch 10 SSTL	NA	241-ER-151	244-BX DCRT	N	N
108/837/8649/8901	L1, V1	51	2	Concrete	Sch 40	NA	221-B	244-CR DCRT	N	N
4001/T029	L1, V1	76	3	Double	CS A53, Sch 40	400	241-A-B	202-A	N	Y
4508/B105	L1, V1	76-102	3-4	Concrete	ASTM A-312, 304L	NA	241-AZ-101	241-AX-152	N	Y
4509/4507	L1, V1	102	4	Concrete/double	SSTL	NA	241-AZ-101	241-AX-155	N	Y
4511/B106	L1, V1	76-102	3-4	Concrete	ASTM A-312, 304L	NA	241-AZ-102	241-AX-152	N	N
4512/4600	L1, V1	102	4	Concrete	SSTL	NA	241-AZ-102	241-AX-155	N	N
814/4002/4028/G026	L1, V1	76	3	Concrete	SSTL A312, 304L	100	244-AR Vault	PUREX	N	Y

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in²)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 East Area active transfer lines (cont'd)										
833/8618/8612	L1, V1	76	3	Concrete	SSTL A312, 304L	100	221-B	244-AR Vault	N	N
834/8615/8653	L1, V1	76	3	Concrete	SSTL A312, 304L	100	221-B	244-AR Vault	N	N
9653/243	L1, V1	76	3	Concrete	Sch 10 SSTL	NA	221-B	241-ER-151	N	N
A106/4504	L1, V1	102	4	Concrete	SSTL A312, 304L	100	241-AX-152	241-AY-102	N	N
A108/4501	L1, V1	102	4	Concrete	SSTL A312, 304L	100	241-AX-152	241-AY-101	N	N
B106/4505	L1, V1	76-102	3-4	Concrete	ASTM A-312, 304L	NA	241-AX-152	241-AY-102	N	N
B108/4502	L1, V1	76-102	3-4	Concrete	ASTM A-312, 304L	NA	241-AX-152	241-AY-101	N	N
CDH3018[d]	L1, V1	102	4	Direct buried	A53 CS, Sch 40	120	241-ER-152	225-B	N	Y
D008	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
D020	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
D040	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
D070	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
D149	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
D186	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
DR-334	L1, V	250	10	Double	CS, Sch 40	N/A	242-A	241-AW-102	Y	Y
DR-335	L1, V	250	10	Double	CS, Sch 40	N/A	242-A	241-AW-102	Y	Y
DR-338	L1, V	76	3	Double	CS, Sch 40	N/A	242-A	DR-334	Y	Y
DR--343	L2, V	150	6	Direct buried	CS, Sch 40	N/A	242-A	241-AW-102	N	Y
E006	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
E167	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
F241	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
F274	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in²)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 East Area active transfer lines (cont'd)										
F377	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
F429	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
F719	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
F791	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
G057	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
G180	L1, V1	51	2	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
G212	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
LIQW702	L1, V1	76	3	Concrete	SSTL A312, 304L	150	204-AR Waste Unloading Facility	241-A-A	N	N
LLW4002[d]	L1, V1	51	2	Direct buried	SSTL A312, 304L	NA	241-ER-152	225-B	N	Y
LLW4076[d]	L1, V1	51	2	Direct buried	SSTL A312, 304L	NA	241-ER-152	225-B	N	Y
M044	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
M045	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
PW-481	L1, V1	76	3	Double	CS, Sch 40	N/A	241-A-350	242-A Evaporator	N	N
R165	L1, V1	51	2	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
R345	L1, V1	76	3	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
SL100	L1, V1	51	2	Double	CS A53, Sch 40	400	241-AX-B	241-A-B	N	Y
SL101	L1, V1	51	2	Double	CS A53, Sch 40	400	241-AX-A	241-A-A	N	Y
SL160	L1, V1	51	2	Double	CS ASTM A53	400	241-AN-B	241-AZ-102	N	Y
SL167	L1, V1	51	2	Double	CS A53, Sch 40	400	242-A Evaporator	241-AW-B	N	Y
SL168	L1, V1	51	2	Double	CS A53, Sch 40	400	242-A Evaporator	241-AW-A	N	Y
SL500	L1, V1	51	2	Double	CS A53, Sch 40	400	AZ-102	241-AX-A	N	Y

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in²)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 East Area active transfer lines (cont'd)										
SL502	L1, V1	51	2	Double	Sch 40, CS	NA	241-AX-B	241-AY-102	N	Y
SL509	L1, V1	51	2	Double	CS A53, Sch 40	400	241-AW-B	241-AP VP	N	Y
SL510	L1, V1	51	2	Double	CS A53, Sch 40	400	241-AW-A	241-AP VP	N	Y
SN200	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-102	N	Y
SN201	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-103	N	Y
SN202	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-105	N	Y
SN203	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-106	N	Y
SN200SN213	L1, V1	76	3	Double	CS A53, Sch 40	400	241-AX-B	241-A-B	N	Y
SN201/SN214	L1, V1	76	3	Double	CS A53, Sch 40	400	241-AX-A	241-A-A	N	Y
SN207	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-109	N	Y
SN208	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-101	N	Y
SN208	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-104	N	Y
SN208	L1, V1	32	1.25	Concrete	CS A53, Sch 40	400	244-BX DCRT	241-BY-110	N	Y
SN215	L1, V1	76	3	Concrete/double	CS A53, Sch 40	400	244-A DCRT	241-A-A	N	Y
SN216	L1, V1	76	3	Concrete/double	CS A53, Sch 40	400	244-A DCRT	241-A-B	N	Y
SN219	L1, V1	76	3	Double	CS A53, Sch 40	400	241-A-B	241-AW-B	N	Y
SN220	L1, V1	76	3	Double	CS A53, Sch 40	400	241-A-A	241-AW-A	N	Y
SN232	L1, V1	76	3	Double	CS A53, Sch 40	400	244-A DCRT	241-ER-153	N	Y
SN233	L1, V1	76	3	Double	CS A53, Sch 40	400	244-A DCRT	241-ER-153	N	Y
SN234	L1, V1	76	3	Double	CS A53, Sch 40	400	244-A DCRT	241-ER-153	N	Y
SN244[e]	L1, V1	76	3	Concrete	SSTL A312, 304L	100	244-CR Vault	241-ER-153	N	Y
SN247	L1, V1	51	2	Concrete	CS	NA	241-AN-101	241-AX-B	N	Y

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in^2)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 East Area active transfer lines (cont'd)										
SN260	L1, V1	51	2	Double	CS A53, Sch 40	400	241-AN-B	241-AZ-102	N	Y
SN269	L1, V1	76	3	Double	CS A53, Sch 40	400	242-A Evaporator	241-AW-102	N	Y
SN270	L1, V1	76	3	Double	CS A53, Sch 40	400	242-A Evaporator	241-AW-102	N	Y
SN600	L1, V1	51	2	Double	Sch 40, CS	NA	241-AZ-102	241-AX-A	N	Y
SN609	L1, V1	76	3	Double	CS A53, Sch 40	400	241-AW-102	241-AP	N	Y
SN610	L1, V1	76	3	Double	CS A53, Sch 40	400	241-AW-102	241-AP	N	Y
U039	L1, V1	51	2	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
U136	L1, V1	51	2	Concrete	SSTL A312, 304L	150	PUREX	241-A-151	N	N
V021	L1, V1	76	3	Concrete/double	SSTL A312, Sch 40	150	241-A-151	241-AW-A	N	Y
V022	L1, V1	76	3	Concrete/double	SSTL A312, Sch 40	150	241-A-151	241-AW-B	N	Y
V023	L1, V1	76	3	Concrete/double	SSTL A312, Sch 40	150	241-A-151	241-AW-B	N	Y
4029/4004/G341	L1, V1	76	3	Concrete/double	CS A53, Sch 40	400	202-A	241-A-A	N	Y
V228	L1, V1	76	3	Concrete	11 Ga 18-8 SSTL	120	241-ER-151	241-ER-153	N	N
V229	L1, V1	76	3	Double	CS A53	120	241-ER-151	241-ER-152	N	N
V360	L1, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-EW-151	241-ER-151	N	N
V361	L1, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-EW-151	241-ER-151	N	N
V362	L1, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-EW-151	241-ER-151	N	N
V363	L1, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-EW-151	241-ER-151	N	N
V364	L1, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-EW-151	241-ER-151	N	N
V366	L1, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-EW-151	241-ER-151	N	N
V714	L1, V1	76	3	Double	Sch 40, SSTL	NA	241-AX-155	241-AR-151	N	Y
V714	L1, V1	76	3	Double	SSTL A312, 304L	150	PUREX	241-AR-151	N	Y

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in^2)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 East Area active transfer lines (cont'd)										
V719	L1, V1	76	3	Double	SSTL	NA	241-AZ-152	241-AX-155	N	Y
V720	L1, V1	76	3	Double	CS A53, Sch 40	400	241-AR-151	241-AY-102	N	Y
V8912[d]	L1, V1	51	2	Direct buried	A53 CS, Sch 40	120	241-ER-152	225-B	N	Y
200 West Area active transfer lines										
202	L1, V1	51	2	Double	SSTL 40S	300	241-Z (P-D-5-1)	244-TX DCRT	N	Y
203	L1, V1	51	2	Double	SSTL 40S	300	241-Z (P-D-5-1)	244-TX DCRT	N	Y
V398	L1, V1	76	3	Concrete/double	CS A53 Sch 40	60	241-TX-152	241-U152	N	Y
V404	L1, V1	76	3	Concrete/double	CS A53 Sch 40	60	241-TX-152	241-U152	N	Y
SN6012	L1, V1	51	2	Direct buried concrete	CS A53, Sch 40	400	244-TX DCRT	241-T-104	N	N
7624	L1, V1	51	2	Direct buried concrete	CS A53, Sch 40	400	244-TX DCRT	241-T-110	N	N
SL118	L1, V1	NA	NA	Direct buried	NA	NA	241-S-D	241-SX-B	N	N
SN216/SN282	L, V1	76	3	Double	CS A53, Sch 40	400	241-U-D	241-SY-B	N	Y
SN245	L, V1	25	1	Concrete	CS A53 Sch 40	400	244-S DCRT	241-S-107	N	N
SN246	L, V1	25	1	Concrete	CS A53 Sch 40	400	244-S DCRT	241-S-107	N	N
SN247	L, V1	25	1	Concrete	CS A53 Sch 40	400	244-S DCRT	241-S-107	N	Y
SN248	L, V1	25	1	Concrete	CS A53 Sch 40	400	244-S DCRT	241-S-107	N	N
SN249	L, V1	25	1	Concrete	CS A53 Sch 40	400	244-S DCRT	241-S-107	N	Y
SN275[e]	L, V1	76	3	Double	CS A53 Sch 40	400	241-SY-A	241-S-A	N	Y
SN276[e]	L, V1	76	3	Double	CS Sch 40	400[d]	241-SY-B	241-S-B	N	Y
SN283	L, V1	76	3	Double	CS A53, Sch 40	400	242-S Evaporator	241-SY-102	N	Y
SN7624	L, V1	51	2	Concrete	CS A53, Sch 40	400	244-TX DCRT	241-T-110	N	Y
SNL3150	L, V2	76	3	Double	SSTL 304L, Sch 40	1430	241-SY-A	244-A	N	N

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in²)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 West Area active transfer lines (cont'd)										
SNL 5350	L1, V1	76	3	Double	Fibercast Dualcast 3 mm (0.120 in.) thick	125	219-S Building	244-S DCRT	N	N
V360	L, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-UX-154	241-EW-151	N	Y
V361	L, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-UX-154	241-EW-151	N	Y
V362	L, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-UX-154	241-EW-151	N	Y
V363	L, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-UX-154	241-EW-151	N	Y
V364	L, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-UX-154	241-EW-151	N	Y
V366	L, V	76	3	Concrete	11 Ga 18-8 SSTL	120	241-UX-154	241-EW-151	N	Y
V374	L2, V2	76	3	Concrete	11 Ga 18-8 SSTL	120	221-U	241-UX-154	N	N
V387	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	241-TX-154	241-TX-152-DB	N	Y
V388	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	241-TX-154	241-TX-152-DB	N	Y
V402	L, V1	76	3	Concrete/double	CS A53 Sch 40	400	244-TX DCRT	241-TX-152	N	Y
V406	L, V1	76	3	Concrete/double	CS A53 Sch 40	400	244-TX DCRT	241-TX-152	N	Y
V453/V421	L, V1	76	3	Concrete	11 Ga 18-8 SSTL	NA	241-U-152	241-U-151	N	N
V455	L, V1	76	3	Double	11 Ga 18-8 SSTL	NA	241-S-151	241-U-151	N	Y
V456	L3, V1	89	3.5	Concrete/double	CS A53 Sch 40	400	244-S DCRT	241-U-151	N	Y
V503/4700	L4, V1	89	3.5	Concrete/double	SSTL Sch 40S	250	241-S-151	241-UX-154	N	Y
V505/5701	L, V1	76	3	Concrete	SSTL, Sch 10	NA	241-UX-154	241-S-151	N	Y
V517	L, V1	89	3.5	Concrete	SSTL	NA	202-S	241-S-151	N	N
V522	L, V1	76	3	Double	CS A53 Sch 40	400	244-S DCRT	241-S-151	N	Y
V560	L, V1	76	3	Double	CS A53 Sch 40	400	244-S DCRT	241-S-151	N	Y
V561	L, V1	76	3	Double	CS A53 Sch 40	400	244-S DCRT	241-SY-B	N	Y
V562	L, V1	76	3	Double	CS A53 Sch 40	400	241-SY-A	244-S DCRT	N	Y

Table 2-22. Active 200 East and 200 West Area Transfer Lines. (8 sheets)

Transfer line identification	Notes[a]	Size		Type	Materials	Design pressure (lb/in^2)[b]	Connection facility	Connection facility	Heat trace[c]	Cathodic protection[c]
		mm	in.							
200 West Area active transfer lines (cont'd)										
V657	L2, V1	76	3	Direct buried	SSTL	NA	241-T-151	241-T-153	N	N
V658	L2, V1	76	3	Direct buried	SSTL	NA	241-T-151	241-T-153	N	N
V730	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	221-T	241-TX-154	N	N
V732	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	221-T	241-TX-154	N	N
V734	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	221-T	241-TX-154	N	N
V735	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	221-T	241-TX-154	N	N
V737	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	221-T	241-TX-154	N	N
V738	L, V1	89	3.5	Concrete	11 Ga 18-8 SSTL	120	221-T	241-TX-154	N	N

Source: WHC-SD-WM-HIE-007, 1996, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[a]In the notes column:
L = leak detection, unspecified
L1 = low point leak detection
L2 = no leak detection
L3 = leak detection probe
L4 = leak detection by smears
V = ventilation system, unspecified
V1 = ventilation provided by tanks
V2 = no ventilation provided.

[b]To convert lb/in^2 to Pa multiply by 6,894.8.
[c]In the heat trace and cathodic protection columns:
N = no.
Y = yes.
[d]Could not verify.
[e]Temporary blank.

ASTM = American Society for Testing and Materials.
CS = carbon steel.
DCRT = double-contained receiver tank.
Ga = gauge.
NA = not available.
PUREX = Plutonium Uranium Extraction (Facility).
SSTL = stainless steel.
VP = valve pit.

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 East Area inactive transfer lines			
4001	241-AX-151	NA	Cut and capped
4002	241-AX-151	NA	Cut and capped
4003	241-AX-151	NA	Cut and capped
4004	241-AX-151	NA	Cut and capped
4006	241-AX-151	NA	Cut and capped
4007	244-AR Vault	241-AX-151	Isolation blank
4009	241-AX-151	NA	Cut and capped
4012	241-CR-153	241-AX-151	Facility isolated
4014	241-AX-151	NA	Cut and capped
4017	241-AX-151	NA	Cut and capped
4018	241-AX-151	NA	Cut and capped
4019	241-AX-151	NA	Cut and capped
4020	241-AX-151	NA	Cut and capped
4021	241-AX-151	241-AY-151	Facility isolated
4021	241-AY-151	241-AX-152	Facility isolated
4022	241-AX-151	241-AX-152	Facility isolated
4530	241-AY-151	241-A-153	Facility isolated
6249	241-BYR-152	241-BXR-152	Facility isolated
6449	241-BYR-153	241-BXR-153	Facility isolated
7412	241-BYR-154	241-BXR-151	Facility isolated
7425	241-BYR-154	241-BXR-151	Facility isolated
8021	241-AY-152	241-AX-103	Facility isolated
8022	241-AY-152	241-AX-103	Facility isolated
8023	241-AY-152	241-AX-102	Facility isolated
8024	241-AY-152	241-AX-102	Facility isolated
8025	241-AY-152	241-AX-101	Facility isolated
8026	241-AY-152	241-AX-101	Facility isolated
8027	241-AY-152	241-AX-104	Facility isolated
8028	241-AY-152	241-AX-104	Facility isolated
8061	241-AY-152	241-AX-104	Facility isolated
8063	241-AY-152	241-AX-101	Facility isolated
8064	241-AY-152	241-AX-103	Facility isolated
8064	241-AY-152	241-AX-102	Facility isolated

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 East Area inactive transfer lines (cont'd)			
8555	241-CR-151	NA	Cut and capped
8656	241-AX-151	244-CR DCRT	Facility isolated
9012	241-BXR-151	241-BR-152	Facility isolated
9025	241-BXR-151	241-BR-152	Facility isolated
9212	241-BYR-152	241-BXR-151	Facility isolated
9212	241-BYR-152	241-BXR-152	Facility isolated
9225	241-BYR-152	241-BXR-151	Facility isolated
9225	241-BYR-152	241-BXR-152	Facility isolated
9249	241-BYR-152	241-BXR-152	Facility isolated
9412	241-BYR-153	241-BXR-151	Facility isolated
9425	241-BYR-153	241-BXR-151	Facility isolated
9425	241-BYR-153	241-BXR-153	Facility isolated
9449	241-BYR-153	241-BXR-153	Facility isolated
9623	241-BYR-154	241-BXR-151	Facility isolated
9624	241-BXR-151	241-BR-152	Facility isolated
9626	241-BYR-153	241-BXR-151	Facility isolated
9626	241-BYR-153	241-BXR-153	Facility isolated
9630	241-BXR-151	241-BR-152	Facility isolated
9631	241-BYR-152	241-BXR-152	Facility isolated
9631	241-BYR-152	241-BXR-151	Facility isolated
9632	241-BYR-153	241-BXR-151	Facility isolated
9632	241-BYR-153	241-BXR-153	Facility isolated
9633	241-BYR-154	241-BXR-151	Facility isolated
9633	241-BYR-154	241-BXR-151	Facility isolated
9633	241-BYR-154	241-BXR-151	Facility isolated
9633	241-BYR-154	241-BXR-151	Facility isolated
9633	241-BYR-154	241-BXR-151	Facility isolated
9636	241-BXR-151	241-B-252	Facility isolated
9644	241-BXR-151	NA	Facility isolated
9644	241-BXR-151	NA	Facility isolated
9644	241-BXR-151	NA	Facility isolated
9719	241-BXR-151	241-ER-151	Facility isolated
4005/810	241-AX-151	244-AR Vault	Facility isolated

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 East Area inactive transfer lines (cont'd)			
4107VO331	241-AX-151	241-A-152	Facility isolated
6307/V336	241-BYR-152	241-BX-153	Facility isolated
7435/9365/V304	241-BYR-154	241-B-252	Facility isolated
7507/9712	241-BYR-154	B-SWAMP	Facility isolated
814/4015	241-AX-151	NA	Cut and capped
8653/8618	241-ER-151	241-CR-151	Facility isolated
9625/9212	241-BYR-152	241-BXR-151	Facility isolated
9625/9212	241-BYR-152	241-BXR-152	Facility isolated
9653/141	221-B	NA	Cut and capped
A4013	241-CR-152	241-AX-151	Facility isolated
D601D505	241-AZ-152	241-AY-152	Facility isolated
S601/S517	241-AZ-152	241-AY-152	Facility isolated
S602	241-AZ-152	NA	Cut and capped
S604	241-AZ-152	NA	Cut and capped
S606	241-AZ-152	NA	Cut and capped
S610	241-AZ-152	NA	Cut and capped
SN650	241-A-B	241-AP-102	Capped
V-341	241-BX-154	221-B	Facility isolated
V004	241-A-152	241-A-151	Facility isolated
V005	241-A-152	241-A-151	Facility isolated
V006	241-A-152	241-A-151	Facility isolated
V006	241-A-152	241-A-151	Facility isolated
V006	241-A-152	241-A-151	Facility isolated
V006	241-A-152	241-A-151	Facility isolated
V007	241-A-152	241-A-151	Facility isolated
V007	241-A-152	241-A-151	Facility isolated
V007	241-A-152	241-A-151	Facility isolated
V050	241-A-152	241-C-104	Facility isolated
V051	241-A-152	241-C-104	Facility isolated
V1000	241-CR-152	244-CR Vault	Facility isolated
V101	241-C-153	NA	Cut and capped
V108/812	241-C-151	244-AR Vault	Facility isolated
V109	241-C-151	241-A-101	Facility isolated

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 East Area inactive transfer lines (cont'd)			
V110	241-C-151	244-CR Vault	Facility isolated
V113	241-C-151	241-AX-101	Facility isolated
V113	241-C-151	241-AX-103	Facility isolated
V121	241-C-152	NA	Cut and capped
V136	241-C-153	NA	Cut and capped
V137	241-C-153	NA	Cut and capped
V141	241-C-153	NA	Cut and capped
V142	241-C-153	NA	Cut and capped
V147	241-C-153	NA	Cut and capped
V200	241-B-154	221-B	Facility isolated
V2000	241-BXR-152	241-BX-155	Facility isolated
V2001	241-BX-155	241-BR-152	Facility isolated
V210V111	241-B-154	241-C-151	Facility isolated
V214/8902	241-B-154	221-B	Facility isolated
V225	241-B-151	241-ER-151	Facility isolated
V228	241-CR-153	241-ER-153	Facility isolated
V235	241-BX-153	241-B-151	Facility isolated
V236	241-BX-153	241-B-151	Facility isolated
V237	241-B-151	241-BX-101	Facility isolated
V242	241-BX-153	241-B-152	Facility isolated
V252	241-BX-153	241-B-152	Facility isolated
V253	241-BX-153	241-B-152	Facility isolated
V285	241-BX-154	241-B-252	Facility isolated
V305	241-B-252	241-BY-109	Facility isolated
V310	241-B-154	241-C-152	Facility isolated
V313	242-B-151	242-B Evaporator	Cut and capped
V314	241-BX-155	241-B-151	Facility isolated
V314	242-B-151	242-B Evaporator	Cut and capped
V319	241-BX-155	241-B-152	Facility isolated
V329	241-B-154	221-B	Facility isolated
V330	241-B-154	221-B	Facility isolated
V331	241-B-154	221-B	Facility isolated
V332	241-B-154	221-B	Facility isolated

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 East Area inactive transfer lines (cont'd)			
V333	241-B-154	221-B	Facility isolated
V334	241-B-154	221-B	Facility isolated
V335	241-BX-154	221-B	Facility isolated
V336	241-BX-154	221-B	Facility isolated
V337	241-BX-154	221-B	Facility isolated
V339	241-BX-154	221-B	Facility isolated
V340	241-BX-154	221-B	Facility isolated
V342	241-BX-154	221-B	Facility isolated
V716	241-AR-151	244-AR Vault	Facility isolated
V718/817	241-AR-151	244-AR Vault	Facility isolated
V743	221-B	241-C-154	Facility isolated
200 West Area inactive transfer lines			
1006	205-S	240-S-152	Facility inactive
1115	240-S-151	202-S	Isolation blank
1140	240-S-151	202-S	Isolation blank
1145	240-S-151	202-S	Isolation blank
1236	240-S-151	202-S	Isolation blank
1540	240-S-151	202-S	Isolation blank
1541	240-S-151	202-S	Isolation blank
3130	240-S-151	202-S	Isolation blank
3591	240-S-151	202-S	Isolation blank
3592	240-S-151	202-S	Isolation blank
3603	240-S-151	None	Isolation blank
3610	240-S-151	202-S	Isolation blank
3635	240-S-151	202-S	Isolation blank
3658	240-S-151	202-S	Isolation blank
3666	240-S-151	202-S	Isolation blank
4242	240-S-151	202-S	Isolation blank
4851	241-TX-155	241-UX-154	Facility isolated
5012	241-UR-152	241-UR-151	Facility isolated
5025	241-UR-152	241-UR-151	Facility isolated
5225	241-UR-151	241-UR-153	Facility isolated
5412	241-UR-151	241-UR-154	Facility isolated

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 West Area inactive transfer lines (cont'd)			
5425	241-UR-151	241-UR-154	Facility isolated
5624	241-UR-152	241-UR-151	Facility isolated
5626	241-UR-151	241-UR-154	Facility isolated
5630	241-UR-152	241-UR-151	Facility isolated
5632	241-UR-151	241-UR-154	Facility isolated
4859/4703	241-TX-155	241-UX-154	Facility isolated
No number	242-S Evaporator	241-S-103	Process blank
No number	242-S Evaporator	241-S-103	Process blank
No number	241-UA	241-UB	Cut and capped
No number	241-UA	241-UB	Cut and capped
No number	240-S-152	204-S	Decommissioned
SL100	241-UC	241-S-152	Facility isolated
SL101	241-UD	Blocked	Pipeline blocked
SL101	241-S-152	Blocked	Line blocked
SL113	242-S Evaporator	NA	Failed pipeline
SL114	242-S Evaporator	NA	Failed pipeline
SL115	241-S-A	241-S-C	Failed pipeline
SL117	241-S-C	241-SX-A	Process blank
SL126	241-S-D	NA	Cut and capped
SL138	241-S-152	242-S Evaporator	Facility isolated
SL139	241-S-152	Blocked	Pipeline blocked
SL139/SL114	242-S Evaporator	241-S-B	Process blank
SL175	241-SY-A	241-S-152	Facility isolated
SL176	241-SY-B	241-S-152	Facility isolated
SM264	244-U DCRT	241-UD	244-U DCRT is inactive
SN-204	244-TX DCRT	241-TX-17A	Isolation blank
SN-216	241-UD	Blocked	Line blocked
SN200	244-TX DCRT	NA	Isolation Blank
SN202	241-UA	241-UC	Cut and capped
SN203	241-UB	241-UD	Cut and capped
SN208	244-TX DCRT	241-TX-11A	Isolation blank
SN211	244-TX DCRT	NA	Isolation blank

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 West Area inactive transfer lines (cont'd)			
SN217	241-S-C	241-SX-A	Process blank
SN218	241-S-D	241-SX-B	Process blank
SN249/704	244-TX DCRT	241-TY-103	Isolation blank
SN266	244-U DCRT	NA	Line blocked
V360	241-WR	241-UX-154	Facility isolated
V375	241-TX-155	241-UX-154	Facility isolated
V376	241-TX-155	241-UX-154	Facility isolated
V382	241-TX-155	241-UX-154	Facility isolated
V399	241-T-152	241-TX-155	Facility isolated
V405	241-T-152	241-TX-155	Facility isolated
V405	241-TX-155	241-T-152	Facility isolated
V410	241-U-151	241-TX-155	Facility isolated
V411	241-T-151	241-TX-155	Facility isolated
V412	241-TX-155	Blocked	Facility isolated
V416	241-TX-153	241-U-152	Facility isolated
V426	241-U-152	241-U-153	Facility isolated
V427	241-U-152	241-U-153	Facility isolated
V428/V461	241-U-152	241-U-153	Facility isolated
V445	241-T-151	241-U-151	Facility isolated
V450	241-U-151	241-U-153	Facility isolated
V456	241-SX-152	NA	Cut and capped
V458	241-U-153	240-S-151	Facility isolated
V459	241-U-153	240-S-151	Facility isolated
V460	241-U-153	240-S-151	Facility isolated
V465	241-U-153	241-U-110	Facility isolated
V466	241-U-153	241-U-110	Facility isolated
V467	241-U-153	241-U-110	Facility isolated
V470	241-U-153	241-U-107	Facility isolated
V471	241-U-153	241-U-107	Facility isolated
V471	241-U-153	241-U-107	Facility isolated
V472	241-U-153	241-U-107	Facility isolated
V472	241-U-153	241-U-107	Facility isolated
V526	241-S-155	241-SX-151	Facility isolated

Table 2-23. Inactive Transfer Lines. (8 Sheets)

Transfer line identifier	Connection facility	Connection facility	Comments
200 West Area inactive transfer lines (cont'd)			
V527	241-S-155	241-SX-151	Facility isolated
V528	241-S-155	241-SX-151	Facility isolated
V529	241-S-151	241-SX-151	Facility isolated
V530	241-S-151	241-SX-151	Facility isolated
V597	241-TY-153	241-TX-153	Facility isolated
V6002	241-TR-152	241-T-103	NA
V6006	241-TR-152	241-T-102	NA
V601	241-T-152	241-TX-153	Facility isolated
V6010	241-TR-152	241-T-101	NA
V610	241-TX-153	242-T Evaporator	Facility isolated
V653	241-T-151	221-T	Facility isolated
V654	241-T-151	221-T	Facility isolated
V657	241-T-153	241-T-151	Facility isolated
V658	241-T-153	241-T-151	Facility isolated
V667	241-T-152	221-T	Facility isolated
V668	241-T-152	221-T	Facility isolated
V669	241-T-152	221-T	Facility isolated
V671	241-T-152	224-T	Facility isolated
V675	241-T-153	241-T-152	Facility isolated
V676	241-T-153	241-T-152	Facility isolated
V707	241-T-252	221-T	Facility isolated
V762/4853	241-SX-152	241-UX-154	Facility isolated

Source: WHC-SD-WM-HIE-007, 1996, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DCRT = double-contained receiver tank.

NA = not available.

Table 2-24. Typical Primary and Supporting Activities at Tank Waste Remediation System Facilities Required to Support Operations. (2 sheets)

Activity	Waste storage/ concentration	Waste transfer	Waste characterization
Primary activities to support operations			
Air lance	X		
Air lift circulators	X		X
Ammonia gas sampling	X		
Auger sampling	X		X
Cathodic protection		X	
Chemical additions	X	X	
Core sampling - push and rotary modes [a]	X		X
Gas vapor sampling - in-tank	X		X
HEPA filter change out	X		
Infrared scanning	X		
Interim stabilization or salt well pumping	X		
Intrusion prevention	X		
Lighting augmentation	X	X	X
Line integrity assessments		X	
Liquid-level monitoring	X	X	X
Liquid observation wells	X		
Liquid (grab) sampling	X	X	X
Photography (in-tank or pit)	X	X	
Raw and treated water additions	X	X	
Salt well screen	X	X	
Sample handling	X	X	X
Sludge-level monitoring	X		X
Sludge sampling	X		X
Slurry distributor	X		
Specific gravity probe monitoring	X	X	X
Thermocouple or multiple instrument tree	X		
Utility additions or upgrades	X	X	
Valve positioning and jumper installation		X	
Waste minimization activities	X		

Table 2-24. Typical Primary and Supporting Activities at Tank Waste Remediation System Facilities Required to Support Operations. (2 sheets)

Activity	Waste storage/ concentration	Waste transfer	Waste characterization
Waste transfer leak detection (swabbing or surveillance camera)		X	
Supporting activities			
Cover block installation and removal	X	X	X
Crane operations	X	X	X
Decontamination activities	X	X	X
Dry well scanning	X		
Electrical grounding and bonding	X	X	X
Flammable gas monitoring (sniffing)[b]	X	X	X
Greenhouse or confinement construction, decontamination, and removal	X	X	X
Groundwater monitoring	X		
In-tank equipment installation, operation, and removal	X	X	X
Radiological monitoring and surveys	X	X	X
Riser access	X	X	X
Vehicle operations	X	X	X

[a]With the exception of flammable gas hazards, rotary mode core sampling is outside the scope of this Final Safety Analysis Report; see WHC-SD-WM-SAD-035, 1996, *A Safety Assessment for Rotary Mode Core Sampling in Flammable Gas Single-Shell Tanks, Hanford Site, Richland, Washington*, Rev. 0-a, Westinghouse Hanford Company, Richland, Washington.

[b]Using portable monitors.

HEPA = high-efficiency particulate air (filter).

Table 2-25. Tank Farm Radionuclide Monitoring Systems by Facility and Stack Number. (2 sheets)

Facility	Area monitored	Stack description number	Monitor description	
			Type	Material
Single-shell tanks				
241-C-105/106	Portable	296-P-16	CAM	Beta-gamma
241-C-106	Primary (WRSS) Operations	296-C-006	CAM	Beta-gamma
241-SX	Primary	296-S-15	CAM	Beta-gamma
Double-shell tanks				
241-SY	Annulus	296-P-22	CAM	Beta-gamma
241-SY	Primary	296-P-23	CAM	Beta-gamma
241-SY	Primary backup	296-P-28	CAM (2)	Beta-gamma
241-AY/AZ	241-AZ-702 Primary Ventilation	296-A-42	CAM	Beta-gammas
241-AY/AZ	241-A-702 Isolated	296-A-17	SZC (2) Tritium (3)* C-14 (2)* CAM	Beta-gamma
241-AY/AZ	241-A-702 Isolated	296-P-26	CAM	Beta-gamma
241-AY-101	Annulus	296-A-18	CAM	Beta-gamma
241-AY-102	Annulus	296-A-19	CAM	Beta-gamma
241-AZ	Annulus	296-A-20	CAM	Beta-gamma
241-AW	Primary	296-A-27	SZC (2) CAM	Beta-gamma
241-AW	Annulus	296-A-28	CAM	Beta-gamma
241-AN	Primary	296-A-29	CAM	Beta-gamma
241-AN	Annulus	296-A-30	CAM	Beta-gamma
241-AP	Primary	296-A-40	SZC (2) CAM	Beta-gamma
241-AP	Annulus	296-A-41	CAM	Beta-gamma

Table 2-25. Tank Farm Radionuclide Monitoring Systems by Facility and Stack Number. (2 sheets)

Facility	Area monitored	Stack description number	Monitor description	
			Type	Material
Double-contained receiver tanks				
200 East Area				
244-A	Primary/annulus	296-A-25	CAM	Beta-gamma
244-BX DCRT	Primary/annulus	296-B-28	CAM	Beta-gamma
244-CR Vault	Primary	296-C-5	CAM	Beta-gamma
200 West Area				
244-S	Primary/annulus	296-S-22	CAM (2)	Alpha Beta-gamma
244-TX	Primary/annulus	296-T-18	CAM (2)	Alpha Beta-gamma
Other facilities				
204-AR	Primary	296-A-26	CAM	Beta-gamma

Source: WHC-SD-WM-ES-291, 1994, *Tank Farm Sampling System Configuration and Efficiency Study*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

*System is inactive.

CAM = continuous air monitor.

DCRT = double-contained receiver tank.

SZC = silver zeolite cartridge.

Table 2-26. Fire Suppression and Detection Systems at Tank Farm Facilities. (2 sheets)

Building	Fire suppression systems			Fire detection systems		
	Wet	Dry	Halon*	Smoke	Heat	Pull box
200 East Area						
204-AR	X			X	X	X
209-E	X				X	X
241-A-271				X		X
241-A-701					X	X
241-A-702				X		X
241-AN-271				X		X
241-AP-271				X		X
241-AP-273				X		X
241-AW-271				X		X
241-AX-801-A				X		X
241-AX-801-B				X		X
241-AY-801				X		X
241-AZ-271	X					
241-AZ-701	X					
241-AZ-702	X					
241-AZ-801				X		X
241-BY-254				X		X
241-BY-301				X		X
241-BY-302				X		X
244-AR					X	X
244-AR-2707					X	X
244-AR-292					X	X
244-AR-701					X	X
244-AR-715					X	X
244-BX					X	X

Table 2-26. Fire Suppression and Detection Systems at Tank Farm Facilities. (2 sheets)

Building	Fire suppression systems			Fire detection systems		
	Wet	Dry	Halon*	Smoke	Heat	Pull box
200 East Area (cont'd)						
271-CR	X					X
272-AW	X					X
2750-E CASS room and hallway	X			X		X
200 West Area						
213-W		X				X
241-SX-271				X		X
241-SX-2707					X	X
241-SX-281				X		X
241-SX-701				X		X
241-SY-271				X		X
241-SY-272				X		X
241-SY-DACS			X	X	X	X
241-T-601					X	X
244-S					X	X
244-TX					X	X
244-U					X	X
272-WA	X					X

*Halon is a trademark of Allied Chemical Corporation, New York, New York.
CASS = Computerized-Automated Surveillance System.
DACS = Data Acquisition and Control System.

Table 2-27. Water Supplies to Tank Waste Remediation System Facilities and Potential Water Use. (2 sheets)

Facility/tank farm	Water[a]	Supply location	Potential water use[b]
200 East Area			
Single-shell tank farms			
241-A	SW	241-CR-271	Flush water
	RW	V40R V47R	
241-AX[c]	RW	V78R	Flush water
241-B	SW	241-B-701	Flush water
	RW	V29R	
241-BX	RW	V28R	Flush water
241-BY[c]	SW	241-BY-254	Flush water
	RW	241-BY-254 V30R V31R V32R	
241-C[c]	SW	241-CR-271	Flush water
	RW	241-CR-271 241-C-801 V41R V65R	
Double-shell tank farms			
241-AN[c]	RW	NI	Flush water, ventilation system deentrainer
241-AP[c]	RW	NI	Flush water, ventilation system deentrainer
241-AW[c]	RW	NI	Flush water, dip tube drip system
241-AY	RW	V76R	Condenser cooling water, ventilation system deentrainer, flush water
241-AZ[c]	RW	241-AZ-801 V73R V75R	Condenser cooling water, ventilation system deentrainer, flush water, in-facility fire protection
Catch tanks or double-contained receiver tanks			
241-A-302A	NI	NI	NI
241-A-350	NI	NI	NI
241-A-417	NI	NI	NI
241-AX-152	RW	241-AX-152	Pump dilution water, flush water
241-AZ-151	NI	NI	NI
241-AZ-154	NI	NI	NI
241-ER-311	NI	NI	NI
244-A	NI	NI	NI
244-BX[c]	NI	NI	NI
244-CR	NI	NI	NI

Table 2-27. Water Supplies to Tank Waste Remediation System Facilities and Potential Water Use. (2 sheets)

Facility/tank farm	Water[a]	Supply location	Potential water use[b]
200 West Area			
Single-shell tank farms			
241-S	RW	V48R	NI
241-SX	RW	241-SX-701 241-SX-271 241-SX-281 241-SX-401 241-SX-402 2707SX V48R	NI
241-T	RW	V16R	NI
241-TY	NI	NI	NI
241-TX	RW	V26R	Flush water
241-U	SW	241-U-271	Flush water
	RW	241-U-271 V37R	
Double-shell tank farms			
241-SY[c]	RW	NI	Flush water, ventilation system deentrainer
Catch tanks or double-contained receiver tanks			
241-S-304	NI	NI	NI
241-TX-302C	NI	NI	NI
241-U-301B	NI	NI	NI
241-UX-302A	NI	NI	NI
244-S	RW	244-S	Dip tube drip system, transfer pump dilution water
244-TX[c]	RW	244-TX	Dip tube drip system, transfer pump dilution water, flush water
244-U	RW	244-U	Transfer pump dilution water, flush water
Other area tank farms , catch tanks , or double-contained receiver tanks , and other support facilities			
241-EW-151	NI	NI	NI
204-AR[c]	RW	NI	In-facility fire protection, ventilation system fire protection, flush water
244-AR[c]	NI	NI	NI
209-E	SW	V143S	NI
	RW	V35R	
213-W	NI	NI	In-facility fire protection
2727-WA	RW	NI	NI

[a]Flexible hoses can be used for flush water where no water identified.

[b]Use as identified in WHC-SD-WM-HIE-007, 1996, *Tank Waste Remediation System FSAR Hazard/Identification Facility Configuration Verification Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[c]Water supply systems have flow totalizers.

NI = none identified, no valve number provided, no use provided.
RW = raw water.
SW = sanitary water.
V = valve.

Table 2-28. Compressed Air Supply to Tank Waste Remediation System Facilities. (2 sheets)

Facility or tank farm	Compressed air supply		Primary use
	Primary	Other	
200 East Area			
Single-shell tank farms			
241-A	241-A-701	Portable	Purge air, weight factor
241-AX	241-A-701	Portable	Purge air, weight factor
241-B	241-B-701	Portable	Purge air
241-BX*	Conex	241-BY-302 241-BY-302A	Purge air
241-BY*	Conex	241-BY-302 241-BY-302A	Purge air
241-C	241-C-701	Portable	Purge air
Double-shell tank farms			
241-AN	241-AN-273	Portable	Leak detection, tank pressure
241-AP	241-AP-273	Portable	Leak detection, tank pressure
241-AW	241-AW-273	242-A	Leak detection, tank pressure (air lift circulators, specific gravity, Tank 241-AW-102 only)
241-AY	241-A-701	Portable	Purge air, air lift circulators, specific gravity, weight factor
241-AZ	241-A-701	Portable	Air lift circulators, specific gravity, weight factor
Double-contained receiver tanks			
244-A*	Fixed	Portable	Purge air, specific gravity, weight factor
244-BX*	Conex	Portable	Purge air, weight factor
244-CR	241-C-701	Portable	Purge air, specific gravity, weight factor
200 West Area			
Single-shell tank farms			
241-S	Salt well pump skid	Portable	Specific gravity, weight factor
241-SX	Portable	Salt well pump skid	As required
241-T	Portable	Salt well pump skid	Specific gravity, weight factor
241-TX	Conex	Portable	Purge air
241-TY	Conex	Portable	As required
241-U	241-U-701	Salt well pump skid	Specific gravity, weight factor

Table 2-28. Compressed Air Supply to Tank Waste Remediation System Facilities. (2 sheets)

Facility or tank farm	Compressed air supply		Primary use
	Primary	Other	
Double-shell tank farms			
241-SY	242-S	Portable	Leak detection, tank pressure, specific gravity, weight factor
Double-contained receiver tanks			
244-S	244-S-271	Portable	Purge air, specific gravity, weight factor
244-TX	Conex	Portable	Purge air, specific gravity, weight factor
244-U	701-U	Portable	Purge air, specific gravity, weight factor
Other area tank farms, catch tanks, or double-contained receiver tanks, and other support facilities			
204-AR*	Fixed	Portable	Weight factor, specific gravity
244-AR*	Fixed	Portable	Weight factor
209-E	209-A	Portable	As required
213-W	Portable	Portable	As required
2727	Portable	Portable	As required
241-AZ-702A	241-AZ-701	Portable	Ventilation system controls

NOTE: Primary usage taken from WHC-SD-WM-HIE-007, 1996, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
*Fixed or conex system installed; no building or structure identified.

Table 2-29. Control Facilities and Change Trailers for Tank Waste Remediation System Facilities. (2 sheets)

Facility	Instrument building or control room number[a]	Change trailer building number[a,b]
200 East Area		
Single-shell tanks		
241-A Tank Farm	241-A-271	MO-439, T-121
241-AX Tank Farm	241-A-271	MO-439
241-B Tank Farm	244-BX	MO-825
241-BX Tank Farm	244-BX	MO-824
241-BY Tank Farm	241-BY-254, 241-BY-301	MO-299
241-C Tank Farm	241-CR-271, MO-211	MO-822, MO-826, T-120
Double-shell tanks		
241-AN Tank Farm	241-AN-271, 241-AN-274	MO-820
241-AP Tank Farm	241-AP-271, 242-A	MO-815
241-AW Tank Farm	241-AW-271, 242-A	MO-818
241-AY Tank Farm	241-A-271, 241-AY-801	MO-439, T-121
241-AZ Tank Farm and 241-AZ-156	241-A-271, 241-AZ-801-A	MO-439, T-121
Other facilities		
Catch tanks	None	None
DCRTs[b]		
244-A	244-A	MO-816
244-BX	244-BX	None
B Pond	216-B-3A1	None
200 West Area		
Single-shell tanks		
241-S Tank Farm	241-S-271	MO-298, MO-295
241-SX Tank Farm	241-SX-271	MO-298
241-T Tank Farm	None	MO-821
241-TX Tank Farm	None	MO-817
241-TY Tank Farm	None	None
241-U Tank Farm	241-U-271	MO-297
Double-shell tanks		
241-SY Tank Farm	241-SY-271, 242-S, DACS-1	MO-295, MO-296

Table 2-29. Control Facilities and Change Trailers for Tank Waste Remediation System Facilities. (2 sheets)

Facility	Instrument building or control room number[a]	Change trailer building number[a,b]
Other facilities		
Catch tanks	None	None
DCRTs[c]		
244-U	244-U-271	None
244-S	244-S-271	None
244-TX	244-TX-271	None
600 Area		
241-EW-151	None	None

[a]None. No building was identified during walkdown.

[b]No building number available. Building or facility exists, but no building number is assigned to the facility.

[c]Most facilities not identified.

DACS = Data Acquisition and Control System.

DCRT = double-contained receiver tank.

MO = mobile office.

T = trailer.

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AC	Administrative Control
AICC	adiabatic isochoric complete combustion (pressure)
ALARA	As Low As Reasonably Achievable
ALC	air lift circulator
ARF	airborne release fraction
ARR	airborne release rate
AWF	Aging Waste Facility
CAM	continuous air monitor
COB	cleanout box
CPS	criticality prevention specification
CSER	criticality safety evaluation report
CWM	conservative waste model
DCRT	double-contained receiver tank
DBA	design basis accident
DBE	design basis earthquake
DDT	deflagration-to-detonation transition
DOE	U.S. Department of Energy
DST	double-shell tank
E	east
EBA	evaluation basis accident
ED3A	ethylene diamine triacetate
EDTA	ethylenediaminetetraacetic acid
ERPG	Emergency Response Planning Guideline
ESE	east, southeast
FSAR	Final Safety Analysis Report
GRE	gas release event
HazOp	hazard and operability study
HEDTA	hydroxyethylethylenediaminetriacetic acid
HEPA	high-efficiency particulate air (filter)
HMP	hazardous materials protection
HVAC	heating, ventilation, and air conditioning
ID	identifier/inside diameter
IDA	iminodiacetic acid
IMUST	inactive miscellaneous underground storage tank
JCO	Justification for Continued Operation
LCO	Limiting Condition for Operation
LCS	Limiting Control Setting
LFL	Lower Flammability Limit
LPF	leak path factor
MAR	material at risk
MISF	miscellaneous inactive storage facility
MMI	Modified Mercalli Intensity

LIST OF TERMS (Cont'd)

MUST	miscellaneous underground storage tank
NA	not applicable
NPH	normal paraffinic hydrocarbon
NR	no release
NTA	nitrilotriacetic acid
OCC	Occupational Safety
ORP	Office of River Protection
OGT	overground transfer
PE	potentially present elsewhere in/adjacent to facility
PEL	permissible exposure limit
PF	potentially present in the facility
PFP	Plutonium Finishing Plant
PHA	preliminary hazard analysis
PPE	personal protective equipment
ppmv	parts per million-volume
PSO	Program Secretarial Officer
PT	potentially present in the tanks
PUREX	Plutonium Uranium Extraction (Facility)
rad	radiological consequences
RCRA	*Resource Conservation and Recovery Act of 1976*
RCSTS	replacement cross-site transfer system
REDOX	reduction-oxidation
REG	risk evaluation guideline
RF	respirable fraction
RL	U.S. Department of Energy, Richland Operations Office
RMCS	rotary mode core sampling
RP	Radiation Protection
SARA	*Superfund Amendments and Reauthorization Act (SARA) of 1986*
SARP	Safety Analysis Report for Packaging
SC	Safety-Class
SL	Safety Limit
SOF	sum-of-fractions
SS	Safety-Significant
SSC	structure, system, and component
SST	single-shell tank
T	time
TBP	tributyl phosphate
T.CD.V	DCRT with active ventilation
T.DS.A.H.	flammable gas (hydrogen), double-shell tank with airlift circulators
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
tox	toxicological consequences
TRU	transuranic

LIST OF TERMS (Cont'd)

T.SD.L.V	high heat load tank, either single-shell or double-shell with active ventilation
TSR	Technical Safety Requirement
T.SS.D	dry crust, single-shell tank
TWA	time-weighted average
TWRS	Tank Waste Remediation System
ULD	unit liter dose
UNH	uranyl nitrate hexahydrate
USQ	Unreviewed Safety Question
VSU	vertical storage unit
WG	water gauge
WRSS	waste retrieval sluicing system

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3.0 HAZARD AND ACCIDENT ANALYSES

3.1 INTRODUCTION

This chapter describes the methodology and presents the results of the hazard and accident analyses performed for the facilities and operations described in Chapter 2.0, "Facility Description." This chapter also includes the facility hazard classification. Based on the results of the hazard and accident analyses, Safety-Class and Safety-Significant structures, systems, and components (SSCs); Technical Safety Requirements (TSRs); and additional Defense-in-Depth controls are identified for protection of the public, onsite workers, and facility workers. Chapter 4.0, "Safety Structures, Systems, and Components," provides details on the safety SSCs identified; and Chapter 5.0, "Derivation of Technical Safety Requirements," provides the derivation basis of TSRs necessary to support the separate TSR document required by DOE 5480.22, *Technical Safety Requirements*. Design and operational features required specifically to protect the environment from uncontrolled releases of radioactive and hazardous material are also identified in this chapter.

Reference

DOE 5480.22, 1996, *Technical Safety Requirements*, Change 2, U.S. Department of Energy, Washington, D.C.

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3.2 REQUIREMENTS

U.S. Department of Energy (DOE) orders and standards that provide requirements and guidance for performing hazard and accident analyses to establish the safety basis of nuclear facilities are as follows:

- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)
- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (1992)
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (1994).

Additional design codes, standards, regulations, and DOE orders relevant to specific hazards are identified in other Final Safety Analysis Report (FSAR) chapters that interface with this chapter.

DOE requirements on the definition of the Hanford Site boundary and on risk guidelines are provided in the following letters:

- The definition of the Hanford Site boundary for safety analyses is contained in Scott (1995), *Clarification of Hanford Site Boundaries for Current and Future Use in Safety Analyses*, Kruger (1996), *Further Discussion on Previous Site Boundary Memorandum*, and TWRS-RT-SER-02, *Safety Evaluation Report for the Basis for Interim Operation and Flammable Gas/Slurry Growth Unreviewed Safety Question: Justification for Continued Operation and Technical Safety Requirements*.
- Risk guidelines to be used in the Tank Waste Remediation System (TWRS) FSAR are contained in Kinzer (1996), *Interim Radiological Dose Acceptance Criteria for the Hanford Tank Farms Safety Analysis*, with clarifications documented in Bacon (1996), *Tank Waste Remediation System Accident Analysis Risk Evaluation Guidelines*.

References

Bacon, R. F., 1996, *Tank Waste Remediation System Accident Analysis Risk Evaluation Guidelines* (letter 9651709 to J. E. Kinzer, U.S. Department of Energy, Richland Operations Office, April 22), Westinghouse Hanford Company, Richland, Washington.

DOE 5480.23, 1994, *Nuclear Safety Analysis Reports*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE-STD-1027-92, 1992, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

DOE-STD-3009-94, 1994, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

Kinzer, J. E., 1996, *Interim Radiological Dose Acceptance Criteria for the Hanford Tank Farms Safety Analysis* (letter 96-MSD-069 to A. L. Trego, Westinghouse Hanford Company, April 8), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Kruger, P. W., 1996, *Further Discussion on Previous Site Boundary Memorandum* (letter 9600588 to Director, Pacific Northwest National Laboratory, and President, Westinghouse Hanford Company, March 5), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Scott, W. B., 1995, *Clarification of Hanford Site Boundaries for Current and Future Use in Safety Analyses* (letter 9504327 to Director, Pacific Northwest Laboratory, and President, Westinghouse Hanford Company, September 26), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

TWRS-RT-SER-02, 1997, *Safety Evaluation Report for the Basis for Interim Operation and Flammable Gas/Slurry Growth Unreviewed Safety Question: Justification for Continued Operation and Technical Safety Requirements*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3.3 HAZARD ANALYSIS

The methodology and results of the hazard analysis, conducted for the TWRS facilities and operations described in Chapter 2.0, are presented in this section. The results of the final hazard classification of TWRS facilities are also presented.

The types of events considered in the TWRS facilities hazard analysis were internal events, external events, and natural phenomena events that can cause the uncontrolled release of radioactive or hazardous materials and affect the public, workers, or the environment. Single and multiple failures (i.e., as a result of equipment and human errors) and common-cause failures were considered to be accident initiators. Sabotage and terrorism events were not considered.

The hazard analysis addressed both inactive and active facilities. Inactive facilities were addressed as follows:

- Facilities classified as miscellaneous inactive storage facilities (MISFs) including inactive miscellaneous underground storage tanks (IMUSTs) and other inactive underground and aboveground storage facilities were analyzed.

- Interfaces with inactive facilities outside the scope of the FSAR that had a physical connection to TWRS systems, including the inactive evaporators (242-S and 242-T), were analyzed.

- Inactive facilities within the scope of the FSAR, including the 244-AR Vault, were analyzed.

- Abandoned or inactive portions of TWRS systems physically connected to active TWRS facilities were included in the analysis of the facility to which they were connected.

Supplemental hazards analysis for the waste retrieval sluicing system (WRSS) is provided in Addendum 1. Supplemental hazards analysis for the replacement cross-site transfer system (RCSTS) is provided in Addendum 2. Supplemental hazards analysis for the 241-AZ-702 ventilation system is provided in Addendum 3. Supplemental hazards analysis for the 241-AZ-101 mixer pump test is provided in Addendum 4. Supplemental hazard analysis for remediation activities and operations in Tank 241-SY-101 are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

The hazard analysis for the TWRS FSAR is a systematic and predominantly qualitative evaluation of the spectrum of risks to the public, workers, and the environment. The hazard analysis consists of the following activities:

- **Hazard Identification**—Identifies hazardous materials and energy sources (e.g., radiological and chemical hazards) associated with facility design, processes, and

operations. Hazards associated with internal, external, natural phenomena, and common cause events are identified. This process provides information used to identify potential hazardous conditions resulting in the uncontrolled release of material (i.e., accident scenarios). Hazard identification supports the final hazard categorization of the facility.

- **Hazard Topography**—Ensures comprehensive coverage of material at risk (MAR), phenomena, configurations, operations, and facilities by supporting the selection and mapping of the representative hazard evaluation results to the appropriate TWRS facility.

- **Hazard Evaluation**—Identifies hazardous conditions and qualitatively assesses their frequency of occurrence and severity of consequence. The frequency and consequence estimates are used to rank, or bin, the events in a risk matrix. Ranking the events in this manner facilitates identification of those hazardous conditions that are of greatest concern (i.e., highest risk) and provides a basis for selection of the accidents that require a more detailed quantitative analysis.

- **Accident Selection**—Hazardous conditions identified by the hazard evaluation are used to select candidate accidents for more detailed quantitative analyses. The accidents selected to be analyzed represent the range of hazardous conditions identified by the hazard evaluations.

- **Control Identification**—Safety-Class and Safety-Significant SSCs, TSR controls, and other controls required to protect the public, workers, and the environment are identified on the basis of the results of the hazard and accident analysis.

- **Hazard Classification**—The final hazard category of each TWRS facility is determined on the basis of the radiological and toxicological consequences of hazardous conditions associated with that facility. The categorization provides input data for a graded approach to safety management of each facility.

Reference

HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

3.3.1 Methodology

This section presents the methodology used to perform the TWRS hazard analysis. A flow diagram of the hazard analysis process is illustrated in Figure 3.3.1-1. Hazards that can contribute to the uncontrolled release of radioactive or hazardous materials are systematically and comprehensively identified through the hazard identification process (Section 3.3.1.1). Representative analysis cases are identified and applied to appropriate TWRS facilities by use of the hazard topography (Section 3.3.1.2). A representative analysis is a hazard evaluation of a specific facility or condition that can be applied to one or more facilities or conditions in TWRS. The hazard evaluation process (Section 3.3.1.3) identifies hazardous conditions for the representative cases and identifies causes, preventive and mitigative features, and qualitative estimates of the frequency and consequence. Use of representative analysis is possible because of the many similarities in the configuration and operation of TWRS storage tanks. Analyzing representative cases is valid for two reasons:

- The hazard evaluations are qualitative assessments that apply to any specific situation with similar characteristics.

- Although there are 177 major tanks in TWRS, the tanks share similar physical characteristics.

The results of the hazard evaluations are used to select candidate accidents for quantitative analysis (Section 3.3.1.4). The results of the hazard evaluations and accident analyses are then used to identify the safety SSCs, TSR controls, and other controls required to protect the public, workers, and the environment (Section 3.3.1.5). Results of the hazard and accident analyses also support determination of the final facility hazard classification (Section 3.3.1.6). Results of the hazard analysis activities are recorded in a hazard analysis database (Section 3.3.1.7).

3.3.1.1 Hazard Identification. The hazard analysis includes identification of the hazards associated with TWRS design, processes, and operations. Hazards are defined as material (referred to as MAR) with a potential adverse effect on people or the environment and the energy sources that could contribute to the uncontrolled release of that material. The hazard identification methods and techniques include the following:

- Review of past TWRS safety documents

- Review of TWRS reportable event history (e.g., unusual occurrence reports)

- Review of historical records of similar operations (e.g., waste storage tanks at the Savannah River Site)

- Participation by current and former TWRS operations and engineering personnel in the hazard analysis effort

- Use of standardized checklists of potential hazardous materials and energy sources

- Review of information regarding TWRS MAR
- Review of TWRS facilities and operations descriptions
- Review of existing hazard analyses of TWRS facilities.

The hazard identification activity included a review of occurrence reports for TWRS (200 Area tank farms and affiliated facilities). These reports were examined to assist in assuring that a comprehensive set of hazards and potential accident causes were addressed by the hazard analysis activity. This was accomplished by comparing the nature of the occurrences with potential causes or accidents identified by the hazard analysis and verifying that those occurrences not covered were not material to the hazard analysis results. Review of the occurrences also was used to assist in determining frequencies for some of the hazardous conditions in the TWRS hazard and operability study (HazOp) and preliminary hazards analysis (PHA).

An initial set of hazards is identified on a tank farm and other facility level using a hazard identification form and related checklist in Tables 3.3.1.1-1 and 3.3.1.1-2. All the hazards from the checklist that are known to be present in or nearby each TWRS facility are recorded on the form. Only those hazards present are identified. The result of this exercise is the transformation of a generic hazard checklist into a TWRS-specific hazard set. This set of hazards was used to assure a comprehensive hazard identification for the TWRS facilities as a group. The hazard evaluation was based on all the hazards identified, not just those present at a specific facility.

A field verification by means of a TWRS document review and facility walkdown supports (1) identifying MAR (type, form, quantity, and location) and (2) relating the hazard identification to each tank. The field verification information is used to update the hazard identification information and support the hazard evaluations and selection of controls. The information generated by the hazard identification and field verification processes is captured in a hazard analysis database.

The information about the material present in each TWRS facility is used to confirm or adjust the assumptions about the MAR used in the hazard evaluations. The accident analysis results are also calculated using conservative assumptions about the material that may be present, not using the existing inventory. The TWRS MAR assumptions used in the TWRS facility accident analyses were made through use of the following:

- **Chemical Inventory**—The TWRS maximum hazardous chemical inventory is developed using two sources. The first source is a listing of chemicals from the Hanford Hazardous Material Inventory Database, which is used to meet the requirements of *Superfund Amendments and Reauthorization Act of 1986*. This database contains a list of purchased and stored chemicals within the facility. The second source of information is WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*. This document contains the bounding limits for chemical unit liter concentrations for the tanks within the facility.

- **Radiological Inventory**—The TWRS worst-dose radiological inventory is based on information in WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, and WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*. These documents contain bounding unit liter doses (ULD) for the tanks within the facility.

3.3.1.2 Hazard Topography. The TWRS hazard topography is used to ensure comprehensive coverage of MAR, phenomena, configurations, operations, and facilities. TWRS documents, including WHC-EP-0182-96, *Waste Tank Summary Report for Month Ending March 31, 1996*; WHC-SD-WM-SARR-009, *Construction/Maintenance Activities and Operations Analysis Summaries*; and WHC-SD-WM-HIE-007, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report*, are used to help define the hazard topography. Details of waste inventory and configuration were used to generalize conditions in the TWRS facilities. Therefore, the historical record provided by WHC-EP-0182-96, WHC-SD-WM-SARR-009, and WHC-SD-WM-HIE-007 is considered sufficient to support the hazard evaluations. The hazard topography is specifically used to accomplish the following:

- Identify the types of TWRS facility situations that are directly analyzed by a hazard evaluation (e.g., identify the specific representative analyses)

- Map the representative hazard evaluation results to each TWRS facility in the scope of this FSAR

- Store the results of the hazard identification effort for each TWRS facility in the scope of this FSAR.

The tabular results of the evaluation of potential energy sources associated with TWRS facilities is documented in WHC-SD-WM-HIE-007 and are shown in Appendix A of the FSAR. The form used to gather the energy source information is shown in Table 3.3.1.1-1. The key to the numerical designators used in Appendix A is shown in Table 3.3.1.1-2.

The following hazard topography data is stored in the hazard analysis database and includes the following information:

- **Facility Identifier**—The facility identifier used by the TWRS project.

- **Facility Type**—The TWRS facility type code (see Table 3.3.1.2-1) is used to relate hazard evaluation results to each facility. For example, a double-shell tank (DST) on the flammable gas watch list would be coded with a facility type code of "DS.H." All hazardous conditions involving DSTs and hydrogen gas fires or explosions would also be assigned a DS.H code. This allows all hazardous conditions involving hydrogen fires/explosions to be related to the appropriate DSTs.

- **Capacity**—The design capacity of the vessel(s) at a facility.

- **Material Inventory**—The inventory of radioactive and/or hazardous materials in a facility. It includes the type, form, quantity, and location of the material (the location identification is generally the same as the facility identification).

- **Unique Phenomena**—The unique phenomena associated with each facility. Unique phenomena include high heat, flammable gas, organics, and radiolysis.

- **Unique Configuration**—The unique major configuration items for each facility. Unique configurations include interfaces with other facilities, the existence of active or passive ventilation, DSTs, and single-shell tanks (SSTs).

- **Representative Analyses**—The hazard evaluations that contain results applicable to a facility.

3.3.1.3 Hazard Evaluation. The hazard evaluation is a structured and systematic examination of the TWRS facilities and operations described in Chapter 2.0, using standard industry (American Institute of Chemical Engineers) hazard evaluation techniques. The TWRS hazard evaluation was performed by a team of cognizant TWRS Operations and Engineering personnel, safety analysts familiar with TWRS, and technical experts in specialty areas.

The hazard evaluations are based on the hazard identification results and the TWRS facility design, operation, test, and maintenance activities. Hazard evaluations representative of all TWRS facilities were performed. The representative hazard evaluations were chosen based on selection criteria designed to ensure comprehensive coverage of TWRS facilities and their design and operation variations. Those variations for which specific hazard evaluations were performed include the following:

- Major or unique MAR inventory

- Major phenomenology (e.g., high heat, flammable gas, organics, radiolysis)

- Major configuration variations (e.g., interface with evaporator, active ventilation, passive ventilation, DSTs, SSTs)

- Routine TWRS operations (e.g., waste transfers, in-tank activities, waste sampling)

- Unique facilities (e.g., 204-AR Waste Unloading Facility, 2727-W Sodium Storage).

- Unique operations (e.g., Tank 241-C-106 WRSS as evaluated in Addendum 1).

Waste storage and transfer operations within TWRS were analyzed by evaluating the systems used for these operations including the RCSTS (Addendum 2). Routine operations and maintenance activities were analyzed at specific tanks to provide a context for the identification of potential hazardous conditions related to expected activities. The following three tanks were examined:

- 241-AZ-102: Actively ventilated DST in 200 East Area
- 241-BX-109: Passively ventilated SST in 200 East Area
- 241-SY-101: Actively ventilated DST in 200 West Area.

Routine operations and maintenance activities addressed include the following:

- Acoustic sensors (installation, operation, and removal)
- Air lance (installation, operation, and removal)
- Airlift circulators (installation, operation, and removal)
- Ammonia gas sampling (bubbler, draeger tube, or stack)
- Auger sampling (installation, operation, and removal)
- Cathodic protection (installation and operation)
- Core sampling (installation, operation, and removal)
- Drywell scanning
- Gas sampling (in tank or in ventilation system)
- Groundwater monitoring
- High-efficiency particulate air (HEPA) filter change out
- Infrared scanning (installation, operation, and removal)
- Lighting upgrade
- Liquid level monitoring (installation, operation, and removal)
- Liquid observation well (installation, operation, and removal)
- Liquid sampling
- Manual tape removal
- Photography (still, video - in tank)
- Pressure test transfer lines
- Salt well screen (installation, operation, and removal)
- Sample handling
- Sludge sampling
- Slurry distributor (installation, operation, and removal)
- Specific gravity probe monitoring (installation, operation, and removal)
- Stabilization (installation, operation, and removal of salt well pumps)
- Thermocouple or multiple instrument tree (installation, operation, and removal)
- Utility additions and upgrades
- Water lancing or hydraulic jetting.

These operations were analyzed by separating them into common subtasks and performing a hazard evaluation of each subtask at the applicable tank. The subtasks analyzed and their hazard analysis identifiers are as follows:

- BND—Bonding
- CVR—Cover Block Installation and Removal
- CRN—Crane Operations
- DCN—Decontamination Activities
- GRN—Greenhouse or Confinement Construction and Removal
- ITK—In-Tank Equipment Installation, Operation, and Removal
- RAD—Radiological Monitoring and Surveys
- RSR—Riser Access (and possible asbestos removal)
- SFF—Sniffing (gas monitoring)
- VEH—Vehicle Operations.

The representative hazard evaluations and the technique used for the respective analyses are listed in Table 3.3.1.3-1. The hazard evaluation technique applied depended on the nature of the TWRS facility or operation being analyzed. The following hazard evaluation techniques were used:

- **HazOp**—systems, equipment, and processes

- **PHA**—facility operations and situations that are primarily operations driven

- **What-if Analysis**—external events, natural phenomena, and potential common-cause failures.

HazOp—The HazOp study was developed to identify and evaluate safety hazards in systems, equipment, and processes and to identify operability problems which, although not hazardous, could compromise the productivity goals the plant was designed to achieve. Although originally developed to anticipate hazards and operability problems for technology with which organizations have little experience, the HazOp study has been found to be very effective for use with existing operations. However, completion of a HazOp study is time consuming and, depending on the complexity of the failure being investigated, can require considerable resources (e.g., personnel, information, software). Use of the HazOp study requires a detailed source of information concerning the design and operation of a process.

In a HazOp study, an interdisciplinary team uses a creative, systematic approach to identify hazard and operability problems that could lead to undesirable consequences. Because these problems usually are caused by deviations from the process design, an experienced team leader systematically guides the team through the plant design. A fixed set of words (called "guide words") is applied at specific points or "study nodes" in the plant design and is combined with specific process parameters to identify potential deviations from the intended operation. Process

parameters that may be examined include flow, temperature, pressure, viscosity, composition, phase, level, addition, reaction, maintenance, testing, instrumentation, and sampling. Guide words (and their meanings) include the following:

- **No/none**—negation of design intent
- **More**—quantitative increase
- **Less**—quantitative decrease
- **As well as**—qualitative increase
- **Part of**—qualitative decrease
- **Reverse**—logical opposite of intent
- **Other than**—complete substitution.

AIChE (1992), *Guidelines for Hazard Evaluation Procedures*, gives a more detailed description of this technique.

PHA—The PHA technique is derived from the MIL-STD-882E, *U.S. Military Standard System Safety Program Requirements*. This technique is used to analyze facility operations and situations that are primarily operations driven. A PHA focuses in a general way on the hazardous materials and major process areas of a plant. The PHA technique normally is used in the preliminary phase of plant development for cases where experience provides little or no insight into potential safety problems. The technique may also be helpful when analyzing large, existing facilities or prioritizing hazards when circumstances prevent a more extensive technique from being used. A PHA can be performed by one or two people who have a process safety background.

A list of hazards and generic hazardous situations is examined to determine if any apply to the facility being analyzed using the following process characteristics:

- Raw materials
- Intermediate and final products (and their reactivity)
- Plant equipment
- Facility layout
- Operating environment
- Operational activities (e.g., testing, maintenance)
- Interfaces among system components
- Energy sources.

A PHA yields a qualitative description of the hazards related to a process design. A PHA also provides a qualitative ranking of hazardous situations that can be used to prioritize recommendations for reducing or eliminating hazards in subsequent phases of the life cycle of the process.

Using the PHA technique requires that analysts have access to available plant design criteria, equipment specifications, material specifications, and other sources of information. AIChE (1992) gives a detailed description of this technique.

What-if Analysis—The What-if analysis is used to analyze external events, natural phenomena, and potential common-cause failures. The What-if analysis is a brainstorming approach in which a group of experienced people familiar with the subject process ask questions or voice concerns about possible undesired events. The What-if analysis is not as inherently structured as other techniques (e.g., HazOp analysis). Instead, it requires the analyst to adapt the basic concept to the specific application.

Because What-if analysis is so flexible, it can be performed at any stage of the process, using whatever process information and knowledge are available. For each area of the process, two or three people may be assigned to perform the analysis; however, a larger team may be preferred. It is better to use a large group for a complex process, dividing the process into smaller pieces, than to use a small group on the whole process.

The What-if analysis encourages the hazard analysis team to think of questions that begin with "what if." However, any process safety concern can be voiced, even if the concern is not phrased as a question. Usually a scribe records all the questions on a chart pad, marking board, or word processor. Then the questions are divided into specific areas of investigation (usually related to consequences of interest) such as electrical safety, fire protection, or personnel safety. Each area is subsequently addressed by a team of knowledgeable people. The questions are formulated based on experience and applied to existing drawings and process descriptions. For an operating plant, the investigation may include interviews with plant staff not represented on the hazard analysis team. AIChE (1992) gives a more detailed description of this technique.

For each technique used, the hazard evaluation is summarized in the hazard analysis database and includes the following information:

- Hazardous condition
- Cause
- Consequences
- Frequency category
- Safety consequence category
- General remarks.

Potential hazardous conditions (excluding those identified as common industrial hazards) are developed based on the hazards identified and the application of the hazard evaluation methods described above. The description of each hazardous condition includes release of material from a location as the result of an event.

The hazard evaluation tables contain descriptions of causes for hazardous conditions. The identification of causes was based on the hazard identification results, reviews of the systems, historical event data, and other sources of information (existing safety documentation) including discussions with experienced facility personnel. The causes of hazardous conditions include internal events, external events, and natural phenomena events. Single and multiple failures (equipment and human errors) are considered as well as common-cause failures. Both human errors of commission and omission (i.e., human reliability) are identified as potential causes or

contributors to hazardous conditions. The potential causes of a postulated hazardous condition are identified to support a qualitative frequency evaluation.

Each hazardous condition was assessed to determine a qualitative frequency of occurrence and consequence in accordance with Tables 3.3.1.3-2 and 3.3.1.3-3, respectively. The assessment of likelihood and consequence for each hazardous condition is a collective qualitative judgment of the hazard analysis team. The assessment is made for the initial hazard analysis with the impact of existing controls taken into consideration. Subsequent likelihood and consequence assessments are made without considering controls and with considering controls (safety SSCs and TSRs). Because controls were already selected, likelihood assessments considering controls were not done for the hazardous conditions identified in Addenda 1, 2, 3, and 4. These assessments are input to the hazard analysis database. The likelihood assessments are made in occurrences per tank farm year.

The general criteria used for likelihood assessments are as follows:

- **F3**—The hazardous condition based on the cause(s) postulated has occurred or is likely to occur
- **F2**—The hazardous condition based on the cause(s) postulated is foreseeable, but unlikely
- **F1**—The hazardous condition based on the cause(s) postulated is perhaps possible, but extremely unlikely
- **F0**—The hazardous condition based on the cause(s) postulated is considered too improbable to warrant further consideration.

Frequency assessments for hazardous conditions that are close to the upper limit of a category are conservatively assigned to the higher likelihood category.

The consequence category assessments address potential impacts on health and safety and the environment. The following criteria are used to assign hazardous conditions to the consequence categories listed in Table 3.3.1.3-3. The general criteria for consequence assessments are as follows:

- **S3**—Based on the MAR and cause(s) postulated, there is sufficient material and release energy to impact a receptor at the Hanford Site boundary
- **S2**—Based on the MAR and cause(s) postulated, there is sufficient material and energy to impact a receptor 100 m (328 ft) from the source of the MAR
- **S1**—Based on the MAR and cause(s) postulated, the release is confined to the facility where it occurred

- **S0**—Based on the MAR and cause(s) postulated, there is insufficient material released to affect facility workers

- **E3**—All S3 hazardous conditions or major leaks from large storage tanks

- **E2**—All S2 hazardous conditions or liquid releases or leaks outside facility boundaries

- **E1**—Postulated releases not included in E3 or E2

- **E0**—No release postulated.

The more severe consequence categories encompass the less severe consequence categories. For example, a hazardous condition assessed as having onsite consequences (i.e., S2) is also considered to have facility worker consequences (i.e., S1).

The hazard analyses identified preventive features (existing controls) that have the potential to prevent and therefore reduce the estimated frequency of a postulated hazardous condition. Design and administrative controls (e.g., procedures, policies, and programs) are included as preventive features. Preventive controls were identified primarily by reviewing selected facility procedures and process description documentation and by consulting experienced facility personnel.

The hazard analyses also identified mitigative features (existing controls) that have the potential to mitigate the consequences of a postulated hazardous condition. Design and administrative controls (e.g., procedures, policies, and programs) are included as mitigative features. Mitigative controls were identified primarily by reviewing selected facility procedures and process description documentation and by consulting experienced facility personnel.

The hazard evaluations are documented in individual reports that identify the participants and hazard evaluation scope, MAR, major assumptions, references, and the information in the HazOp, PHA, and What-if forms (WHC-SD-WM-TI-759, *Hazard Evaluations for the Tank Waste Remediation System Final Safety Analysis Report*).

Supplemental hazard evaluations for projects not within the original scope of the FSAR are included in the designated addenda, as applicable. Hazards evaluations for the WRSS are contained in Addendum 1. Hazard evaluations for the replacement cross-site transfer system are contained in Addendum 2. Hazard evaluations for the 241-AZ-702 ventilation system are contained in Addendum 3. Hazard evaluations for the 241-AZ-101 mixer pump test are contained in Addendum 4. Supplemental hazard analysis for remediation activities and operations in Tank 241-SY-101 are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

The historical hazards evaluations for the Light Duty Utility Arm, the Cone Penetrometer, and the 242-A Package Boilers are documented in HNF-SD-WM-HIE-010, *Hazard Identification and Evaluation for Deploying the Light Duty Utility Arm in Flammable Gas Facility Group 3 Tanks*; HNF-2174, *Hazard Evaluation for Deploying the Extended Reach End Effector on the Light Utility Duty Arm in Flammable Gas Facility Group 3 Tanks*; HNF-SD-WM-HIE-012, *Hazard Identification and Evaluation for Deploying the Cone Penetrometer in the Tank Farm for Vadose Zone Characterization*; and HNF-1727, *Hazard Evaluation of the 242-A Package Boiler System Impact on Tank Farms*. The data presented in these documents has been revised to be consistent with the format and assumptions used in the FSAR and has been integrated into the Hazards Analysis Database.

3.3.1.4 Candidate Accident Selection. The hazardous conditions identified by the hazard evaluation are used to select candidate accidents for more detailed quantitative analysis. The general selection criteria used are consistent with guidance in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports:* "The range of accident scenarios analyzed in a safety analysis report should be such that a complete set of bounding conditions to define the envelope of accident conditions to which the operation could be subjected are evaluated and documented." Information generated by the accident selection process is included in the Hazard Analysis Database. The database structure is documented in HNF-SD-WM-TI-764, *Hazard Analysis Database Report.*

The hazard evaluation identifies a set of hazardous conditions that can result in the uncontrolled release of radioactive/hazardous material from TWRS facilities. Because of the way in which the cases for hazard evaluation were selected, this set of hazardous conditions addresses all the facilities within the scope of the FSAR and includes all significant variations of MAR and release causes.

The objective of the accident selection process is to identify a subset of these hazardous conditions, which bounds the consequences and represents the various release situations for characterizing the level of safety of TWRS, and to provide a quantitative basis for the identification of controls (e.g., safety SSCs and TSRs). The list of bounding, representative, hazardous conditions becomes the list of candidate accidents. As a check of the selection process, each hazardous condition is binned under a candidate accident. If hazardous conditions remain that cannot be represented by existing candidate accidents, additional candidate accidents are identified.

To aid the selection process, each hazardous condition is classified according to the nature of the uncontrolled release (e.g., release attributes) and the cause of the release. This supports the selection process by identifying classes of hazardous conditions from which candidate accidents can be selected. Also considered in the selection process is identification of conditions with bounding consequences and high risk. The list of candidate accidents represents the spectrum of consequences and accident types (e.g., release attributes and causes) identified by the hazard evaluations.

The accident selection process is iterative, with insight from the accident analysis and control decision process used to refine the list of accidents actually analyzed and to identify the hazardous conditions represented by each accident. The hazard analysis results reflect this iteration by providing the list of accidents analyzed (representative accidents) and binning the hazardous conditions by representative accident.

Candidate accidents are selected based on the following criteria: (1) accidents that bound those of lesser, but similar potential consequences, (2) accidents that represent the highest risk, and (3) other accidents, while not necessarily bounding, that represent accidents presenting some unique but important phenomenological challenge to system safety. The selection process comprises six steps:

1. Initial screening
2. Assignment of accident release attributes
3. Creation of hazardous material release bins
4. Sorting of the hazardous conditions by cause group
5. Selection of representative bounding accidents for each release attribute category
6. Selection of unique accidents.

In accordance with DOE-STD-3009-94 and consistent with the graded approach, the risks of a facility/activity may be characterized and appropriate controls developed based on the detailed analysis of a representative set of accidents.

3.3.1.4.1 Initial Screening. All hazardous conditions not assessed as S3 (offsite consequences) or S2 (onsite consequences) are dropped from the selection process. These hazardous conditions will be addressed on the basis of the qualitative hazard analysis results only.

3.3.1.4.2 Assignment of Accident Release Attributes. Each hazardous condition (i.e., accident) is described with certain accident release attributes (Table 3.3.1.4-1) related to uncontrolled release of the MAR. The attributes are described to ensure that at least one candidate accident representing the possible spectrum of release conditions is selected. The hazardous material release attributes used are as follows:

- Initial energy available to release the hazardous material
- Initial release location
- Initial form of the release.

Initial conditions are used for the attribute assignments because it is possible (and sometimes likely) that other conditions may evolve during the course of the accident progression. For example, a release may begin as a pool of liquid on the ground but become airborne as wind blows over the pool. The progression of the accident is more thoroughly examined in the detailed accident analysis.

The attributes related to energy level have three designations: high, moderate, and low (Table 3.3.1.4-1). A high energy level, designation "A," is assigned to energetic events such as explosions, fires, and criticality. A moderate energy level, designation "B," is assigned to events such as liquid spray from pressurized lines and dropping hardware into a material that disturbs it or causes it to splash or become airborne. A ventilation system that is breached when the fans are running may be assigned to a moderate energy classification. A low energy level, designation "C," includes events such as leaks from nonpressurized liquid containers and leaks from passive ventilation systems.

The attributes related to the initial release location have three designations: atmospheric, ground surface, and subsurface (Table 3.3.1.4-1). In some cases, the accident may result in release to more than one destination. An accident resulting in significant portions of materials being released to more than one destination is assigned one location attribute associated with the most severe consequence. If it is clear that the overall accident significance is related to one location and that only minor effects are possible from the others, then only one location attribute is assigned.

Three attributes are related to the initial form of the release: vapor/gas/aerosol, liquid/slurry, and solid/sludge (Table 3.3.1.4-1). Again, the accident may result in release of more than one form of material and thus be assigned the attribute associated with most severe consequence. If it is clear that the overall accident significance is related to one form and only minor effects are possible from the others, then one form attribute is assigned.

3.3.1.4.3 Creation of Accident Release Categories. Once the release attributes are assigned to each hazardous condition (accident), they are collected to form accident release categories or "bins." Collecting accidents into bins involves grouping all accidents with common release attributes. For example, a certain accident may be assigned a high energy level for material that is released to the atmosphere in the form of a vapor; the accident attributes would therefore be high/atmosphere/vapor. If bins are labeled using combinations of designators for the attributes shown in Table 3.3.1.4-1, then the designation for the example would be "A-1-a." All accidents with designator "A-1-a" are grouped together.

3.3.1.4.4 Sorting of Hazardous Conditions by Cause Group. The hazardous conditions in each accident release category are next organized by cause group. This includes grouping by common accident phenomena (e.g., fire, criticality). The codes used to group the accidents (hazardous conditions) by cause are listed in Table 3.3.1.4-2. For example, hazardous conditions involving a dome collapse and the dropping of a load are coded with "C1O." Those resulting in dome collapse caused by structural degradation "B12." All these hazardous conditions are grouped in the same release attribute bin. Examination of the various causes supports selection of a representative set of accidents from each release attribute group.

3.3.1.4.5 Selection of Representative Bounding Accidents from Each Release Bin. Within each release attribute bin (1) the most severe accident in terms of consequence and (2) the highest risk accident considering likelihood and consequences are selected. In some cases, the most severe and highest risk accidents are the same accident.

3.3.1.4.6 Selection of Unique Accidents. Accidents are selected to represent additional unique causes and MAR within each release attribute bin. These unique causes are selected to support the development of controls for accidents with similar consequences but different causes and to assure all potential consequences are addressed. Unique accidents are selected from the set of highest risk accidents with unique causes or MAR.

Adjustments are made to the list of candidate accidents based on results from accident analysis activities. A table is developed to identify the candidate accidents and the accidents analyzed to accommodate this anticipated situation. The reasons for any differences among the list of candidate accidents and the accidents analyzed are explained, and the hazardous conditions are regrouped based on the set of analyzed accidents.

The final list of analyzed accidents represents all the S3 (offsite) and S2 (onsite) hazardous conditions identified by the hazard analysis. These hazardous conditions are grouped by accident to facilitate incorporation of the information and conclusions from the accident analysis into the hazard analysis results when considering controls and hazard classification.

3.3.1.5 Controls Identification. The hazard analysis results, together with the accident analysis results, are used to identify Safety-Class and Safety-Significant SSCs, TSRs, and other controls required to protect the public, workers, and the environment. The process of control identification is illustrated in Figure 3.3.1.5-1. Controls for protection of the public and onsite workers (100 m [328 ft]) are selected on the basis of the results of both the hazard analysis and the accident analysis. Controls for protection of facility workers and the environment are based primarily on the qualitative hazard analysis results.

The principal bases used for identifying safety SSCs and TSRs are risk guidelines. The objective is to identify the necessary and sufficient safety SSCs and TSRs that result in satisfying the risk guidelines and providing Defense-in-Depth. The risk guidelines for the offsite public and onsite workers are given in Table 3.3.1.5-1. For facility workers, Safety-Significant SSCs and TSRs may be required for hazardous conditions with significant facility worker consequences (S1) and with an uncontrolled frequency of anticipated (F3). Table 3.3.1.5-2 is a risk matrix that illustrates the application of the risk guidelines for all the hazardous conditions. The risk matrix indicates what type of control decision is made for each hazardous condition based on the qualitative hazard evaluation results.

The relationship between the quantitative risk guidelines and the qualitative risk matrix is determined by the frequency/consequence results of the accident analysis. For example, if the most severe consequence result for a hazardous condition (accident) exceeds the dose limit for the onsite worker, that hazardous condition is considered to have an S2 consequence with the corresponding frequency. This combination of frequency/consequence determines the risk index of a hazardous condition based on Table 3.3.1.5-2. If a hazardous condition has a frequency of F2 and a consequence of S2, it has a risk index of 12. For those hazardous conditions not directly analyzed as accidents, the risk index is determined by the qualitative frequency and consequence results of the hazard evaluations as refined by the information from the accident analysis.

Decisions on classifying SSCs as Safety-Class and Safety-Significant, selecting required TSR controls, identifying Defense-in-Depth controls, and identifying additional controls specifically for environmental protection were developed with a disciplined methodology and process using established control decision criteria. Applying this control decision methodology and process, controls were derived on the basis of control decision criteria, the best available information, and the collective expertise and experience of the participating hazard and accident analysts, engineering, operations, and management personnel.

The control decision criteria are based on the following documents:

- DOE 5480.22, *Technical Safety Requirements*, Change 2 (1996)
- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (1994)
- WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual,* Section 6, "Technical Safety Requirements," Rev. 1 (1989), and Section 9, "Safety Classification of Structures, Systems, and Components," Rev. 2 (1992).

Appendix B of Section 6 and Table 1 of Section 9 of WHC-CM-4-46 contain the fundamental control decision criteria followed in selecting TSRs and classifying safety SSCs, respectively. One modification was made to these criteria. Instead of using the referenced risk guidelines in WHC-CM-4-46 (Section 7, "Risk," Rev. 4), more conservative risk guidelines prescribed by DOE were used (Table 3.3.1.5-1). Additionally, the U.S. Department of Energy, Richland Operations Office (RL), has directed that TSR controls be developed and implemented for the toxicological hazards (Wagoner 1996). For accidents where the toxicological consequences are of primary concern, TSR controls are developed consistent with criteria used to develop radiological controls. Controls designated to prevent or mitigate radiological consequences that exceed both the radiological and toxicological risk guidelines are evaluated to ensure that the controls also protect against toxicological hazards. If the radiological controls are determined to be adequate, separate TSR controls for toxicological hazards are not developed; however, the TSR bases are expanded to include toxicological hazards. A principal criterion used in determining the necessary and sufficient controls required to protect the public and onsite workers was the comparison of postulated accident frequency and consequences with the risk guidelines. Additional discussion of the use of the risk guidelines is provided in Sections 3.4.1 and 3.4.2.

Additional criteria that guided control decisions were the following:

- Controls are limited primarily to existing SSCs. Exceptions were made if the control could be implemented rapidly and no reasonable alternative existed.[1]

- Control preferences are as follows:

    1. Controls that prevent the accident versus those that mitigate its consequences
    2. Passive engineered versus active engineered controls
    3. Engineered controls versus administrative controls.

- Controls providing significant Defense-in-Depth are classified as safety SSCs or are elevated to a TSR control.

- TSR controls are not developed for postulated accidents resulting in only environmental consequences.[2]

- SSCs are <u>not</u> classified Safety-Class or Safety-Significant solely for preventing or mitigating postulated accidents resulting in environmental consequences.

Other criteria that were important considerations in control decisions are listed below:

- Control reliability, availability, and maintainability

- Control effects on facility workers (i.e., increased radiation doses or toxicological exposures—As Low As Reasonably Achievable issues)

- Control optimization and integration

- Control cost/benefit

- Control human factors impacts

- Control impacts on TWRS mission.

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[1]Although control decisions were primarily limited to existing SSCs, the control decision process did identify new SSCs or significant modifications to existing SSCs as possible alternative or additional controls. New safety SSCs that may further reduce the risk of a postulated accident, especially accidents that exceed the risk evaluation guidelines with existing controls, are candidates for cost-benefit analysis and future implementation.

[2]For accidents with significant environmental consequences where controls are required beyond those identified for the protection of the safety of the public, onsite workers, and facility workers, additional controls specifically for environmental protection are identified (Section 3.3.2.3.4). These specific environmental controls are implemented through TWRS programs and procedures and are enforced through existing environmental regulations, permits, and agreements.

The assessment of alternative controls with respect to the above criteria was based on the knowledge and experience of cognizant operations, engineering, safety analysis, and management personnel. For example, when evaluating alternative controls to prevent or mitigate a postulated accident, the reliability, availability, and maintainability of potential safety SSCs were assessed qualitatively based on discussions with TWRS operating and engineering personnel.

Systems with known high failure rates, low availability, or maintainability problems were either not selected or multiple controls were selected. The estimated reliability of a safety SSC, along with the postulated accident frequency and consequences, provided a qualitative estimate of risk that was considered in assessing the sufficiency of a safety SSC. Where judged necessary, additional controls were identified. Human reliability was similarly considered, with an assumed error rate of 1×10^{-2} per event. Where experience showed that a single potential control was not sufficiently reliable, it was either not selected or multiple controls were selected. In a limited number of cases, a human factors task analysis was performed and quantified (e.g., assessment of operator response time to shut down a waste transfer pump following receipt of an alarm).

Because control decisions depend on the postulated accident consequence analyses, the conservatism of the accident analyses also influenced control decisions. As required by DOE 5480.22 and Section 6 of WHC-CM-4-46, key initial conditions in the accident analysis that are under the control of an operator are identified and protected by TSR controls.

The control decisions were generally qualitative, except for the comparison of calculated accident analysis results with the risk guidelines. Control decisions were documented in accordance with the procedure for selecting controls (Dunford 1996). The application of safety SSC and TSR controls to all hazardous conditions identified for TWRS facilities and operations is presented in the following sections.

As shown in Figure 3.3.1.5-1, the safety SSCs, TSRs, and other controls are identified in a four-step process. First, for each postulated accident selected for quantitative analysis, a necessary and sufficient set of controls is identified. Second, using the hazard topography, a determination is made whether the selected controls acceptably prevent or mitigate the postulated accident at all TWRS facilities where the accident could occur. If necessary, controls are identified for other TWRS facilities and operations. Third, each hazardous condition represented by the analyzed accident is reviewed to determine if the selected controls acceptably prevent or mitigate the represented hazardous condition. Again, if necessary, additional or different controls are identified for the represented hazardous condition. Fourth, the total set of controls chosen to protect the public and onsite worker is reviewed to determine whether any significant facility worker hazards remain uncontrolled. Additional controls are identified for worker protection if necessary.

Controls for environmental protection are determined also on the basis of safety SSCs, TSR controls, other controls providing Defense-in-Depth, and other TWRS information. First, the controls identified for the protection of the public, onsite worker, and facility worker are examined to determine hazardous conditions for which the environment is also protected. Results of the controls examination are incorporated in the hazard analysis. Secondly, the existing TWRS

programs and activities that address the hazardous conditions with severe environmental (i.e., E3 or E2) consequences are identified and included in the TWRS FSAR.

The decisions on safety SSCs, TSR controls, and other controls providing Defense-in-Depth are documented, incorporated into the hazard and accident analyses, and provided to support Chapters 4.0 and 5.0.

Other controls providing Defense-in-Depth for each accident were identified following the identification of safety SSCs and TSR controls. Controls identified as "Defense-in-Depth" were selected based on the following criteria:

- It is standard practice or the capability currently exists at TWRS
- It covers a substantial portion of the topography of facilities and represented hazardous conditions
- It has a perceptible impact on the assessment of the frequency and/or consequence of the accident or represented hazardous conditions
- It provides additional facility worker protection.

The decisions on these additional controls are reflected in the accident analysis discussions in Chapter 3.0. These additional controls are also incorporated in the results of the hazard analysis for all hazardous conditions with potential offsite, onsite and worker consequences (S3, S2, and S1), and severe environmental (E3 and E2) consequences.

3.3.1.6 Hazard Classification. A final hazard classification of TWRS facilities is based on the results of the hazard and accident analyses. Hazard classification is selected on the basis of the definitions of hazard categories in DOE 5480.23 and the methodology for hazard classification in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. As allowed by DOE-STD-1027-92, TWRS facilities that are independent (i.e., hazardous materials in one facility cannot interact with hazardous materials in another facility) are segmented, and their individual hazard classifications are determined.

3.3.1.7 Hazard Analysis Database. The hazard analysis database is developed and used to collect the results of the hazard analysis activities and to generate reports and evaluations to support the hazard and accident analyses. The database and data fields are described in HNF-SD-WM-TI-764. The results from the hazard analysis activities are input to the hazard analysis database. This database supports the activities of hazard identification, hazard topography, hazard evaluation, and safety SSC and TSR identification. As these activities proceed along with the accident analysis, additional information becomes available. This additional information results in refinements of the initial qualitative judgments made in the hazard analysis. These refinements are incorporated in the hazard analysis results by updating the hazard analysis database. The final hazard analysis results are reflected in the updated database.

During the development of the hazards analysis data set, the quality, integrity, and accuracy of the data were ensured by the FSAR development process. This process includes internal peer review, interorganizational review, and outside peer review of the reported data. Special field walkdowns documented in WHC-SD-WM-HIE-007 verify the facility configuration and hazards reported. Internal consistency within the database was verified periodically by the analysts performing the work.

The hazard analysis data, including hazard identification, hazard evaluation, and accident selection, is part of the TWRS Authorization Basis. These results will be subject to revision as a result of the Authorization Basis amendment process. Because the intent of the hazard analysis database is to make the current hazard analysis results available to potential users, the database will be kept current with the approved Authorization Basis, including approved amendments.

The minimum information to be maintained to support the TWRS Authorization Basis will include the results of the (1) hazard topography definition, (2) hazard identification, (3) hazard evaluation, (4) accident selection, and (5) control allocation.

TWRS Nuclear Safety and Licensing has ownership and responsibility for configuration management of the hazard analysis database. The configuration management requirements, responsibilities, and procedures are described in HNF-2353, *Nuclear Safety and Licensing Desk Instructions.*

The hazard analysis database contains the TWRS hazard topography and the hazard identification and evaluation results. This data is interrelated through use of the facility type code (Table 3.3.1.2-1). The contents of the hazard identification and hazard topography data tables are described in Sections 3.3.1.1 and 3.3.1.2, respectively. The hazard evaluation results are contained in the database as follows:

- **Identifier**—An identifier for each entry in the database that includes an indication of the facility or operation analyzed.

- **MAR**—A place keeper that indicates the location of the material inventory considered for release in each entry (Table 3.3.1.7-1). Specific inventory information for each facility or location is contained in the hazard topography. The hazard evaluations use the place keepers to allow the analysis to be developed on a representative basis. For example, the hazardous conditions postulated in the hazard evaluation that result in the uncontrolled release of material from tank ventilation systems use the MAR for these events as "contamination in ventilation system." The accident analysis uses a reasonably conservative quantified description of this MAR for the purpose of determining potential consequences.

- **Hazardous Condition**—A brief description of the uncontrolled release of material including the location of the release and the condition of release.

- **Cause**—A brief description of the cause of the uncontrolled release; generally an identification of the initiating event for the release.

- **Frequency**—The qualitative assessment of the frequency of the hazardous condition (Table 3.3.1.3-2). Two frequency estimates are included: frequency without controls and frequency with selected SSCs and TSR controls. These entries are subject to update based on accident analysis results.

- **Consequence**—The qualitative assessment of the consequence of the hazardous condition (Table 3.3.1.3-3). This entry is subject to update based on accident analysis results.

- **Risk**—The combination of frequency and consequence (Table 3.3.1.5-2). Two risk estimates are included: risk without controls and risk with selected SSCs and TSR controls. These entries are subject to update based on accident analysis results.

- **Selected Controls**—Selected SSCs and TSR controls that may be identified as preventive or mitigative features.

- **Release Attribute**—This code is from the accident selection process (Table 3.3.1.4-1) and is used to support candidate accident selection.

- **Cause Group**—This is the hazardous condition cause group code (Table 3.3.1.4-2) used to support candidate accident selection and selection of controls.

- **Facility Type**—This is TWRS facility type code (Table 3.3.1.2-1) used to relate the hazard evaluation results to each TWRS facility using the hazard topography.

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Figure 3.3.1-1. Flow Diagram of the Hazard Analysis Process.

Figure 3.3.1-1. Flow Diagram of the Hazard Analysis Process.

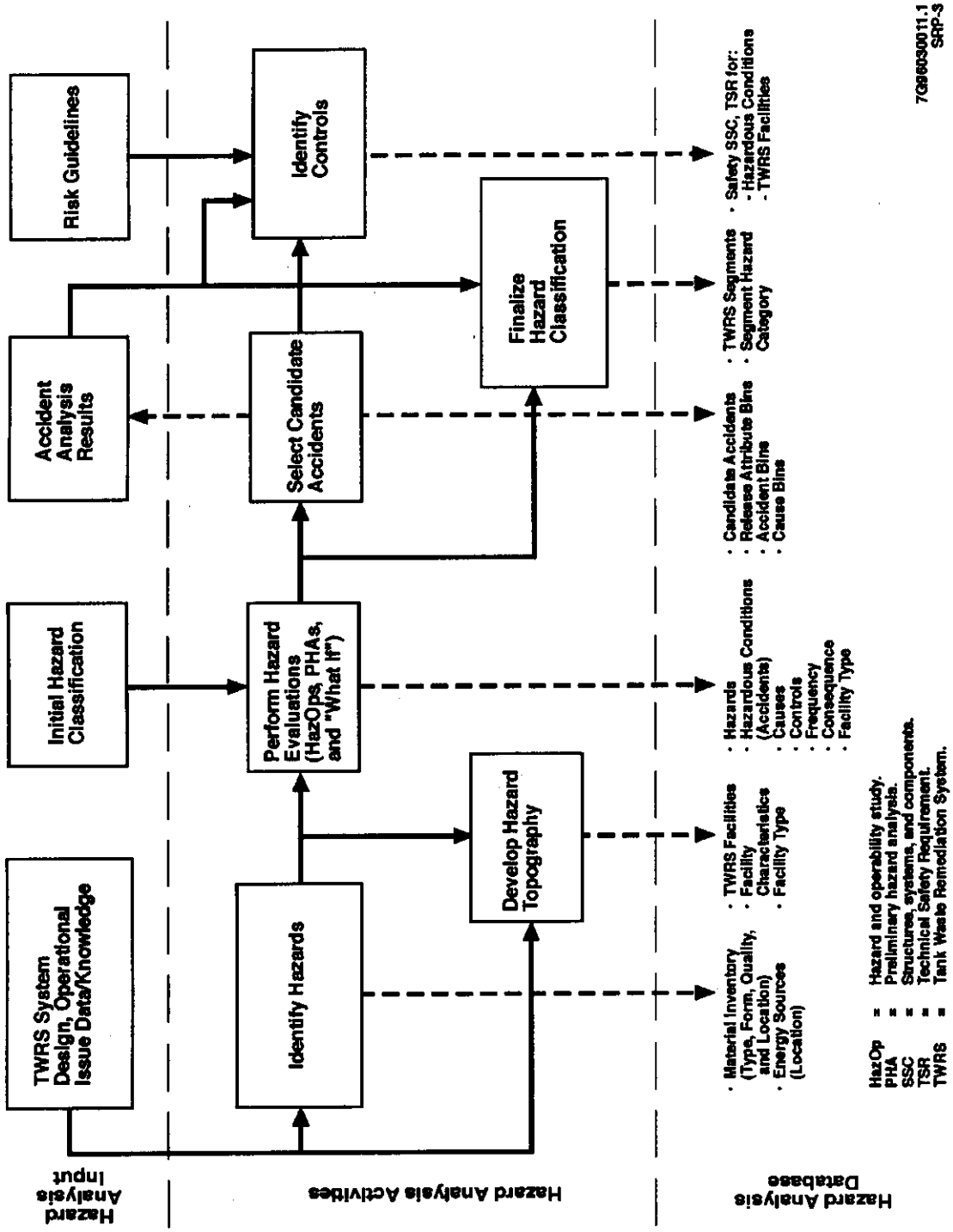

Figure 3.3.1.5-1. Process to Identify Controls.

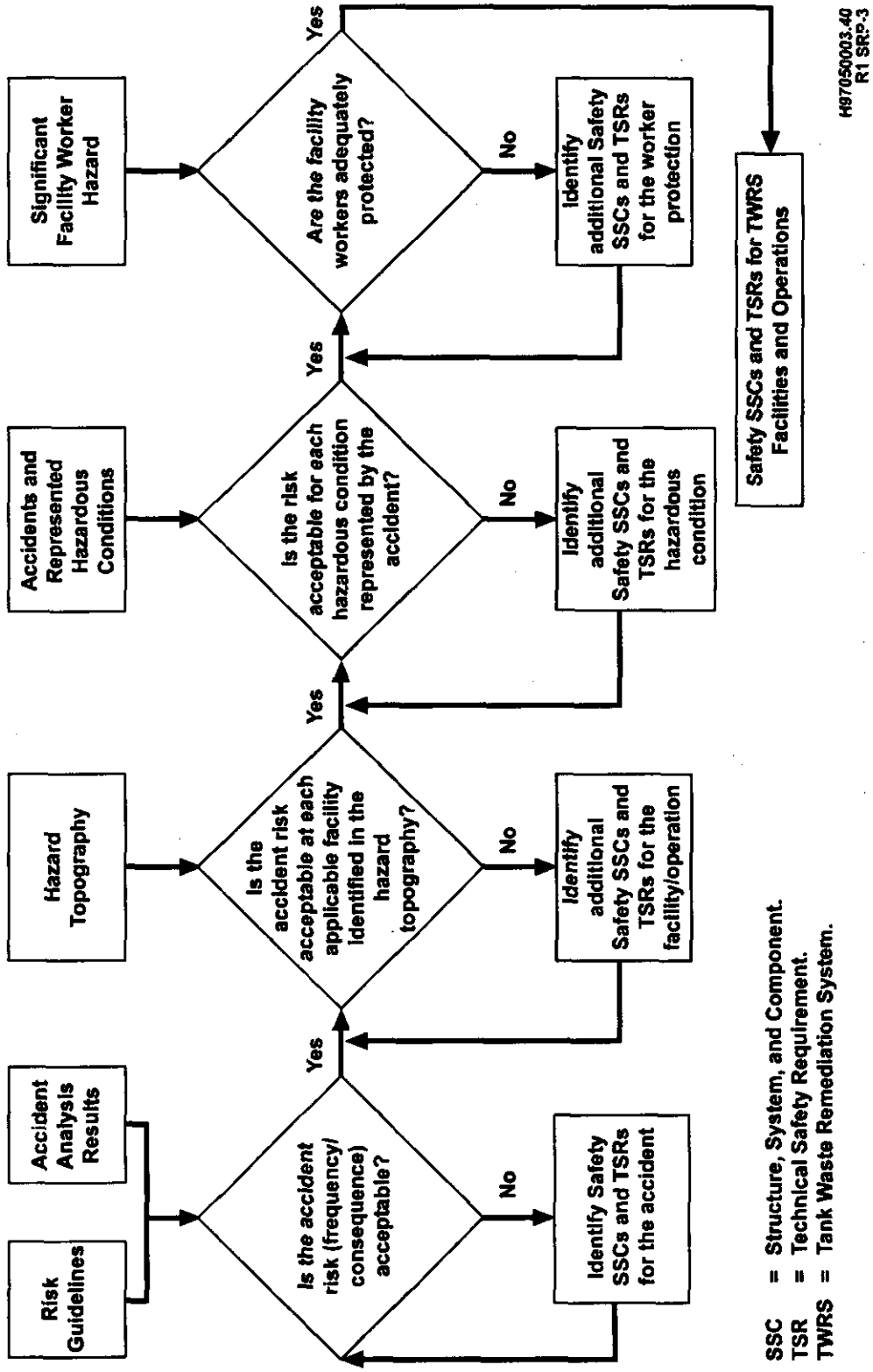

Table 3.3.1.1-1. Sample Hazards Identification Form.

Energy classification*	Tank A		Facility B		Facility C	
	PT	PE	PF	PE	PF	PE
Corrosive						
Explosive/pyrophoric						
Nuclear criticality						
Flammable materials						
Thermal radiation						
Chemical reactions						
Friction						
Electrical						
Kinetic-rotational						
Kinetic-linear						
Mass, gravity, height						
Pressure-volume						
Thermal (except radiant)						

SAMPLE

Note: The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

*See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

PT = potentially present in the tanks.

PF = potentially present in the facility.

PE = potentially present elsewhere in/adjacent to facility.

Table 3.3.1.1-2. Hazard Identification Checklist and Energy Designators.

A Corrosive	D Flammable materials	H Electrical	K Mass, gravity, height
1 Acids 2 Caustic 3 Natural chemicals 4 Decon solution 5 High temperature waste 6 Other	1 Packing materials 2 Rags 3 Gasoline 4 Lube oil 5 Coolant oil 6 Paint solvent 7 Diesel fuel 8 Buildings and contents 9 Trailers and contents 10 Grease 11 Hydrogen 12 Nitric acid 13 Organics 14 Gases-other 15 Liquids-other 16 Sodium 17 Other	1 Battery banks 2 Diesel units 3 Transformers 4 Wiring 5 Switchgear 6 Underground wiring 7 Cable runs 8 Service outlets/fittings 9 Pumps 10 Motors 11 Heaters 12 Power tools 13 Small equipment 14 Electrical equipment 15 Hot plates 16 High voltage 17 Locomotive, electrical 18 Transmission lines 19 Other	1 Human effort 2 Stairs 3 Lifts and cranes 4 Bucket and ladder 5 Trucks 6 Slings 7 Hoists 8 Elevators 9 Jacks 10 Scaffold and ladders 11 Pits 12 Elevated doors 13 Vessels 14 Vaults 15 Excavations 16 Raw water lines 17 Other
B Explosive/pyrophoric	**E Thermal radiation**	**I Kinetic-rotational**	**L Pressure-volume**
1 Caps 2 Primer cord 3 Dynamite 4 Scrub chemicals 5 Dusts 6 Hydrogen 7 Gases, other 8 Nitrates 9 Peroxides-superoxides 10 Pu and U metal 11 Other	1 Furnaces and boilers 2 Steam liners 3 Lab equipment 4 Solar 5 Other	1 Centrifuges 2 Motors 3 Pumps 4 Fans 5 Laundry equipment 6 Shop equipment 7 Other	1 Boilers 2 Surge tanks 3 Autoclave 4 Test Loops 5 Gas bottles 6 Pressure vessels 7 Stressed members 8 Gas receivers 9 Negative pressure collapse 10 Steam headers and lines 11 Positive pressure release 12 Other
C Nuclear criticality	**F Chemical reactions**	**J Kinetic-linear**	**M Thermal (except radiant)**
1 Vaults 2 Temporary storage areas 3 Shipping and receiving areas 4 Filters 5 Casks 6 Burial ground 7 Storage racks 8 Canals and basins 9 Decon solution 10 Trucks, forklifts, dollies 11 Hand carry 12 Cranes/lifts 13 Hot cells, assembly, inspection 14 Laboratories 15 Tanks 16 Other	1 Uncontrolled chemical reactions 2 Other **G Friction** 1 Belts 2 Bearings 3 Fans 4 Gears 5 Motors 6 Power tools 7 Other 8 All	1 Cars, trucks, buses 2 Forklifts, dollies, carts 3 Railroad 4 Obstructions 5 Crane loads 6 Pressure vessel blowdown 7 Other	1 Convective 2 Exposed components 3 Heaters 5 Fire boxes 6 Electric wiring, equipment 7 Furnaces 8 Steam lines 9 Welding torch 10 Other

Table 3.3.1.2-1. Tank Waste Remediation System Facility Type Codes.

Effluent retention	
ER	Cribs, ditches, ponds
Facilities	
F204	204-AR Waste Unloading Facility
F213	213-W Compactor Building
F244	244-AR Vault
Multiple	
M	Multiple facilities (e.g., as in the case of common cause event)
Other	
A	Abandoned or inactive TWRS equipment
G	General
O	Other (interfacing facilities/equipment)
OM	Miscellaneous inactive storage facility
Pipes	
PA	Aboveground pipe
PC	Contained pipe (e.g., cross-site line)
PD	Double-encased pipe
PS	Single-encased pipe (direct buried)
Storage Facilities	
S90	Less than 90-Day storage pad, intermediate holding area, satellite accumulation area
SS	2727-W Sodium Storage
SV	Vertical storage

Tanks* (see example section below)		
T	Tanks, nonspecific (add any appropriate tank type designators; if applicable to all tanks, do not add any tank type designator)	
CD	DCRT (244-TX, 244-U)	
CN	Non-DCRT catch tank, drainage type (vent and lift station, aging waste vent)	
DS	Double-shell tanks nonspecific (add any appropriate characteristic designators)	
	A	Air lift circulators (aging waste tanks)
	C	Caustic addition tank (e.g., Tank 241-AN-107)
	E	Evaporator feed tank
	H	Flammable gas tanks (hydrogen)
	O	Organic tanks
	P	Active transfer/mixer pumps (e.g., Tank 241-SY-102)
	V	Active ventilation
SS	Single-shell tanks nonspecific (add any appropriate characteristic designators)	
	D	Dry crust tank (Tank 241-SX-114)
	H	Flammable gas tanks (hydrogen)
	L	High heat load (7,600 W [26,000 Btu/h])
	O	Organic tanks
	V	Active ventilation tanks
SD	Double-shell tanks or single-shell tanks (add any appropriate characteristic designators, see DS and SS)	
Pits boxes and caissons		
WB	Clean out box, sluice transfer box	
WD	Diversion box, diverter station, pump pit, valve pit	
WF	Flush pit, service pit, caisson, leak detection pit	

*Example of facility type code for tanks: the letter T indicates that the facility is a tank of some kind. Each additional designator separated by periods will supply additional information as indicated in the column under the tank section of the table.

T.DS.A.H = Flammable gas (hydrogen), double-shell tank with air lift circulators.
T.SD.L.V = High heat load tank, either single-shell or double-shell with active ventilation.
T.SS.D = Dry crust, single-shell tank.
T.CD.V = DCRT with active ventilation.
DCRT = double-contained receiver tank.
TWRS = Tank Waste Remediation System.

Table 3.3.1.3-1. Representative Hazard Analysis. (2 sheets)

Facility/topic	Hazard evaluation identifier	Technique	Characteristics
Facility interfaces - 222-S Laboratory, 242-A Evaporator, 242-S Evaporator, 242-T Evaporator, B Plant, T Plant, U Plant, PUREX, PFP	I-222S, I-242A, I-242S, I-242T, I-BPLANT, I-TPLANT, I-UPLANT, I-PUREX, I-PFP	HazOp	Impacts on TWRS facilities of active physical interfaces
204-AR Waste Unloading Facility	204AR	HazOp	Lab waste, transfer of waste by vehicle
244-AR Vault	244AR	HazOp	Storage for liquid waste
Overground transfers	OGT	HazOp	SST waste transfer overground
Tank 241-C-106	106C	HazOp	SST, high heat, active ventilation
Tank 241-AN-107	107AN	HazOp	DST, caustic addition
Tank 241-AW-102	102AW	HazOp	DST, evaporator interface, active ventilation
Tank 241-S-102	102S	HazOp	SST, flammable gas, organics, passive ventilation
Tank 241-SX-114	114SX	HazOp	SST, dry crust, high heat, active ventilation
Cross-site transfer (Tank 241-SY-102) (selected portions of Project W-058)	XS, WO58, RCSTS	HazOp	DST, waste transfer by pipeline, replacement cross-site transfer system
Light Duty Utility Arm	LDUA	HazOp	Equipment for in-tank sampling
Tank 241-AZ-101 mixer pump test	W151	HazOp	Mixer pump operation
209-E Storage Area	90D	PHA	Storage for RCRA and low-level waste
213-W Compactor	213W	PHA	Equipment decontamination activities
244-AR Vault	244AR-PHA	PHA	Storage for liquid waste
2727-W Building	2727W	PHA	Liquid sodium storage
Cleanout boxes	COB	PHA	Interface with waste transfer system
Cribs, ditches, and ponds	CDP	PHA	Disposal of liquid waste
Inactive miscellaneous underground storage tank (plus other inactive facilities)	Identifier ends in -I, e.g., CRN-05-I	PHA	Various types and forms of radioactive and hazardous material
Siphoning	TSF	PHA	Various types and forms of radioactive and hazardous material
Tank operations (Tank 241-AZ-102)	BND, CVR, CRN, DCN, GRN, ITK, RAD, RSR, SFF, VEH	PHA	DST, aging waste
Tank operations (Tank 241-BX-109)	BND, CVR, CRN, DCN, GRN, ITK, RAD, RSR, SFF, VEH	PHA	SST, passive ventilation
Tank operations (Tank 241-SY-101)	BND, CVR, CRN, DCN, GRN, ITK, RAD, RSR, SFF, VEH	PHA	DST, flammable gas, active ventilation, mixer pump
Vertical storage units	VSU	PHA	Storage for solid low-level waste
Cone Penetrometer	CP	PHA	Exploration of vadose zone
Tank 241-C-106 sluicing	W320	PHA	Sluicing high heat waste
Tank farm 241-AZ ventilation upgrade	W030	PHA	Active ventilation operation and design
242-A Package Boiler	PB	PHA	Tank farm impacts from adjacent system
Common cause failure	CCF	What if	Events with potential impact on multiple TWRS facilities

Table 3.3.1.3-1. Representative Hazard Analysis. (2 sheets)

Facility/topic	Hazard evaluation identifier	Technique	Characteristics
External events	EE	What if	Events with potential impact on multiple TWRS facilities
Natural phenomena	NP	What if	Events with potential impact on multiple TWRS facilities

COB = cleanout box
DST = double-shell tank.
HazOp = hazard and operability study.
PFP = Plutonium Finishing Plant.
PHA = preliminary hazard analysis.
PUREX = Plutonium Uranium Extraction (Facility).
RCRA = Resource Conservation and Recovery Act of 1976
SST = single-shell tank.
TWRS = Tank Waste Remediation System.

Table 3.3.1.3-2. Likelihood Categories.

Category	Definition
F3 ($>10^{-2}$)	Anticipated events: frequency greater than once in 100 operating years
F2 ($>10^{-4}$ to $\leq 10^{-2}$)	Unlikely: frequency less than or equal to once in 100 years and greater than once in 10,000 operating years
F1 ($>10^{-6}$ to $\leq 10^{-4}$)	Extremely unlikely: frequency less than or equal to once in 10,000 years and greater than once in 1 million operating years
F0 ($\leq 10^{-6}$)	Beyond extremely unlikely: frequency of less than or equal to once in a million operating years

Table 3.3.1.3-3. Consequence Categories.

Category	Definition
S3	Significant radiological or chemical exposure to the public
S2	Significant radiological or chemical exposure to onsite worker
S1	Significant radiological or chemical exposure to facility worker
S0	No significant effect outside facility systems. No consequences for facility workers, onsite workers, or public
E3	Offsite discharge or discharge to groundwater
E2	Significant discharge onsite
E1	Localized discharge of hazardous material
E0	No significant environmental consequence

Table 3.3.1.4-1. Accident Release Attributes.

Accident release attributes		
Initial energy level	Initial release location	Initial release form
A. High	1. Atmosphere	a. Vapor/gas/aerosol
B. Moderate	2. Ground surface	b. Liquid/slurry
C. Low	3. Subsurface	c. Solid/sludge
OCC - Occupational Safety		
RP - Radiation Protection		
NR - No Release		
NA - Not applicable		

Table 3.3.1.4-2. Hazardous Condition Cause Group Codes. (2 sheets)

Cause group description	Criticality	Fire/ explosion	Tank dome collapse	Release	Human error release	Nonrelease/ occupational
Addition of aggravating materials/ exothermic reaction	A01	B01	C01	D01	E01	F01
Internal aggravating causes	A02			D02	E02	
Over concentration	A03				E03	F03
Intrusive activity	A04	B04		D04	E04	F04
Nonspecific/multiple external events or phenomena/other	A05		C05	D05	E05	F05
Error in transfer/backflow/ overflow/filling DST annulus	A06	B06	C06	D06	E06	F06
Ventilation failure		B07	C07	D07	E07	F07
Internal buildup of flammable gas/internal ignition source		B08				F08
External fire/external ignition source		B09		D09		F09
Excess weight/dropping/heavy snow			C10	D10	E10	F10
Vacuum			C11	D11		
Structural degradation/leak		B12	C12	D12		F12
Over-rated equipment			C13		E13	
Confinement failure				D14	E14	F14
Excess agitation					E15	
Corrosion				D16		
Water hammer				D17		
Seismic event/volcanic activity				D18		

Table 3.3.1.4-2. Hazardous Condition Cause Group Codes. (2 sheets)

Cause group description	Criticality	Fire/ explosion	Tank dome collapse	Release	Human error release	Nonrelease/ occupational
Flooding, pipe failure			C19	D19		
High winds/tornados/hail				D20		
Lightning		B21		D21		
Excavation				D22		F22
Aircraft crash		B23		D23		
Low temperature/freezing				D24		
Vehicle accidents		B25		D25	E25	F25
Structural damage		B26	C26	D26	E26	F26

DST = double-shell tank.

Table 3.3.1.5-1. Risk Guidelines.

Radiological risk guidelines			
Event frequency category	Event frequency (yr^{-1})	Effective dose equivalent Sv (rem)	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^{0}$	5.0 E-03 (5.0 E-01)	1.0 E-03 (1.0 E-01)
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	5.0 E-02 (5.0 E+00)	5.0 E-03 (5.0 E-01)
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	1.0 E-01 (1.0 E+01)	4.0 E-02 (4.0 E+00)
Toxic chemical risk guidelines			
Event frequency category	Event frequency (yr^{-1})	Primary concentration guidelines	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^{0}$	≤ ERPG-1	≤ PEL-TWA
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	≤ ERPG-2	≤ ERPG-1
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	≤ ERPG-3	≤ ERPG-2

Source: Bacon, R. F., 1996, *Tank Waste Remediation System Accident Analysis Risk Evaluation Guidelines* (letter 9651709 to J. E. Kinzer, U.S. Department of Energy, Richland Operations Office, April 22), Westinghouse Hanford Company, Richland, Washington.

ERPG = Emergency Response Planning Guideline.

PEL = permissible exposure limit.

TWA = time-weighted average.

Table 3.3.1.5-2. Risk Matrix.

Likelihood	Consequences			
	S0	S1	S2	S3
F3	7	11[a]	14[b]	16[b]
F2	4	8	12[a]	15[b]
F1	2	5	9[a]	13[a]
F0	1	3	6	10

[a]Considered for identification of safety structures, systems, and components and Technical Safety Requirements.

[b]Requires identification of safety structures, systems, and components and Technical Safety Requirements.

Table 3.3.1.7-1. General Material At Risk Categories.

Category	Location
Material at risk for contents	• Tank contents • Tank headspace • Rail or truck tanker contents • Ventilation filter contents • Contents of pipeline and source tank during transfer • Contents of sump or encasement
Material at risk for contamination	• Contamination in ventilation system • Contamination in pit of box • Contamination on vehicle • Contamination on equipment or tools

3.3.2 Hazard Analysis Results

The results of the hazard analysis activities, control decision process, and accident analysis for onsite consequences are summarized in this section. This includes results of the hazard identification and evaluation, accident selection, and control identification activities. Accidents with offsite consequences are described in Section 3.4.2. Details of the hazard analysis are provided in the following appendices:

- Appendix A, "Hazard Topography"

  Appendix A provides a concise compilation of data that is used to perform the hazard analysis of TWRS facilities and to make control decisions. It contains information on all the TWRS facilities within the scope of the FSAR. This data is used to assure that all the TWRS facilities are adequately assessed by the hazard analysis, either by explicit hazard evaluations for that facility or by implicit representation in a hazard evaluation of a similar facility, and to support the identification of controls for each facility by providing facility configuration information. The information in Appendix A is historical and has not been updated.

- Appendix B, "Summary of Occurrences"

  Appendix B identifies reported occurrences at TWRS. This information is used to assure that past events are appropriately considered in the hazard analysis and to support qualitative estimates of hazardous condition frequency. Consideration of actual events contributes to the comprehensiveness, utility, and credibility of the hazard analysis.

- Appendix C, "Representative Accidents"

  Appendix C contains the results of the accident selection process and identifies which of the hazardous conditions with S3 and S2 consequences are represented by the 29 representative accidents that are analyzed in the TWRS FSAR.

- Appendix D, "Hazard Evaluation Results"

  Appendix D organizes the results of the hazard evaluations (i.e., identified hazardous conditions) by consequence. This allows for rapid location of hazardous conditions within the same consequence category.

- Appendix E, "Control Allocation Tables"

  Appendix E describes how to generate tables showing how the various controls, including safety related SSCs, TSR controls, and additional Defense-in-Depth controls, apply to all the hazardous conditions identified by the hazard evaluations.

The allocation of controls to each hazardous condition assures comprehensive control identification and is part of the control identification process. This information shows how risk is being managed for the spectrum of hazardous conditions identified at TWRS.

Appendix E previously provided control allocation tables. These tables have been deleted and replaced with a summary statement indicating that the safety SSCs, TSR controls, and Defense-in-Depth controls are allocated for hazardous conditions in the hazards analysis database (Allen 1999). Information on how to query the hazards analysis database is also provided in Appendix E.

The individual hazard evaluations are documented in WHC-SD-WM-TI-759, *Hazard Evaluations for the Tank Waste Remediation System Final Safety Analysis Report*. The results of the hazard evaluations, as refined by the accident analyses and control decision process, have been captured in the hazard analysis database as described in HNF-SD-WM-TI-764, *Hazard Analysis Database Report.*

The hazard analysis process produced a set of hazardous conditions based on the evaluation of TWRS facilities, operations, and maintenance activities. The selection of representative accidents and identification of controls are based on this set of hazardous conditions and the information produced by the accident analysis. Therefore, in the FSAR, controls are directly associated with individual hazardous conditions. These controls can be related to specific activities analyzed in the FSAR by examining how the activities were addressed in WHC-SD-WM-TI-759 and using the information in Appendixes D and E. Table 3.3.2-1 illustrates how the hazard analysis results are related to accidents and controls for three TWRS activities and a few selected example hazardous conditions. The examples in Table 3.3.2-1 have been selected to illustrate the relationship to controls for hazardous conditions that have representative accidents and those that do not.

The hazard analysis of activities in the FSAR is done to identify the risk from uncontrolled releases of radioactive and/or toxic material. If any radiation protection or occupational safety hazardous conditions are discovered by the analysis, they are documented and passed to the appropriate program to be addressed. Additional analysis, such as the Job Hazard Analysis, are required for all work performed in the field. The results of the FSAR hazard analysis and others (e.g., Job Hazard Analysis) form a complete hazard analysis of activities addressing the Authorization Basis, radiation protection, and occupational safety aspects. Table 3.3.2-1 contains only data that was generated by the FSAR hazard analysis process.

3.3.2.1 Hazard Identification. The results of the hazard identification for the TWRS FSAR Hazard Analysis activity comprises five parts:

- Description of the MAR in the various TWRS facilities, Section 3.3.2.1.1
- Identification of energy sources including those that could potentially contribute to the uncontrolled release of MAR, Section 3.3.2.1.2

- Identification of hazards from natural phenomena, external events, and common cause hazards, Section 3.3.2.1.3

- Summary of TWRS occurrences in support of the hazard identification efforts, Section 3.3.2.1.4

- Description of hazards considered, but not included in the hazard evaluation, Section 3.3.2.1.5.

Results of these five hazard identification aspects are presented in the following sections.

The results of the hazards identification for WRSS are provided in Addendum 1. The results of the hazards identification for the RCSTS are provided in Addendum 2. The results of the hazards identification for the 241-AZ-702 ventilation system are provided in Addendum 3. The results of the hazards identification for the 241-AZ-101 mixer pump test are provided in Addendum 4. Supplemental hazard analysis for remediation activities and operations in Tank 241-SY-101 are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

The historical hazards evaluations for the Light Duty Utility Arm, the Cone Penetrometer, and the 242-A Package Boilers are documented in HNF-SD-WM-HIE-010, *Hazard Identification and Evaluation for Deploying the Light Duty Utility Arm in Flammable Gas Facility Group 3 Tanks*; HNF-2174, *Hazard Evaluation for Deploying the Extended Reach End Effector on the Light Utility Duty Arm in Flammable Gas Facility Group 3 Tanks*; HNF-SD-WM-HIE-012, *Hazard Identification and Evaluation for Deploying the Cone Penetrometer in the Tank Farm for Vadose Zone Characterization*; and HNF-1727, Hazard Evaluation of the 242-A Package Boiler System Impact on Tank Farms.

3.3.2.1.1 Material at Risk. The MAR is the material at a facility with the potential to have an adverse effect on people or the environment. To characterize the hazard associated with a particular MAR, the location, type, form, and quantity of the MAR is identified. Table 3.3.2.1.1-1 summarizes the MAR found to be present at the analyzed facilities; more detailed discussions of the MAR are included in the following facility-specific sections. The MAR is also identified for each analyzed facility in the hazard topography (see Appendix A), which was developed from information obtained during the hazard evaluation activities and the facility walkdowns. The facility walkdowns are documented in WHC-SD-WM-HIE-007, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report*.

Other materials present in TWRS were not covered by the hazard identification process. These items, which include small quantities of hazardous materials such as solvents used for cleaning, are controlled by standard practices (such as those covered by the U.S. Department of Transportation and the Occupational Safety and Health Administration) and are not considered to be a threat to personnel or the environment analyzed in the FSAR.

Double-Shell Tank Facilities. The DSTs at TWRS facilities are located throughout the 200 East and 200 West Areas and are grouped into six Tank Farms: 241-AN, 241-AP, 241-AW, 241-AY, 241-AZ (200 East Area) and 241-SY (200 West Area). There are twenty-four 4.54 million-L (1.2 million-gal) (nominal) nonaging waste DSTs in the 241-AN, 241-AP, 241-AW and 241-SY Tank Farms. There are four 3.8 million-L (1.0 million-gal) aging waste tanks in the 241-AY and 241-AZ Tank Farms.

The DST system is used for the interim storage of liquid mixed waste generated at the Hanford Site facilities. Several operating plants in the 200 East and 200 West Areas of the Hanford Site facility transfer liquid mixed waste through transfer lines to designated DSTs. Other types of liquid mixed waste are received in the DSTs from railcar transfers and tank truck transfers.

The MAR identified for the DST system were high-level radioactive waste, hazardous materials that could be evolved from the liquid radioactive waste (ammonia, NO_x, etc.), and nonradioactive toxic materials used in operation activities. In some cases, such as the interface transfer equipment between the DST ancillary equipment, the MAR was considered to be facility-specific material (i.e., Plutonium Finishing Plant [PFP] waste). For contaminated ancillary structures, such as diversion boxes, the MAR is considered to be the DST high-level radioactive waste, with quantities to be determined based on best estimates of residual material. The MAR inventory varies in type, form, and quantity from one tank to another. These variations are identified in the Appendix A; however, for the development of the accident analyses the MAR identified by the source term documents (WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*, and WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*) was used. This was done to identify a bounding consequence for each accident potentially affecting tank inventory.

The MAR is present throughout the DST system including the ancillary components outside of the tank boundary. Particulates and condensates are present in the ventilation systems, and residues can be found throughout the transfer lines and the ancillary systems including cleanout boxes (COBs) and the miscellaneous pits and boxes servicing the tank systems.

Single-Shell Tank Facilities. The SSTs at TWRS facilities are located in the 200 East and 200 West Areas of the Hanford Site and are grouped into 12 tank farms: 241-A, 241-AX, 241-B, 241-BX, 241-BY, and 241-C (200 East Area) and 241-S, 241-SX, 241-T, 241-TX, 241-TY, and 241-U (200 West Area). Although administratively removed as acceptable and approved receivers of waste in 1980, the SSTs are considered to be actively storing first- and second-cycle radioactive and mixed wastes received from various processing facilities in the 200 East and 200 West Areas.

The SSTs were constructed between 1943 and 1964 and have capacities between 2.0 million and 3.8 million L (530,000 and 1.0 million gal). The 241-B, 241-C, 241-T, and 241-U Tank Farms each have four additional tanks that are smaller in capacity, holding 208,000 L (55,000 gal).

The waste in the SSTs was generated by chemical processing of spent fuel from reactors located in the 100 Areas. The waste is considered highly radioactive and toxicologically hazardous and is present in three general waste forms: sludge, salt cake, and liquid. Sludge consists of the solids (hydrous metal oxides) precipitated from the neutralization of acid wastes before their transfer to the SSTs. Salt cake consists of the various solids formed from the evaporation of water from the alkaline waste. Liquids exist as supernatant and interstitial liquid in the tanks. The MAR inventory varies in type, form, and quantity from one tank to another. These variations are identified in Appendix A; however, for the development of the accident analyses, the MAR identified by the source term documents (WHC-SD-WM-SARR-011 and WHC-SD-WM-SARR-037) was used. This was done to identify a bounding consequence for each accident potentially affecting tank inventory.

The MAR is present throughout the SST system including the ancillary components outside of the tank boundary. Particulates and condensates are present in the ventilation systems, and residues can be present in the transfer lines and the ancillary systems including COBs, diversion boxes, and the miscellaneous pits servicing the tank systems.

204-AR Waste Unloading Facility. The 204-AR Waste Unloading Facility is located in the 200 East Area of the Hanford Site. It serves as a radioactive liquid waste unloading facility for newly generated wastes from the Hanford Site facilities.

The liquid wastes are delivered to 204-AR by either a railroad tank car (75,700-L [20,000-gal] capacity) or a tank trailer (18,925-L [5,000-gal] capacity). The liquid wastes are transferred to a designated DST. The 204-AR Waste Unloading Facility has the capability for in-line chemical addition to the waste during pump-out operations to meet DST storage specifications. This involves the interaction with the four chemical makeup tanks: TK-2, TK-3, TK-4, and TK-5. TK-2 contains sodium nitrite solution; TK-3 contains sodium hydroxide solution; TK-4 and TK-5 are currently empty, but did contain high pH buffer solution and 50% sodium hydroxide solution, respectively. There is also a catch tank, TK-1, that collects liquid waste from the floor drains. It must be anticipated that the catch tank could potentially hold any of the liquid waste that is present at the facility.

An underground diesel fuel storage tank is also located at the 204-AR Waste Unloading Facility. The tank has a capacity of 2,080 L (550 gal) and normally contains 1,890 L (500 gal) of fuel.

The 204-AR Waste Unloading Facility is a limited control facility and therefore is not permitted to receive waste that has a fissile content of greater than 0.01 g/gal per tank car. The safety analysis report for packaging further restricts the fissile material to less than 15 g per batch transfer.

The MAR at the 204-AR Waste Unloading Facility is the liquid waste that is transported in the railcar or trailer. Liquid waste processed by 204-AR originates primarily from the 340 Facility, T Plant, and the 222-S Laboratory. Waste constituents such as heavy metals (e.g., chromium and lead) and process chemicals (e.g., 50% nitrite and dilute caustics) used for

in-line chemical addition present potential toxicological hazards. Radiological hazards (both airborne and waterborne contamination and radiation dose) to workers are present, with the majority of contamination concerns from beta and alpha sources.

The material hazards are located in the facility material transfer system, the building ventilation system, and within the tanks of the railcars, trucks, and the 204-AR Building. The hazard will be present as a residue or liquid in the transfer systems, as particulates/residue in the ventilation systems HEPA filters, as a liquid process condensate in the ventilation system moisture separators, and a liquid in the tank systems. Material hazards may also be found on contaminated equipment or soiled laundry within sheds and other storage areas of the facility.

244-AR Vault. The 244-AR Vault, located in the 200 East Area, was originally designed to provide lag storage and transfer capability for the Plutonium Uranium Extraction (PUREX) Facility's neutralized current acid waste. This waste was transferred to and from B Plant and to the 241-AY and 241-AZ Tank Farms. Because of the inoperable status of the PUREX Facility and B Plant, the 244-AR Vault is no longer performing this function.

Four tanks are located within the vault: 244-AR TK-001, TK-002, TK-003, and TK-004. Tanks TK-001 and TK-002 have a capacity of 176,000 L (46,400 gal); tanks TK-003 and TK-004 have capacities of 17,800 L (4,700 gal). Each of the four tanks is known to contain liquid waste from historical information, but no current characteristics data is available. Tank 244-AR TK-002 also contains a strontium sludge, but the exact composition is not available.

The MAR present at the facility comes from the waste left in the facility tanks after transfers were completed to other tanks in the 200 Area. Little information exists characterizing the waste and its status in the tanks. The quantity of waste in the tanks and liquid in the cell sumps is only approximately known.

Material hazards also present at the facility include liquid on the vault cell floors from overflow of the cell sumps, material residues present in the vessel and canyon ventilation system HEPA filters, and liquid process condensate in the seal pots (quantity and activity level unknown).

213-W Compactor Facility. The 213-W Compactor Facility, also referred to as the Dry Waste Compactor Facility, is located near the west boundary in the central part of the 200 West Area. The building was used in the past for decontamination, waste repackaging, and compaction of low-level wastes. Compaction activities have been discontinued and will not be resumed. The facility's present usage is limited to contaminated instrument repair (e.g., continuous air monitors [CAMs], air sampler systems) that takes advantage of the controlled environment. The building is unoccupied except during such activities.

The MAR involves small quantities of waste on contaminated equipment present during instrument repair. Material hazards are also located in the ventilation system HEPA filters, which contain accumulated radioactive particulates/residues.

2727-W Sodium Storage Facility. The 2727-W Sodium Storage Facility is located in the south-central part of the 200 West Area and houses five sodium storage tanks. The building encloses one large room with a floor space of about 214 m^2 (2,300 ft^2).

The five 56,800-L (15,000-gal) tanks were constructed in 1960, originally storing sodium for use as the primary coolant in the Hallam Nuclear Power Facility. In 1967, the five tanks were removed from the reactor and transported to the Hanford Site.

The MAR involves approximately 129,000 L (34,000 gal) of slightly contaminated solid metallic sodium contained in the five tanks. The contamination stems from irradiated ^{23}Na, which produces ^{22}Na which has a half-life of approximately 2.58 yr. Present activity is estimated at 0.00004 μCi/g and a total inventory of ^{22}Na of about 0.005 Ci.

209-E Storage Area (i.e., Less Than 90-Day Waste Storage Pad and Intermediate Holding Area). The less than 90-day waste storage pad is located in the 200 East Area of the Hanford Site. The less than 90-day waste storage pad (209-E) is a 12- x 18-m (40- x 60-ft) covered and fenced concrete pad used for the temporary accumulation of solid and liquid hazardous waste and contact-handled low-level mixed wastes. Curbs are used on the periphery of the pad to segregate hazardous and mixed waste areas and to provide for spill containment.

The Intermediate Holding Area is a staging area for low-level radioactive waste. Intermediate Holding Area is west of, and separated from, the less than 90-day waste storage pad. A chain-link fence encloses an open-air storage area of about 233 x 67 m (765 x 220 ft).

Wastes from TWRS operations are collected and transported to the Intermediate Holding Area for characterization (weighing, radiation monitoring, assaying). After characterization, most waste containers are staged for transportation to an offsite waste compaction facility. The compacted waste normally is transported to a disposal site but could also be returned to the Intermediate Holding Area for disposal staging. Some waste containers at the Intermediate Holding Area are staged for transport to disposal sites without compaction.

The MAR at the facility reflects the nature of the less than 90-day waste storage pad operations; a variety of wastes and waste forms are stored temporarily until they can be transported to a treatment, storage, and disposal facility. Mixed waste material includes solvents, oils, paints, and cleaning material used on jobs within radiation zones. Other contributors are equipment and material that have come into contact with in-tank waste. Potential hazardous wastes include household-grade and vehicle batteries; transformers containing polychlorinated biphenyl; ballasts from light fixtures; asbestos; and a variety of solvents, oils, paints, and cleaning material used in radiologically uncontaminated areas.

Low-level waste at the Intermediate Holding Area includes containerized rags, paper, wood, and metal products that have come into contact with contamination other than tank wastes. Such wastes have been determined to produce less than 2.0×10^{-5} Sv/h (2 mrem/h) on contact.

No tank or ventilation systems are present at this facility. All of the material hazards are located in the storage containers, drums, and U.S. Department of Transportation boxes.

Cleanout Boxes. The TWRS COBs are located primarily on the newer transfer lines. The COBs were designed and installed to permit the introduction of a water snake into the primary piping to dislodge plugs. Because of difficulties encountered in their use, changes in radiation protection requirements for TWRS operations, and low frequency of plugging, the COBs are no longer used. Although the COBs are not used, they are still tied into their associated transfer lines and are exposed to the corresponding contamination.

The MAR for the COBs includes the slurry being transferred through the associated transfer line (to and from the 242-A Evaporator or DSTs) or the residues left from past operation of the transfer lines (SSTs).

Cribs, Ditches, and Ponds. The disposal cribs, ditches, and ponds contain waste water and other effluent discharges from the 200 East and 200 West Area facilities. The capacity of a particular disposal facility is limited and is controlled by regulating the liquid level. Liquid levels are maintained to prevent overflow (upper limit) or to minimize exposure of contaminated sediments (lower limit).

All streams that have the potential to receive radionuclides are monitored and sampled before release to the disposal systems. Any streams exceeding limits placed by state and federal regulations for disposal systems percolating to the soil are rerouted to alternative disposal options such as the DSTs. Radionuclides are received into the crib, ditch, or pond system and filtered or absorbed onto soil particles beneath the facility.

A list of TWRS-owned cribs, ditches, and ponds is provided in Table 3.3.2.1.1-2, which includes information on the source of the facilities' incoming stream and the current operating status of the facility.

The only system that is currently active is the 216-B-3 pond system. The 216-B-3 pond system comprises the 216-B-3 main pond, 216-B-3-3 ditch, 216-B-3A expansion pond, 216-B-3B expansion pond, and 216-B-3C expansion pond. The 216-B-3-3 ditch carries waste water from the 200 Area to the 216-B-3 main pond. The expansion ponds were constructed to receive the increased discharges to the 216-B-3 pond system as a result of the restart of the PUREX Facility and the decommissioning of the Gable Mountain Pond.

Although the cribs, ditches, or ponds may be isolated or inactive, the site may still contain material hazards trapped in the soil from the past activities. Depending on the waste stream that was the source for each facility, the radioactive material, or MAR, contained in each facility will vary in the amounts and types. Because the mechanism for disturbing the radioactive material contained in these facilities may not affect the entire facility, only a portion of the material trapped may be at risk. The actual quantity of material depends on the disturbance mechanism.

Miscellaneous Inactive Storage Facilities. TWRS MISFs include a variety of storage facilities that are no longer in operation (do not receive or send out wastes). These facilities include 63 IMUSTs. TWRS is responsible for 36 of the 63 IMUSTs as discussed in WHC-SD-WM-PD-046, *Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tanks Program Plan*. The IMUSTs represent one of eight potential categories of MISFs. The categories are identified in the preliminary hazard analysis for MISF operations (WHC-SD-WM-TI-759). Because the activities occurring at the IMUSTs are representative of (or more stringent than) the activities occurring at all the other MISFs, and the IMUSTs are considered the MISFs with the MAR of most concern, the hazard evaluation uses the IMUSTs as the basis for MISF analysis.

Almost all of the MISFs have been isolated on an interim basis. The TWRS MISFs range in nominal size from 3,785 L (1,000 gal) per tank to 189,000 L (50,000 gal) per tank. There is not enough information to know the status of most of the other MISFs.

The worst-case TWRS IMUST was chosen to be 244-BXR-003 because it contains the highest estimated curies of ^{137}Cs and ^{90}Sr and because of the potential hydrogen buildup. Additional information on the representative MISF selection is available in the preliminary hazard analysis report included in WHC-SD-WM-TI-759. A worst-case accident involving TWRS MISFs was determined to involve the BXR vault tanks; therefore, the hazard evaluation for the MISFs was developed based on activities and conditions occurring for the BXR vault, specifically 244-BXR-003.

The BXR vault is located in the 200 East Area within the 241-BX Tank Farm. The vault contains four tanks located inside individual cells: 244-BXR-001, 244-BXR-002, 244-BXR-003, and 244-BXR-011. Tanks 244-BXR-001 and 244-BXR-011 have a capacity of 189,000 L (50,000 gal); tanks 244-BXR-002 and 244-BXR-003 have a capacity of 56,800 L (15,000 gal). The vault was isolated in 1985, but when in service it received metal waste slurries from BX and BY tank farms. The MAR consists of ^{137}Cs and ^{90}Sr solids and supernate mixed with nitric acid.

Vertical Storage Units. Forty-six vertical storage units are located throughout the SST farms in the 200 West Area. They consist of a hole in the ground lined with metal drain piping and were designed to store contaminated tank equipment such as riser/shield plugs, cover plates, tank pumps, etc. Currently three of the units contain tank equipment. The remainder contain residual contamination from previously stored contaminated equipment.

The MAR is radioactive material present as surface contamination originating from contact with tank waste on the equipment, interior side walls of the vertical storage units, and potentially on the soil at the bottom of the units.

3.3.2.1.2 Energy Sources. The next step in the hazard identification process entails the identification of the energy sources that could contribute to the uncontrolled release of the MAR. The energy sources for the TWRS facilities were identified using the energy source checklist. The checklist allowed documentation of the energy sources present at the facilities and the unique phenomena occurring in the tanks themselves.

The checklist that was applied to TWRS facilities was developed from the management oversight and risk tree list (DOE-76-45/4 SSDC-4, *Mort User's Manual*) with other energy sources included that were specific to the TWRS facilities analyzed. The checklist is included in Table 3.3.1.1-2.

The results of the analysis for the energy sources present at each facility were recorded in Tables 3.3.2.1.2-1 through 3.3.2.1.2-4. These results reflect the energy sources present during routine operational activities at a facility level. Information on the sources specific to a particular tank or location within the facility was captured in the field verification performed in support of the hazard evaluation and reported in the field verification report (WHC-SD-WM-HIE-007).

Part of the energy source checklist analysis also looked at the unique phenomena occurring in the tanks of TWRS. The specific tank characteristics looked at were:

- High heat
- Flammable gas (hydrogen)
- Organics
- Radiolysis.

Elements in the Hazard Identification Checklist and Energy Designators (Table 3.3.1.1-2) covered these waste conditions and when present were specified in Tables 3.3.2.1.2-1 through 3.3.2.1.2-4 at the facility level. The unique phenomena are also identified in the hazard topography and the field verification report (WHC-SD-WM-HIE-007) for an individual tank when applicable.

3.3.2.1.3 Natural Phenomena, External Events, and Common Cause Hazards. Other hazards were identified during the hazard evaluation through the What-if analyses. Three hazard categories were analyzed: natural phenomena, external events, and common cause.

Natural phenomena events are those events caused by weather, geological events, and naturally occurring effects of age that could affect one or more facilities or locations resulting in the potentially hazardous conditions. For this analysis a list of potential phenomena was developed, the likelihood of the event was assessed, and the resulting consequences were determined.

Potential initiators of hazardous conditions at a facility or operation that come from outside the facility or operation are termed external events. Some of the hazardous conditions associated with the external events were discussed in the HazOps and PHAs; however, these events were analyzed at a single tank or facility level. Because of the potential for external events to affect more than one tank or facility, the events examined during the What-if analysis were used to focus on the effects of external events on multiple facilities or locations.

A common cause is a hazardous condition initiator with potential impacts on more than one location (i.e., sitewide). For this analysis a list of potential events was developed, the likelihood of the event was assessed, and the resulting consequences were determined.

Table 3.3.2.1.3-1 identifies the natural phenomena, external events, and common cause hazardous conditions that were analyzed during the What-if analyses. Those conditions assessed but found not to be applicable to the TWRS facilities are identified in Section 3.3.2.1.5.

3.3.2.1.4 Summary of Occurrences. The hazard identification activity included a review of TWRS (200 Area tank farms and affiliated facilities) occurrence reports. These reports were examined to assure that a comprehensive set of hazards and potential accident causes were addressed by the hazard analysis activity. Comprehensiveness was assured by comparing the nature of the occurrences with the potential causes or accidents identified by the hazard analysis and verifying those occurrences not covered were not material to the hazard analysis results. The review of the occurrences was also used to assist in the determination of frequencies for some of the hazardous conditions in the TWRS HazOp study and PHA.

Two databases of occurrences associated with the 200 Area tank farms and affiliated facilities have been generated in support of this safety analysis report. The development of these databases included a review of all unusual occurrence reports produced by the Atlantic Richfield Hanford Company from January 1972 through June 1977, the Rockwell Hanford Company from June 1977 through June 1987, and the Westinghouse Hanford Company from June 1987 through December 1989. Copies of tank farm associated unusual event reports, critiques, and event fact sheets for the years 1986 through 1990 were reviewed and included in the databases where appropriate. The Occurrence Reporting and Processing System database was obtained electronically for the years 1990 through April 1998. This database includes all unusual occurrence reports, off-normal events, and critiques generated by the Westinghouse Hanford Company and those generated by Lockheed Martin Hanford Corporation from October 1996 through April 1998. This database includes all unusual occurrence reports, off-normal events, and critiques generated by the Westinghouse Hanford Company and those generated by Lockheed Martin Hanford Corporation from October 1996 through April 1998. Searches were made of the Occurrence Reporting and Processing System database for occurrences that took place in the tank farms and associated facilities. Actions that resulted in minor skin contaminations or reports of a minor spread of contamination (specks or contamination spread to personal clothing) from a tank farm or associated facility were not included in the databases. The databases are documented in Appendix B.

The occurrences were reviewed and compared with the list of cause groups from the hazard analysis results. Table 3.3.2.1.4-1 is a summary of this list, which is found in Appendix B. The list comprises representative accidents and the causes of the accidents. No historical occurrences were associated with 22 of the 52 cause groups identified in the hazard analysis. There were 75 types of occurrences that could not be associated with a cause group. These occurrences and the reasons that they do not impact hazard analysis results are listed in Appendix B. Table 3.3.2.1.4-2 is the list of occurrences that were not included in the hazard analyses and the number of times they occurred. All occurrence causes that potentially contribute to uncontrolled releases were covered in the hazard analysis.

For example, Item 37 in Table 3.3.2.1.4-2 identifies "Violation of administrative controls." This information is used to postulate these occurrences as potentially contributing causes to

uncontrolled releases and to indicate that the use of a human error rate of 1×10^{-2} per action is appropriate when qualitatively assessing the frequency of hazardous conditions with administrative controls in place.

3.3.2.1.5 Identified Hazards Not Included in the Analysis Results. This section contains a discussion of hazards that were considered but not included in the analyses results. Many of these hazards were identified from a review of previous TWRS analyses. Based on current knowledge, however, these hazards do not constitute a concern for safe management of TWRS.

Five hazards, which were considered important in other studies, were not included in the accident analyses. These hazards are ferrocyanide reactions in the waste tanks, red oil reactions in the waste tanks, long-term loss of electrical power to the tank farms, natural flooding of the tank farm areas, and aircraft crashes. Each phenomenon was considered in the HazOp, PHA, or What-if analysis but was not represented in the results.

Ferrocyanide and exothermic reactions were considered in the 241-C-103 SST hazard and operability study. Also, a separate topical report was developed concerning the ferrocyanide issue. Based on the current understanding of the chemical degradation process, as verified by available samples, ferrocyanide concentrations are well below those required to represent a combustion hazard. The topical report WHC-SD-WM-SARR-038, *Assessment of the Potential for Ferrocyanide Propagating Reaction Accidents*, provides the details for this hazard.

The issue of red oil formation was considered but not included because red oil cannot be formed in the alkaline wastes stored in the Hanford Site waste tanks. Red oil contains uranium (in the form of the uranyl ion $[UO_2]^{2+}$), organic material, and nitrates. Thus, exothermic red oil reactions involve nitrate as an oxidizing species and organic material as a fuel facilitated by the presence of the uranium. Uranium is present in red oil in the form of an acidic aqueous solution of uranyl nitrate ($UO_2[NO_3]_2$). Red oil reactions require temperatures >135 °C (>275 °F). The nitrates and the organics must be present in specific minimum quantities to produce a significant exothermic reaction (WHC-SD-WM-TI-466, *Summary of Red Oil Issues at Hanford*) that red oil cannot be formed in the alkaline wastes stored in the Hanford Site waste tanks. The summary further notes that in the unlikely event that red oil should be produced in the waste process, contact with the large volume of dilute caustic material would neutralize the acidic aqueous solution.

Loss of electrical power was considered in the common cause failures analysis: What-if analysis. The consequences of a loss of electrical power at TWRS include a failure of automatic monitoring, loss of active ventilation flow, and loss of pumping capabilities. In this case, manual monitoring would need to be initiated; portable exhausters would be needed to maintain airflow; and portable pumps would be needed to perform emergency waste transfers. However, adverse effects such as tank heat-up or burping would not occur for up to 3 mo. Flammable gas accumulations that reach the Lower Flammability Limit take 32 days after ventilation system failure (Section 3.4.2.2.5) for the worst-case DST (Tank 241-SY-101) and 86 days for the worst-case SST (Tank 241-SX-108). Loss of electrical power was not considered a common cause

failure for DCRT ventilation systems. The worst-case DCRT, 244-S, takes approximately 12 days to reach the Lower Flammability Limit as a result of a transfer of liquids from Tank 241-SX-105 and a loss of active ventilation. All other DCRTs (independent of liquid waste transfer source and initial conditions) are predicted to take greater than 30 days to reach flammable conditions (Section 3.4.2.2.5). Loss of DCRT ventilation was, however, postulated in the hazard analysis for each DCRT.

Section 4.5.1.4 concludes that loss of electrical power is not a major contributor to the failure of safety SSCs due to the long time periods required before unfavorable conditions are reached. It is estimated that the frequency of loss of electrical power to TWRS for 30 days is "beyond extremely unlikely." Because of the long response time (at least 30 days) and because no releases would occur in the short term as a direct result of the loss of electrical power, it was not included in the hazard analysis results.

Natural flooding was considered during the assessment but eliminated from the hazard analysis because the tank farm elevations are above the maximum postulated flood level. Section 1.4.2.1.3 identifies the natural flood with the potential to impact tank farms. This flood of Cold Creek is a postulated probable maximum flood caused by precipitation which reaches an elevation of about 195 m (640 ft) above mean sea level on the southwestern portion of 200 West Area. Because the surface elevation of the lowest elevation tank farms (i.e., 241-S, 241-SY, 241-SX, 241-U) is 201 to 204 m (660 to 670 ft) above mean sea level, surface flooding is not anticipated; however, the bottoms of the tanks are below the flood level. Because of the expected short duration of precipitation-caused floods, a significant rise in the water table in these areas is not anticipated, therefore, the tanks would not be impacted. Flood scenarios with potential for longer residence time were evaluated by the U.S. Army Corps of Engineers. The bounding scenario as described in Section 1.4.2.1.1, resulting in the largest realistically conceivable flow on the Columbia River from either a natural or human caused dam failure, was postulated to be 50% breach of Grand Coulee Dam. This breach was determined to result in a flood level of about 143 m (470 ft) above mean sea level at river mile 365, which is well below the bottom of the lowest elevation tank. The design of TWRS tank farms and the average annual rainfall at the Hanford Site of 168 mm (6.6 in.) preclude the possibility that enough storm water will accumulate on top of the tanks to cause a release of radioactive or hazardous materials in the tanks. Flooding in the tank farms caused by system failures was included in the hazard analyses.

The hazard evaluations identified aircraft crashes (fixed wing and rotary wing) as a potential cause of some hazardous conditions (e.g., uncontrolled release of radioactive and/or hazardous material). However, these events were not carried forward for accident selection and control decisions. This was because the likelihood of aircraft crashes is considered to be "beyond extremely unlikely." An assessment of the likelihood of aircraft crashes for a proposed Multi-Function Waste Tank Facility confirms this estimate (WHC-SD-W236A-ANAL-002, *Additional Analysis Related to the Multi-Function Waste Tank Facility*).

3.3.2.2 Hazard Classification. The objective of a hazard classification is to provide input for implementing a graded approach to development of the facility safety analysis report in accordance with DOE 5480.23, *Nuclear Safety Analysis Reports*. To satisfy this objective,

potential consequences of uncontrolled releases of material from postulated accidents are evaluated without consideration for any mitigation systems or administrative controls. This consequence assessment focuses on the impact of material source term releases without controls or regard for event frequency.

DOE 5480.23 defines three hazard classification categories based on the consequences of releases without controls of radioactive and/or hazardous material. If the hazard analysis shows the potential for significant offsite consequences, the facility is classified as Hazard Category 1; if there is a potential for significant onsite consequences, the facility is classified as Hazard Category 2; if there is a potential for only significant localized consequences, the facility is classified as Hazard Category 3.

DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports,* states that the purpose of this section is to present the results of the final hazard classification activity specified in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. DOE-STD-1027-92 provides a uniform methodology for developing the initial and final facility hazard categorization by interpreting the hazard categories defined in DOE 5480.23. DOE-STD-1027-92 also provides the threshold quantities and appropriate ground rules for classifying the facility as Hazard Category 1, 2, or 3, depending on the quantity of radioactive material in the facility. Table 3.3.2.2-1 shows the Hazard Category definitions presented in DOE 5480.23 and the corresponding interpretations presented in DOE-STD-1027-92.

The initial hazard classification of TWRS facilities determined that all the SSTs, DSTs, Aging Waste Facility (AWF) tanks, and associated waste transfer systems are Hazard Category 2. The Hazard Category 2 classification was based on the estimated waste inventories for SSTs, DSTs, and AWF tanks (Dunford 1996) that exceed the Hazard Category 2 threshold values provided in DOE-STD-1027-92.

This final hazard classification is based on the requirements of DOE 5480.23 and the methodology provided by DOE-STD-1027-92. Based on the hazard and accident analyses presented in this FSAR, TWRS facilities clearly exceed the threshold for being categorized as Hazard Category 2 facilities, consistent with the initial hazard classification cited.

DOE-STD-1027-92 presents the interpretation that Category A reactors, as defined in DOE 5480.6, *Safety of Department of Energy-Owned Nuclear Reactors*, is an example of a Hazard Category 1 facility. (The DOE-STD-1027-92 interpretation also includes a caveat that other facilities may be designated as Hazard Category 1 by the Program Secretarial Officer. At this time the Program Secretarial Officer has not been requested to evaluate the hazard classification of TWRS facilities; therefore, this caveat is not considered in this evaluation.) DOE-STD-1027-92 also states that Hazard Category 2 facilities include "the most significant nonreactor nuclear facilities within the DOE complex." Based on these qualitative considerations, it can be concluded that TWRS facilities are appropriately classified as Hazard Category 2.

In addition to the guidance provided by DOE-STD-1027-92, U.S. Department of Energy, Richland Operations Office (RL) has directed the use of risk guidelines to be used to help determine controls (TSRs) and SSCs and should, therefore, also be considered in determining if TWRS facilities present "the potential for significant offsite consequences." As presented in this chapter and summarized in Table 3.3.2.2-2, several accident scenarios result in unmitigated consequences in excess of the risk guidelines. In considering this interpretation of significance, it must be noted that the analyses of postulated accidents are very conservative. These conservatisms include the following:

- Radiological and toxicological waste source terms (WHC-SD-WM-SARR-037 and WHC-SD-WM-SARR-011)

- Simplified transport modeling that does not include deposition or plume rise

- Accident-specific conservative assumptions (e.g., the amount of waste involved in a burn for organic salt-nitrate reactions, the amount of flammable gas released during a gas release event, and the seismic response of structural and operating equipment).

Quantitative estimates of these conservatisms have not been made because the risk can be acceptably managed by (1) selective preventive and mitigative controls; (2) planned operational safety improvements (i.e., increased lightning protection); and (3) planned safety assessments through the Safety Issue Resolution Program to better understand the phenomena, the waste characteristics, and the potential associated risks of specific postulated accidents.

In consideration of these conservatisms, it is reasonable to assume that the unmitigated consequences of some accident scenarios would be below the risk guidelines while others would remain above the risk guidelines. However, application of these guidelines in the context of facility hazard classification is not readily apparent and appears to result in a more conservative interpretation of significant consequences than intended in DOE-STD-1027-92.

It is concluded that TWRS facilities are appropriately classified no higher than Hazard Category 2. This conclusion is based on the interpretations presented in DOE-STD-1027-92 and in accordance with the requirements of DOE 5480.23. Table 3.3.2.2-3 summarizes the results of the final hazard categorization.

The final hazard classification incorporates the DOE-STD-1027-92 concept of facility segmentation. If a facility can be considered an independent segment, the hazard classification for that facility is performed based only on the hazards associated with that facility.

All DSTs, SSTs, AWF tanks, and associated waste transfer systems are Hazard Category 2. This categorization includes the 204-AR Waste Unloading Facility and the 244-AR Vault.

Three facilities (209-E Storage Area, 2727-W Building, and 213-W Compactor Building) and three classes of facilities (MISFs; cribs, ditches, and ponds; and vertical storage units) are physically independent of all other TWRS facilities. The hazard analysis (What-if) determined there is no potential for the MAR in these facilities to interact with the material at other facilities to make the consequences of an accident greater. Therefore, these facilities can be considered as independent segments.

The hazard/accident analysis results for potential consequences from accidents at these facilities are used to determine the final hazard categorization of the facilities. The results of the final hazard analysis are as follows:

- **Vertical Storage Units**—only significant localized (worker) consequences
- **209-E Storage Area**—only significant localized (worker) consequences
- **2727-W Sodium Storage Facility**—only significant onsite consequences from hazardous material
- **213-W Compactor Facility**—only significant localized (worker) consequences
- **Cribs, Ditches, and Ponds**—only significant localized (worker) consequences
- **MISFs**—significant onsite consequences (for MISFs with radioactive inventory only).

In accordance with DOE-STD-1027-92 criteria, the 2727-W Building is classified as a nonnuclear, radiological facility because of the small inventory of radioactive material. The potential for onsite consequences from this facility is from toxic material produced by a sodium fire, not the small radioactive inventory of ^{22}Na.

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Table 3.3.2-1. Example Mapping of Hazard Analysis Results from Activity Through Controls. (6 sheets)

Activity	Subtask/Hazard Analysis ID	Example Hazardous Conditions	Cons/Rep Acc No.	Controls	
				SSCs	TSRs
Air Lancing	Bonding/BND	BND-02	S2/05	SC: SST vent syss SC: SST struct Sup SSC: SC: Tank farm elect dist sys	LCO: SST vent syss - active and passive AC: Flammability cntrls AC: Ign cntrls (flam gas) AC: Flam gas mon cntrls AC: Trans cntrls AC: Process inst and meas and test equip AC: HEPA filter cntrls AC: Emergency prep (fire and waste leak)
	Coverblock Installation and Removal/CVR	CVR-05	S2/07	SS: Physical barriers to vehicle access	AC: Emergency prep (fire) AC: Ign cntrls (vehicle cntrls)
	Crane Operations/CRN	CRN-11	S3/12C	SS: SST struct (100 series tanks only for load drop) SS: DST struct SS: AWF tank struct	AC: Dome loading cntrls - Limits on load height - Hanford Site Hoisting and Rigging Manual for critical lifts
		CRN-11-1C	S2/26	None required.	AC: Dome loading cntrls - Limits on load height - Hanford Site Hoisting and Rigging Manual for critical lifts AC: Emergency prep (waste leak)
		CRN-05-I	S1/NA	None required.	AC: Ign cntrls (vehicle cntrls) AC: Dome loading cntrls - Hanford Site Hoisting and Rigging Manual for critical lifts AC: Emergency prep (fire)
		CRN-14	RP/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
		CRN-27	OCC/NA	None. (Facility worker safety controlled by Industrial Safety & Health Program.)	None. (Facility worker safety controlled by Industrial Safety & Health Program.)

EXAMPLE

Table 3.3.2-1. Example Mapping of Hazard Analysis Results from Activity Through Controls. (6 sheets)

Activity	Subtask/Hazard Analysis ID	Example Hazardous Conditions	Cons/Rep Acc No.	Controls	
				SSCs	TSRs
Air Lancing (cont'd)	Decontamination Activities/DCN	DCN-02	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
	Greenhouse or Confinement Construction and Removal/GRN	GRN-02	S1/NA	None.	None.
	In-Tank Equipment Installation, Operation, and Removal/ITK	ITK-03	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
	Radiological Monitoring and Surveys/RAD	RAD-01	S1/NA	None.	None.
	Riser Access/RSR	RSR-02	OCC/NA	None. (Facility worker safety controlled by Industrial Safety & Health Program.)	None. (Facility worker safety controlled by Industrial Safety & Health Program.)
	Sniffing (gas monitoring)/SFF	SFF-01	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
	Vehicle Operations/VEH	VEH-01	S2/07	None required (All control activity deferred to packaging safety analyses)	None required (All control activity deferred to packaging safety analyses)
Core Sampling (push mode)	Bonding/BND	BND-02	S2/05	SC: SST vent syss SC: SST struct Sup SSC: SC: Tank farm elect dist sys	LCO: SST vent syss - active and passive AC: Flammability cntrls AC: Ign cntrls (flam gas) AC: Flam gas mon cntrls AC: Trans cntrls AC: Process inst and meas and test equip AC: HEPA filter cntrls AC: Emergency prep (fire and waste leak)

EXAMPLE

Table 3.3.2-1. Example Mapping of Hazard Analysis Results from Activity Through Controls. (6 sheets)

Activity	Subtask/Hazard Analysis ID	Example Hazardous Conditions	Cons/Rep Acc No.	Controls	
				SSCs	TSRs
Core Sampling (push mode) (cont'd)	Coverblock Installation and Removal/CVR	CVR-05	S2/07	SS: Physical barriers to vehicle access	AC: Emergency prep (fire) AC: Ign cntrls (vehicle cntrls)
	Crane Operations/CRN	CRN-11	S3/12C	SS: SST struct (100 series tanks only for load drop) SS: DST struct SS: AWF tank struct	AC: Dome loading cntrls - Limits on load height - Hanford Site Hoisting and Rigging Manual for critical lifts
	Decontamination Activities/DCN	DCN-02	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
	Greenhouse or Confinement Construction and Removal/GRN	GRN-02	S1/NA	None.	None.
	In-Tank Equipment Installation, Operation, and Removal/ITK	ITK-08	S3/05	SC: SST vent syss SC: DCRT vent syss SC: 244-AR TK-002 vent sys SC: 244-CR TK-003 vent sys SC: SST struct Sup SSC: SC: Comp air sys SC: Tank farm elect dist sys	LCO: SST vent syss - active and passive LCO: DCRT vent syss LCO: 244-AR TK-002 vent sys AC: Flammability cntrls AC: Ign cntrls (flam gas) AC: Flam gas mon cntrls AC: Trans cntrls AC: Process inst and meas and test equip AC: HEPA filter cntrls AC: Emergency prep (fire and waste leak)
		ITK-10-I	S2/05	None required.	AC: Ign cntrls (flam gas) AC: Flam gas mon cntrls AC: Process inst and meas and test equip AC: HEPA filter cntrls AC: Emergency prep (fire and waste leak)

EXAMPLE ONLY

Table 3.3.2-1. Example Mapping of Hazard Analysis Results from Activity Through Controls. (6 sheets)

Activity	Subtask/Hazard Analysis ID	Example Hazardous Conditions	Cons/Rep Acc No.	Controls	
				SSCs	TSRs
Core Sampling (push mode) (cont'd)	In-Tank Equipment Installation, Operation, and Removal/ITK (cont'd)	ITK-FR-06	S1/NA	None required. (Facility worker exposure controlled by Radiation Protection Program.)	None required. (Facility worker exposure controlled by Radiation Protection Program.)
	Radiological Monitoring and Surveys/RAD	RAD-01	S1/NA	None.	None.
	Riser Access/RSR	RSR-02	OCC/NA	None. (Facility worker safety controlled by Industrial Safety & Health Program.)	None. (Facility worker safety controlled by Industrial Safety & Health Program.)
	Sniffing (gas monitoring)/SFF	SFF-01	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
	Vehicle Operations/VEH	VEH-01	S2/07	None required (All control activity deferred to packaging safety analyses)	None required (All control activity deferred to packaging safety analyses)
Photography (in tank)	Bonding/BND	BND-02	S2/05	SC: SST vent syss SC: SST struct Sup SSC: SC: Tank farm elect dist sys	LCO: SST vent syss - active and passive AC: Flammability cntrls AC: Ign cntrls (flam gas) AC: Flam gas mon cntrls AC: Trans cntrls AC: Process inst and meas and test equip AC: HEPA filter cntrls AC: Emergency prep (fire and waste leak)
	Coverblock Installation and Removal/CVR	CVR-05	S2/07	SS: Physical barriers to vehicle access	AC: Emergency prep (fire) AC: Ign cntrls (vehicle cntrls)
	Decontamination Activities/DCN	DCN-02	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)

EXAMPLE ONLY

Table 3.3.2-1. Example Mapping of Hazard Analysis Results from Activity Through Controls. (6 sheets)

Activity	Subtask/Hazard Analysis ID	Example Hazardous Conditions	Cons/Rep Acc No.	Controls	
				SSCs	TSRs
Photography (in tank) (cont'd)	Greenhouse or Confinement Construction and Removal/GRN	GRN-02	S1/NA	None.	None.
	In-Tank Equipment Installation, Operation, and Removal/ITK	ITK-08	S3/05	SC: SST vent syss SC: DCRT vent syss SC: 244-AR TK-002 vent sys SC: 244-CR TK-003 vent sys SC: SST struct Sup SSC: SC: Comp air sys SC: Tank farm elect dist sys	LCO: SST vent syss - active and passive LCO: DCRT vent syss LCO: 244-AR TK-002 vent sys AC: Flammability cntrls AC: Ign cntrls (flam gas) AC: Flam gas mon cntrls AC: Trans cntrls AC: Process inst and meas and test equip AC: HEPA filter cntrls AC: Emergency prep (fire and waste leak)
	Radiological Monitoring and Surveys/RAD	RAD-01	S1/NA	None.	None.
	Riser Access/RSR	RSR-06-I	S2/05	None required.	AC: Ign cntrls (flam gas) AC: Flam gas mon cntrls AC: Process inst and meas and test equip AC: HEPA filter cntrls AC: Emergency prep (fire and waste leak)
		RSR-01	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
		RSR-04	TRP/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
		RSR-02	OCC/NA	None. (Facility worker safety controlled by Industrial Safety & Health Program.)	None. (Facility worker safety controlled by Industrial Safety & Health Program.)

EXAMPLE

Table 3.3.2-1. Example Mapping of Hazard Analysis Results from Activity Through Controls. (6 sheets)

Activity	Subtask/Hazard Analysis ID	Example Hazardous Conditions	Cons/Rep Acc No.	Controls	
				SSCs	TSRs
Photography (in tank) (cont'd)	Sniffing (gas monitoring)/SFF	SFF-01	S1/NA	None required (Facility worker exposure controlled by Radiation Protection Program.)	None required (Facility worker exposure controlled by Radiation Protection Program.)
	Vehicle Operations/VEH	VEH-01	S2/07	None required (All control activity deferred to packaging safety analyses)	None required (All control activity deferred to packaging safety analyses)

AC = Administrative Control.
AWF = Aging Waste Facility.
Cons = consequences (see Table 3.3.1.3-3).
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
ID = identifier.
NA = not applicable.
OCC = Occupational Safety.
Rep Acc No. = representative accident number (see Table 3.3.2.3.1-3).
RP = Radiation Protection.
SC = Safety-Class.
SS = Safety-Significant.
SSC = structure, system, and component.
SST = single-shell tank.
TSR = Technical Safety Requirement.

EXAMPLE ONLY

Table 3.3.2.1.1-1. Summary of Material at Risk.

Facility	Material at risk
Double-shell tank facilities	High-level radioactive liquid waste, hazardous materials evolved from radioactive waste, nonradioactive toxic materials
Single-shell tank facilities	High-level radioactive and toxically hazardous sludge, salt cake, supernate, and toxic headspace gases
204-AR Waste Unloading Facility	T Plant, 340 Facility, and 222-S Facility wastes (heavy metal, process chemical, and radioactive waste), sodium nitrite, sodium hydroxide, disodium phosphate, diesel fuel
244-AR Vault	Strontium sludge and flush water (specific composition unknown), diesel fuel
213-W Compactor Facility	Miscellaneous contaminated instrumentation
2727-W Sodium Storage Facility	Sodium metal
209-E Storage Area	Tank contacted hazardous and radioactive wastes, toxics, corrosives, and miscellaneous operational wastes
Cleanout boxes	Double-shell tank, 242-A Evaporator, or single-shell tank waste passing through associated transfer lines (or residues left from past operation of lines)
Cribs, ditches, and ponds	Build up in soil of radiological and toxicological particulates from source streams; specific contamination type and quantity dependent on source stream
Miscellaneous Inactive Storage Facilities	^{137}Cs and ^{90}Sr solids and supernate mixed with nitric acid (assumed worst case for accident analysis; contents of 244-BXR-003)
Vertical Storage Units	Tank waste contaminated equipment and residue on vertical storage units

Table 3.3.2.1.1-2. Summary of Material at Risk in Tank Waste Remediation System-Owned Cribs, Ditches, and Ponds. (2 sheets)

Facility	Stream source/operating status
216-A-8 crib	241-AY/AZ Tank Farms steam condensate The crib was permanently isolated in April 1995 by filling crib diversion box with concrete. Crib vent filters were removed and disposed in August 1995.
216-A-30 crib	PUREX steam condensate The crib was permanently isolated in April 1995 by filling crib diversion box with concrete.
216-A-37-2 crib	PUREX steam condensate The crib was permanently isolated in April 1995 by filling crib diversion box with concrete.
216-A-45 crib	PUREX steam condensate The crib was permanently isolated by cutting and capping pipeline feeding crib.
216-B-3 expansion pond	Various cooling water, steam condensate, and chemical sewer from PUREX, B Plant, 242-A Evaporator, powerhouse, 244-AR Vault, and 241-A Tank Farm This multiple lobe pond is the only one in the system that is still in service. Some lobes were certified by Ecology as clean and closed under RCRA in June 1995.
216-B-55 crib	B Plant steam condensate The crib is isolated; portion of the pipe feeding the crib has been removed and the stubs capped.
216-B-62 crib	B Plant process condensate The crib was isolated; the valve was removed in 221-BF Building and a blind flange installed.
216-B-63 ditch	B Plant chemical sewer This ditch was backfilled with clean fill; it was permanently isolated by filling weir box at head end of ditch with concrete in December 1994.
216-S-25 crib	241-SX Tank Farm steam condensate from ventilation system The crib is inactive.
216-S-26 crib	222-S Laboratory waste water Crib was permanently isolated by filling manhole with concrete in June 1995.
216-T-1 ditch	T Plant waste water Permanently isolated by T Plant as part of rerouting the stream to TEDF; ditch was backfilled and interim stabilized by tank farms in April 1995.

Table 3.3.2.1.1-2. Summary of Material at Risk in Tank Waste Remediation System-Owned Cribs, Ditches, and Ponds. (2 sheets)

Facility	Stream source/operating status
216-T-4-2 ditch	T Plant waste water The ditch was backfilled and interim stabilized in July 1995; permanent isolation was accomplished by filling the last manhole along the effluent pipeline with concrete.
216-U-14 ditch	UO_3 cooling water, steam condensate, chemical sewer to open ditch, 242-S Evaporator steam condensate to gravel portion of ditch Discharge from UO_3 eliminated in November 1994; UO_3 permanently isolated the flow to ditch by filling diversion box at 207-U retention basin with concrete. The ditch was interim stabilized in January 1995; discharge from 242-S Evaporator was eliminated and end of pipe capped in April 1995.
216-U-17 crib	UO_3 process condensate The crib was permanently isolated by cutting and capping the crib pipeline in November 1994.
216-W-LC crib	Laundry waste water The crib was permanently isolated in August 1994 by filling last manhole on crib pipeline with concrete.
216-Z-21 pond	PFP steam condensate, cooling waste, storm drains This is also known as the 207-Z retention basin; discharge to the pond was isolated during rerouting of waste stream to TEDF.
216-Z-20 crib	PFP cooling water, steam condensate The crib was permanently isolated by filling last manhole on crib pipeline with concrete.

PFP = Plutonium Finishing Plant.
PUREX = Plutonium Uranium Extraction (Facility).
RCRA = *Resource Conservation and Recovery Act of 1976.*
TEDF = Treated Effluent Disposal Facility.

Table 3.3.2.1.2-1. Double-Shell Hazards Identification.

Energy classification*	241-SY Tank Farm hazards		241-AN Tank Farm hazards		241-AP Tank Farm hazards		241-AW Tank Farm hazards		241-AY Tank Farm hazards		241-AZ Tank Farm hazards	
	PT	PE	PT	PE	PT	PE	PT	PE	PT	PE	PT	PE
Corrosive	2	2	2	1,2,4	2	1,2,4	2	1,2,4	2,5	1,2,4	2,5	2
Explosive/pyrophoric	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8	6	6,7,8	6
Nuclear criticality	15	NA	15	NA	15	NA	15	NA	15	NA	15	NA
Flammable materials	11,13, 14	3,7,8,11, 13,14	11,14	2,3,7,10,11, 14,17	4,11,14	2,3,4,5,7, 10,11,13, 14,17	4,11,14	2,3,4,5,7, 10,17	11,14	2,3,4,7,10,17	11,14	3,7,11
Thermal radiation	NA	NA	NA	NA	5	NA	5	NA	5	NA	5	NA
Chemical reactions	1	NA	1	NA	1	NA	1	NA	1	NA	1	NA
Friction	5	1,2,3,5	2,3,5,7	1,2,3,4,5	5	1,2,3,5	5	1,2,3,5	5	1,2,3,5	2,3,5,7	1,2,3,4,5
Electrical	4,6,9,10, 14	1,4,6,10, 11,13,14, 16,19	4,6,9,10, 14	3,4,5,6,7,8,9, 10,11,14,16	4,6,9,10, 14	3,4,5,6,7,8, 9,10,11,14, 16	4,6,9,10,14	3,4,5,6,7,8, 9,10,11,12, 14,16	4,6,9,10,14	4,5,6,7,8,9, 10,11,12,16, 18	4,6,9,10, 14	1,3,4,5,6,7, 8,9,10,11,14, 16,18
Kinetic-rotational	2,3	2,3,4	2,3	2,3,4	2,3	2,3,4	2,3	2,3,4	2,3	2,3,4	2,3	2,3,4
Kinetic-linear	NA	1,4,5	NA	1,4,5	NA	1,4,5	NA	1,4,5	NA	1,4,5	NA	1,4,5,6,7
Mass, gravity, height	11	3,5,11,15	11,15	3,5,7,10,13, 15	11	3,5,15	11	3,5,15	11	3,5,15	11	3,5,10,15
Pressure-volume	7,9,11,12	5,6	7,9,11	2,5,6	7,9,11	5,6,8	7,9,11	5,6,8	7,9,11	5	7,9,11	NA
Thermal (except radiant)	NA	3,6	3	1,3	NA	3	NA	3,6	NA	3	3	3

Note: The hazard identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards resulting only in personnel injury are not included.

*See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

NA = not applicable.

PE = potentially present elsewhere in/adjacent to facility.

PT = potentially present in tanks.

Table 3.3.2.1.2-2. Single-Shell Hazards Identification. (2 sheets)

Energy classification*	241-A Tank Farm hazards		241-AX Tank Farm hazards		241-B Tank Farm hazards		241-BX Tank Farm hazards		241-BY Tank Farm hazards		241-C Tank Farm hazards	
	PT	PE	PT	PE	PT	PE	PT	PE	PT	PE	PT	PE
Corrosive	2	2	2	NA	2	1,2,4	2	1,2,4,6	2	2	2,5	1,2,4
Explosive/pyrophoric	6,7,8	NA	6,7,8	NA	6,7,8	6	6,7,8	6	6,7,8	NA	6,7,8	6,7,8
Nuclear criticality	15	NA	15	NA	15	15	15	15	15	NA	15	15
Flammable materials	11,13,14	3,4,5,7,17	11,13,14	3,7	11,13,14	2,3,6,7,9, 10,11,13,17	11,13,14	2,3,6,7,9, 10,11,12,13,17	11,13,14	3,7,8	11,13,14	2,3,6,7,8, 9,10,11, 13,14,17
Thermal radiation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	NA
Chemical reactions	1	NA	1	NA	1	NA	1	NA	1	NA	1	NA
Friction	NA	1,2,3,5	NA	5	NA	NA	3,5	NA	5	1,2,3,5	3,5	1,2,3,5
Electrical	4,6,14	1,2,4,5,9, 10,11,16	4,6,14	4,5,9,10, 11,16	4,6,14	3,6,16,18	4,6,9,10,11, 14	3,4,6,8,11,14, 16,18	4,6,9, 10,14	3,4,6,8, 10,11,14, 16,18	4,6,9,10, 11,14	3,4,6,8, 10,11,14, 16,18
Kinetic-rotational	NA	2,3,4	NA	2,3	NA	NA	2,3,4	NA	2,3	2,4	2,3,4	2,4
Kinetic-linear	NA	1,4,5	NA	1,4,5	NA	1,4,5	5	1,4,5	NA	1,4,5	NA	1,4,5
Mass, gravity, height	11	2,3,5,10, 11,13,15	11	3,5,10,11, 15	11	2,3,5,15	3,11	2,3,5,11,15,16	11	3,5,15,16	11,14	2,3,5,10, 11,15,16
Pressure-volume	7,9,11	6	7,9,11	3	7,9,11	NA	7,9,11	5,17	7,9,11	6,8	7,9,11	5,6,8,11, 12
Thermal (except radiant)	NA	3,6	NA	NA	NA	NA	3	3,6	NA	3,6	NA	36

Table 3.3.2.1.2-2. Single-Shell Hazards Identification. (2 sheets)

Energy classification*	241-S Tank Farm hazards		241-SX Tank Farm hazards		241-T Tank Farm hazards		241-TX Tank Farm hazards		241-TY Tank Farm hazards		241-U Tank Farm hazards	
	PT	PE	PT	PE	PT	PE	PT	PE	PT	PE	PT	PE
Corrosive	2	1,2,3,4,5,6	2,5	1,2,3,4, 5,6	2	2,6	2	2,6	2,5	NA	2	1,2,6
Explosive/pyrophoric	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8	6,7,8,10	6,7,8,10	6,7,8	NA	6,7,8	6,7,8
Nuclear criticality	15	NA	15	NA	15	NA	15	NA	15	NA	15	NA
Flammable materials	10,11,13, 14	1,2,3,7,8,9, 10,11, 13,14	11,13,14	3,7,8,11, 13,14	11,13,14	1,2,3,7,8,9, 11,12, 13,14	11,13,14,17	1,2,3,7,9, 11,13,14	11,13,14	3,7,11	11,13,14	1,2,3,4,7, 8,9,10,11, 13,14
Thermal radiation	NA	NA	5	NA	NA	NA	NA	NA	5	NA	NA	NA
Chemical reactions	1	NA	1	NA	1	NA	1	NA	1	NA	1	NA
Friction	3,5,7	NA	5	NA	5,7	NA	3,5	NA	NA	NA	3,5	1,2,3,5
Electrical	4,6,9,10,11, 14	4,5,6,14,18	4,6,10,14	4,5,6,8,13, 14,18	4,6,9,10, 14	4,5,6,9,13, 14,16	4,6,9,11,14	3,4,5,6,16, 18	3,4,6,14, 16	18	4,6,9,10, 11,14	3,4,5,6,7, 8,10,14, 16,18
Kinetic-rotational	2,3,4	NA	2	NA	2	NA	2,3,4	2	NA	NA	2,3,4	2
Kinetic-linear	NA	1,4,5	NA	1,4,5	NA	1,4,5	NA	1,4,5	NA	1,4,5	NA	1,4,5,6
Mass, gravity, height	11	3,5,13,15	11	3,5,7,15	2,11	3,5,15	11	3,5,7,11,15, 17	11	3,5,15	11	3,5,11,15
Pressure-volume	7,9,11	5,6	7,9,11	5	7,9,11	5,6	7,9,11	NA	7,9,11	NA	7,9,11	5,6
Thermal (except radiant)	3,6	6	NA	6	NA	6	3,6	NA	NA	NA	3,6	6

Note: The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

*See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

NA = not applicable.

PE = potentially present elsewhere in/adjacent to facility.

PT = potentially present in tanks.

Table 3.3.2.1.2-3. Miscellaneous Facilities Hazards Identification.

Energy classification*	204-AR hazards		244-AR hazards		2727-W hazards		213-W hazards		209-E hazards		Cribs, ditches, and ponds hazards		Cleanout boxes hazards		Vertical storage vaults hazards	
	PF	PE	PF	PE	PF	PE	PF	PE	PF	PE	PF	PE	PF	PE	PF	PE
Corrosive	2	NA	2	NA	NA	2	NA	NA	1,2	NA	NA	NA	1,2,3,4, 5,6	NA	NA	NA
Explosive/pyrophoric	NA	NA	NA	NA	NA	11	NA	NA	6,7,11	NA	NA	NA	6,7,8	NA	NA	NA
Nuclear criticality	3,10,15	NA	1,15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Flammable materials	3,7,8	NA	1,7,8	NA	16	8,14	2,6,8,13	NA	1,2,6,10, 11,13, 14,15	NA	NA	3,7	11,13,14	3,7	NA	3,7
Thermal radiation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chemical reactions	1	NA	1	NA	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Friction	1,2,3,5	NA	1,3,5	NA	NA	NA	3,4,6	NA	5	NA	NA	NA	NA	NA	NA	NA
Electrical	2,3,4,7, 9,10,11, 16	17	2,3,4,5, 6,9,10, 11, 16	NA	4,14,19	NA	1,4,7,8, 11,12, 13	NA	4,14	NA	NA	NA	4,14	NA	NA	NA
Kinetic-rotational	2,3,4	NA	2,3,4	NA	NA	NA	4	NA	2	NA	NA	NA	NA	NA	NA	NA
Kinetic-linear	1,3,4,5	1,3	5	1,4	NA	1	NA	NA	1,2,4	NA	NA	1,5	NA	1,4,5	NA	1,5
Mass, gravity, height	2,3,5, 10,11, 13,16	NA	2,3,5,7, 10,11,16	NA	10,13	5	12,16	11	1,3,5	NA	NA	NA	1	3,5	NA	3,5
Pressure-volume	6,8	NA	6,8	NA	5	12	NA	NA	5	NA	NA	NA	NA	NA	NA	NA
Thermal (except radiant)	3,6	NA	3,6	NA	NA	NA	3,6	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note: The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

*See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

NA = not applicable.

PE = potentially present elsewhere in/adjacent to facility.

PF = potentially present in facility.

Table 3.3.2.1.2-4. Inactive Miscellaneous Underground Storage Tanks or Miscellaneous Inactive Storage Facilities Hazards Identification.

Energy classification*	Aboveground nonradioactive facility hazards		Aboveground radioactive facility hazards		Underground nonradioactive facility hazards		Underground radioactive facility hazards	
	PF	PE	PF	PE	PF	PE	PF	PE
Corrosive	2	NA	2	NA	2	NA	2	NA
Explosive/pyrophoric	6,7	NA	6,7	NA	6,7	NA	6,7	NA
Nuclear criticality	NA	NA	15	1	NA	NA	15	1
Flammable materials	11,13,14	3,7	11,13,14	3,7	11,13,14	3,7	11,13,14	3,7
Thermal radiation	NA	NA	NA	NA	NA	NA	NA	NA
Chemical reactions	1	NA	1	NA	1	NA	1	NA
Friction	NA	NA	NA	NA	NA	NA	NA	NA
Electrical	NA	NA	NA	NA	NA	NA	NA	NA
Kinetic-rotational	NA	NA	NA	NA	NA	NA	NA	NA
Kinetic-linear	NA	1,4,5	NA	1,4,5	NA	1,4,5	NA	1,4,5
Mass, gravity, height	NA	3,5,11,14	NA	3,5,11,14	NA	3,5,11,14	NA	3,5,11,14
Pressure-volume	7,9,11	NA	7,9,11	NA	7,9,11	NA	7,9,11	NA
Thermal (except radiant)	NA	NA	NA	NA	NA	NA	NA	NA

Note: The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

*See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

NA = not applicable.

PE = potentially present elsewhere in/adjacent to facility.

PF = potentially present in facility.

Table 3.3.2.1.3-1. Natural Phenomena, External Events, and Common Cause Hazards for Tank Waste Remediation System Facilities.

Natural phenomena[a]	External events[b]	Common cause[b]
Lightning	Aircraft crashes	Loss of electrical power
Tornados	Range fires	Loss of water supply
High winds	Dam collapse	Loss of steam supply
Earthquakes	Onsite and offsite transportation accidents	Loss of fuel supply
Ashfall	Water/steam main breaks	Loss of air supply
Eruption of molten lava	Excavation	Disabled or unavailable staff
Severe dust storms/dust devils		Poor quality materials
Accumulation of heavy snow[c]		Aging effects
Severe hail storms		Chemical phenomena
Hydrogen-producing reactions		

[a]Natural phenomena are also considered as potential common cause hazards.
[b]Human error is a contributor to many external and common cause events. Consideration of this contributor occurs as an integral part of the preliminary hazard analysis and What-if process.
[c]Also includes potential impacts from freezing rain and ice storms.

Table 3.3.2.1.4-1. Hazard Analysis Cause Groups and Associated Occurrences.

Cause groups/related occurrences	
Cause group	Number of occurrences*
Criticality	4
Fire/explosion	14
Tank dome collapse	8
Release	156
Human error release	59
Nonreleases/occupational	21

*This number represents occurrences that included some element of events listed under the cause groups.

Table 3.3.2.1.4-2. Occurrences Not Included in the Hazard Analysis. (4 sheets)

Item	Occurrence	Number of occurrences	Comments
1	Occupational injury/hazard (or potential)	21	Not an official part of the study; these events were included when discovered
2	Ventilation heater failure	2	Did not cause a release of radioactive or toxic material (ventilation heater overheat included)
3	Rotten timbers-crib subsidence	1	Potential contamination spread; however, this event did not cause a release of radioactive or toxic material (contamination spread because of natural phenomena included)
4	No protective equipment	7	Included as failure to follow administrative controls in the control section of the study; this event does not cause a release of radioactive or toxic material
5	Tank exceeds level limit	27	No release from this event (tank overflows were included)
6	Waste tank level decrease	121	No release from these events (tank leaks were included)
7	Waste tank level increase	93	Did not cause a release of radioactive or toxic material (tank overflows were included)
8	Tank temperature increase	3	Did not cause a release of radioactive or toxic material (tank bumps were included)
9	Sampling/surveillance failure	11	Included as the failure to follow administrative controls; in the control section of the study
10	Instrument failure caused by auguring	1	If this event resulted in a release, it would be included as an intrusive activity (release caused by intrusive activity included)
11	Increased radiation readings	52	Generally, these events were a result of the migration of soil contamination in laterals or drywells associated with waste tanks (included as subsurface leak)
12	Radioactive/toxic liquid spill	11	Included in the study as leaks and/or contamination spread
13	Radiation alarm caused by welding	1	Did not cause a release; an alarm was inadvertently triggered
14	Waste tank sampler, break, rupture	2	Breaking a sampler does not cause a release; it is an operational problem (spills, leaks were included)
15	High differential pressure across filters	3	High differential pressure does not cause a release, filter plugging can be a precursor to filter rupture (filter failures included)
16	Vehicle collision in tank farm, nothing broken	3	Did not cause a rupture or release (included in in-tank fuel fire, fire in contaminated area or waste transport vehicle accident)
17	Process condensate pH too low	1	Involves clean water, it does not cause a release (mixing of incompatible materials was included)
18	High radiation in excavation	4	Included personnel exposure; an occupational problem which did not involve a release (unplanned excavations or drilling were included)
19	Transfer line plug	4	Did not cause a release (piping leaks caused by plugs were included)
20	Steam used instead of air	1	Caused no release; it was an operational problem (steam intrusion from interfacing systems was included)
21	Indicator failure	22	Covered in the study concerning engineered controls
22	Pump run without cooling water, too acidic	2	Caused no release (pump, piping leaks were included)
23	Re-used out of service waste tank	1	Violation of administrative controls; it did not cause a release (tank leaks were included)
24	Intentional violation of administrative controls	8	Included in the administrative control section of the study

Table 3.3.2.1.4-2. Occurrences Not Included in the Hazard Analysis. (4 sheets)

Item	Occurrence	Number of occurrences	Comments
25	Water spill	11	Involved clean water, no release (tank leaks were included)
26	Encasement contamination	2	Involved a leak into a pipe encasement, which prevented a spill
27	Instrument air off, inaccurate instrument readings	2	Instrument air off, inaccurate instrument readings; this event is included in the failure to follow administrative controls; it does not cause a release: it is an operational problem
28	Tank level below minimum limit	3	This is an operational problem; a violation of administrative controls; no release (tank leaks were included)
29	Radiation activity on filters	3	Did not cause a release; the filters did their job; buildup on the filters is an operational problem (unfiltered release was included)
30	Personnel contamination or over-exposure	16	The study scope did not include these events; they were noted when discovered in the analysis; did not include a release (personnel exposure was considered in all accidents)
31	Undetected basin filling	1	This was an operational problem in that the process that was not detected, and it caused a large volume of slightly contaminated water to be added to the waste tank inventory; no release (piping leaks were included)
32	Radiation discharge to crib exceeded limits	3	Violation of administrative controls; did not result in a release (surface leaks were included)
33	Waste stuck in caisson	1	Operational problem; did not result in a release (structure failures and contamination spread were included)
34	Burial box failure	1	Potential for a spread of contamination; did not result in a release (structure failures were included)
35	Loss of emergency power	3	Did not result in a release; operational, administrative problems (natural phenomena causing power losses were included)
36	Pond radiation exceeded limits	1	Violation of administrative controls; did not result in a release (surface leaks resulting in pool were included)
37	Violation of administrative controls	75	Operational problems; included in the controls section of the study; did not result in a release
38	Error in computer for safety calculations	2	Errors in computer codes do not cause a release, codes are to help understand the behavior of emissions
39	Loss of electric power	12	Discussed in the What-if analysis; was found to not be a significant contributor to a release
40	Activation of fire system	1	Operational problem; did not cause a release (fires and deflagrations were included)
41	Loss of accountability of radiation sources	1	Failure to maintain administrative controls; did not cause a release
42	Ferrocyanide USQ	1	Did not cause a release; it is an administrative process (organic solvent fires were included)
43	Unknown cable attached to riser	1	Was not investigated specifically; it did not cause a release or spread of contamination
44	Missed milestone	5	Administrative milestones; no release mechanism was involved
45	Tank contents, extremely low pH in waste tanks	4	Potential for causing a release because of pH is small; these events did not cause a release (mixing incompatible wastes was included)
46	Criticality USQ - single-shell tank	1	Criticality USQ (nuclear criticality was included)
47	Bomb threat	1	Administrative and operational problem; no release is involved
48	Organic layer, C-103 USQ	1	No release involved with this event (organic solvent fires were included)

Table 3.3.2.1.4-2. Occurrences Not Included in the Hazard Analysis. (4 sheets)

Item	Occurrence	Number of occurrences	Comments
49	Pressurized air lance package	1	Contamination spread or spray leak
50	Stack monitor failure	2	Did not cause a release; results in a failure to follow administrative controls if not repaired (filter failures were included)
51	Waste packaging violations	2	Did not cause a release; violation of administrative controls; included in the control section of the study
52	Flammable gas USQ	1	Flammable gas USQ (flammable gas deflagrations were included)
53	Improper chemical adjustment	1	Included in the administrative controls section of the study; the solution did not cause a release (mixing of incompatible waste was included)
54	Diesel generator failure	1	Considered in the What-if analysis; not a significant contributor to a release
55	Tank pressurized	21	Considered in the Hazard Analysis; however, the pressurizations described in the occurrences would not result in significant consequence unless accompanied by a filter breach. Tank pressurizations considered in the Hazard Analysis can be significantly more severe (tank pressurization and filter failure were included)
56	Oil line ruptured, smoked	1	Potential for fire in a contaminated location (fire in a contaminated area was included)
57	Air compressor failure	6	Considered in the What-if analysis; not a significant contributor to a release
58	Inadvertent flow to crib	1	Involved steam condensate flow to a crib; not a release, like a raw water spill, but a failure to follow administrative controls (surface leaks were included)
59	Human error tripped alarms	3	Did not involve a release; operational problems
60	Removal of thermocouple tree, bent and broken	1	Operational problem; not a release
61	Riser not symmetrical	1	Operational problem; not a release
62	Raw water usage unexplained	2	Did not result in a release; control problems
63	Sludge cooler high vacuum	1	Operational problem; not a potential release
64	Pipe discovered within buffer zone of tank farm	1	No release; problem with controlled drawings
65	Core sample USQ	1	Core sample containing reactive components; inadvertent addition of aggravating material (mixing of incompatible waste included)
66	Carbon monoxide trip caused by operating truck	1	Operational problem; not a release
67	Steam trap failure	1	Created an industrial hazard because of leak temperature; did not result in a release
68	MUST tanks—unknown status	1	MUST tanks were included in the study
69	Rotary mode core sampler operated out-of-specification	5	Administrative control problems; did not result in a release
70	Wrong length auger rod	1	Operational problem; did not cause a release

Table 3.3.2.1.4-2. Occurrences Not Included in the Hazard Analysis. (4 sheets)

Item	Occurrence	Number of occurrences	Comments
71	RMCS over energized	1	Operational and industrial safety problem; no release
72	Discovery of drug paraphernalia	1	Indicates a personnel problem; did not result in a release
73	Soil contamination far deeper than expected	1	Considered as the spread of contamination
74	Missing flange on buried tank riser	1	Tank configuration problem; did not result in a release
75	No authorization basis for facility	1	Inadequate administrative control; did not result in a release

MUST = miscellaneous underground storage tank.
USQ = Unreviewed Safety Question.
RMCS = rotary mode core sampling.

Table 3.3.2.2-1. Hazard Category Definitions and Interpretations.

Hazard Category 1	
DOE 5480.23	The hazards analysis shows the potential for significant offsite consequences.
DOE-STD-1027-92	Category A reactors and facilities designated by PSO. (Category A reactors are those that have a steady-state power level greater than 20 MWt, as defined in DOE Order 5480.6).
Hazard Category 2	
DOE 5480.23	The hazards analysis shows the potential for significant onsite consequences.
DOE-STD-1027-92	Facilities with the potential for nuclear criticality events or with sufficient quantities of hazardous material and energy, which would require onsite emergency planning activities.
Hazard Category 3	
DOE 5480.23	Hazards analysis shows the potential for significant but localized consequences.
DOE-STD-1027-92	Facilities with quantities of hazardous radioactive material, which meet or exceed the Table A.1 (of DOE-STD-1027-92) values.

DOE 5480.6, *1986, Safety of Department of Energy-Owned Nuclear Reactors*, Change 0, U.S. Department of Energy, Washington, D.C.

DOE 5480.23, 1994, *Nuclear Safety Analysis Reports*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE-STD-1027-92, 1992, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

PSO = Program Secretarial Officer.

Table 3.3.2.2-2. Summary of Consequences and Frequencies for Offsite Accidents Consequences Above Offsite Risk Guidelines—Without Controls.

Accident	Consequences				Frequency (duration)
	Radiological, Sv (rem)		Toxicological		
	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	
3.4.2.2, Single-shell tank deflagration in the headspace	6.7 E-03 (6.7 E-01)	5.0 E-03 (5.0 E-01)	6.6 E-01	1 (ERPG-1)	Unlikely (200 s)
3.4.2.2, Double-contained receiver tank burn	3.8 E-03 (3.8 E-01)	1.0 E-03 (1.0 E-01)	1.1 E+00	1 (PEL-TWA)	Anticipated (200 s)
3.4.2.6, Organic salt-nitrate reaction	7.3 E-02 (7.3 E+00)	5.0 E-03 (5.0 E-01)	1.6 E+02	1 (ERPG-1)	Unlikely (40 min)
3.4.2.7, Surface leak resulting in pool	3.6 E-01 (3.6 E+01)	1.0 E-03 (1.0 E-01)	3.2 E-01	1 (PEL-TWA)	Anticipated (36 h)
3.4.2.8, Subsurface leak resulting in pool	7.1 E-03 (7.1 E-01)	1.0 E-03 (1.0 E-01)	3.0 E-02	1 (PEL-TWA)	Anticipated (24 h)
3.4.2.9, Spray leak from waste transfer system	8.3 E-02 (8.3 E+00)	1.0 E-03 (1.0 E-01)	8.9 E-02	1 (PEL-TWA)	Anticipated (24 h)
3.4.2.12, Seismic event, spray leak during transfer	8.3 E-02 (8.3 E+00)	5.0 E-03 (5.0 E-01)	1.4 E-02[a]	1 (ERPG-1)	Unlikely (24 h)
3.4.2.12, Seismic event, pool leak during transfer	3.6 E-01 (3.6 E+01)	5.0 E-03 (5.0 E-01)	1.3 E-02[b]	1 (ERPG-1)	Unlikely (24 h)
3.4.2.12, Seismic event, SST deflagration with dome collapse	6.7 E-03 (6.7 E-01)	5.0 E-03 (5.0 E-01)	6.6 E-01	1 (ERPG-1)	Unlikely (200 s)

[a]Value documented in Table 1 of HNF-SD-WM-CN-119, 1997, *Evaluation of the Effectiveness of the Addition of Seismic Monitors Within the 200 Areas*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

[b]Value documented in Table 3 of HNF-SD-WM-CN-119.

ERPG = Emergency Response Planning Guideline.

PEL = permissible exposure limit.

SOF = sum-of-fractions.

SST = single-shell tank.

TWA = time-weighted average.

Table 3.3.2.2-3. Final Hazard Category for Tank Waste Remediation System Facilities.

TWRS facility	Function	Independent segment	Hazard category
Double-shell tanks (including aging waste facility tanks), and associated waste transfer systems*	Storage and transfer of high-level radioactive waste	No	2
Single-shell tanks and associated waste transfer systems*	Storage and transfer of high-level radioactive waste	No	2
204-AR Waste Unloading Facility	Transfer of dilute waste to TWRS from other Hanford Site facilities	No	2
244-AR Vault	Lag storage and transfer of PUREX waste to TWRS	No	2
Vertical storage units	Storage of contaminated tank equipment	Yes	3
209-E Storage Area	Temporary storage of RCRA, low-level mixed waste, and low-level radioactive waste before disposal	Yes	3
2727-W Sodium Storage Facility	Sodium metal storage	Yes	Radiological facility
213-W Compactor Facility	Contaminated instrument repair	Yes	3
Cribs, ditches, and ponds	Capture of wastewater and effluent discharge	Yes	3
Miscellaneous inactive storage facilities	Storage of various materials ranging from tank waste to diesel fuel to sewage	Yes	2

*Double-contained receiver tanks, catch tanks, process pits, diversion boxes, vault pits, cleanout boxes, and transfer lines.

PUREX = Plutonium Uranium Extraction (Facility).

RCRA = *Resource Conservation and Recovery Act of 1976.*

TWRS = Tank Waste Remediation System.

3.3.2.3 Hazard Evaluation. The hazard evaluation activity for the TWRS FSAR determined a set of potential hazardous conditions that could result in the uncontrolled release of radioactive and/or hazardous material. The significance of a hazardous condition is determined by its likelihood and potential consequences. The results of the accident selection and frequency/ consequence assessment are shown in Appendices C and D, respectively.

The hazard evaluations primarily are used to support the selection of accidents for more detailed analysis and the identification of safety controls. The controls for the safe operation of TWRS are identified based on both the accident and the hazard analysis results. This section addresses both the accident selection and identification of controls. It covers controls for offsite, onsite, worker, and environmental consequences. Details for accidents with potential onsite consequences are described in the hazard evaluation Section 3.3.2.4 and accidents with offsite consequences are described in Section 3.4.2.

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3.3.2.3.1 Accident Selection. Hazardous conditions identified by the hazard evaluation were used to select accidents for detailed quantitative analysis. These accidents, which were selected to be representative, provided an envelope of accident conditions to which TWRS operations could be evaluated. These accidents represent a variety of causes and TWRS facilities, involving different MAR. Included are internal events: criticality in tanks; spray leaks from structures and transfer lines; pool leaks and subsurface leaks from tanks, structures, and transfer lines; external events; fires caused by vehicle accidents; load drop accidents; and natural phenomena (high winds, lightning strikes, and seismic events). They include releases of radioactive or hazardous material from storage tanks; transfer lines; contaminated areas; heating, ventilation, and air conditioning (HVAC) systems; and railcars at the 204-AR Waste Unloading Facility.

An initial set of representative accidents was selected. These accidents represent others with similar release characteristics and accident phenomena or that present a unique but important challenge to a safety system. This initial set of accidents, which represents all the S3 (offsite) and S2 (onsite) hazardous conditions, is known as the candidate accidents.

As a result of examination and early analysis of the candidate accidents, an iterative process occurred between the hazard analysis and the accident analysis. Two types of changes were made to the selection of accidents to be analyzed. First, refinements were made to accommodate a better understanding of certain accident phenomena. For example, it was determined that the tank bump phenomenon was a very specific and complex sequence of events that lead to a specific kind of release and should not be used to represent certain other kinds of pressurized events or ventilation filter failures. Second, additions and refinements were made to accommodate new hazard analyses. After early review revealed certain TWRS processes were not being fully addressed, additional hazard analyses were performed. HazOps were performed at the facility interfaces to analyze the effect of those facilities on TWRS facilities. The differences in the candidate accident list and the analyzed accident list are summarized in Table 3.3.2.3.1-1. The accidents are identified with a number based on the candidate accidents. The original numbering system is retained to allow traceability from the analyzed accidents back to the candidate list.

The final set of analyzed accidents represents all S3 (offsite) and S2 (onsite) hazardous conditions. All accidents considered result in a radioactive or hazardous material release. The final list of all representative accidents is given in Table 3.3.2.3.1-2. This table of analyzed accidents also identifies the section and subsection where the accident analysis is discussed in detail. Table 3.3.2.3.1-3 provides a cross reference between the numbers and hazard identifiers used for the representative (analyzed) accidents in Chapter 3.0 and the appendices. The following is a brief description of each analyzed accident (the gaps in the numbering represent candidate accidents not analyzed [Table 3.3.2.3.1-1]).

1. **Nuclear Criticality**. In this accident fissile material is transferred from the PFP waste storage tank, Tank D-5, to a TWRS DST where the more favorable geometry results in a criticality. Tank D-5 is a wide vertical tank, which is normally stirred and sampled. It is assumed that a combination of errors results in

fissile solution being transferred to a receiver tank (DST). The waste then collects in a depression in the tank sludge layer resulting in a critically favorable geometry. This yields a single neutron burst (insufficient to cause continuous boiling) with dispersal after the burst.

2. **In-Tank Fuel Fire/Deflagration**. In this accident a vehicle fuel tank is damaged while the vehicle is being operated in tank farms. The vehicle fuel tank is ruptured and its contents released. A portion of the fuel enters the waste tank through the damaged riser or through cracks in the cover blocks above the pump pit. Some of the vehicle fuel vaporizes or is aerosolized as the fuel drains to the tank. The remaining portion of fuel pools on the waste surface.

3. **Mixing of Incompatible Material—Tank Pressurization**. This accident is mixing of incompatible material with waste leading to release of radioactive vapors. This involves the addition of nitric acid to a double-contained receiver tank (DCRT). Boiling of waste and entraining of radioactive aerosols occur.

4. **Flammable Gas Deflagrations—DST**. This accident is initiated by ignition or explosion of flammable gases in the headspace of a DST. The flammable gases could be released naturally or as a result of in-tank activity. The ignition source could be installed equipment, an activity in the tank, or natural phenomena. Hydrogen, a major constituent of possible flammable gases, is ignited with very small energy sources. The materials released in an explosion or fire would be existing inventory in the headspace and ventilation system and material resuspended by the explosion/fire. A worst-case set of parameters is used because a large set of concentrations, source terms, and geometries is possible. Depending on conditions, tank failures are possible.

5. **Flammable Gas Deflagrations—SST**. This accident is initiated by ignition or explosion of flammable gases in the headspace of an SST. Flammable gases of concern (hydrogen, ammonia, methane) are produced in the tank waste by three principal means (radiolysis, organic decomposition, and corrosion). Accumulation of flammable gases could occur because of transfer to the tank, because of in-tank processes (i.e., radiolysis), or because of chemical adjustments to the tank. A worst-case set of parameters is used because a large set of concentrations, source terms, and geometries is possible. Depending on conditions, tank failures are possible.

6. **HEPA Filter Failure—Exposure to High Temperature or Pressure**. This accident is release of radioactive material on a HEPA filter of waste tanks, DCRTs, the 204-AR Waste Unloading Facility, the 244-AR Vault, the compactor building, or a catch tank. It is assumed that a fire initiated internally (i.e., by a failed heater) or externally would release materials on the filter.

7. **Fire in Contaminated Area**. This accident is initiated by human error in positioning the crane load or in positioning a support vehicle close to the pit curb. The load swings into the fuel tank of the crane or the support vehicle and hits the pit curb and ignites fuel in the area around an open pit or riser. An uncontrolled release of radioactive and hazardous aerosols and particulate material results.

8. **Waste Transport Vehicle Accident**. Not analyzed in the FSAR. However, this accident is addressed in WHC-SD-TP-SARP-007, *Safety Analysis Report for Packaging (On-site)*, WHC-SD-TP-SARP-001, *Sample Pig Transport System Safety Analysis Report for Packaging (On-site)*, WHC-SD-TP-SARP-002, *Safety Analysis Report for Packaging Onsite Transfer Cask,* and HNF-SD-TP-SARP-023, *Safety Analysis Report for Packaging (On-site) Doorstop Sample Carrier System.*

9. **Organic Solvent Fire/Organic Salt-Nitrate Reaction**. This type of accident includes two scenarios of interest: organic solvent fires and organic nitrate reactions.

   Organic solvent fires were addressed for SSTs, DSTs, and DCRTs. Surface pools, solvent-permeated salt cake burns, and organic vapors were examined. In all cases the solvent is ignited by an internal or external ignition source. In the case of the pool fire, the pressure transient ruptures the HEPA filter and burns until all oxygen is used.

   Organic salt-nitrate propagating reactions may occur in waste tanks where sufficient organic salts exist as a dry fuel and where the fuel is heated to ignition temperatures (230 °C [446 °F]). When organic salts are oxidized by sodium nitrates in the waste, the resulting reaction liberates radionuclides and chemicals in a gaseous form that can pressurize the tank and release large quantities of radionuclides, toxic chemicals, and corrosives to the environment. This hazardous condition is less likely to occur in DSTs because of lower organic salt content and higher moisture content than in SSTs. This reaction will not readily occur in DCRTs, which are used for transferring liquids from one waste tank to another.

10. **Natural Phenomena—High Wind**. This accident is initiated by high winds causing a crane boom to topple onto a tank riser and the riser to puncture the tank dome. Material in the tank headspace and material from the tank's boundaries and waste surfaces would be swept into the atmosphere and widely dispersed by high wind. Potential off-gassing and evaporation of exposed wastes would continue following the initial release.

11. **Natural Phenomena—Lightning**. This accident is initiated by lightning striking in the tank farms, causing fires in one or more tanks. An uncontrolled release of gases, aerosols, and particulates of radioactive and hazardous material from the

ventilation system would result from the ensuing fire. Lightning and other external events, such as aircraft crashes, can be viewed as initiators for accidents already analyzed.

12. **Tank Failure Due to Excessive Loads**. This accident is waste tank dome failure caused by load drop, excess concentrated load external to the tank, and internal loads caused by waste storage. Analysis shows that a load drop of a large mixer pump will result in damage to a small portion of the dome. Dome failure creates a pathway for airborne release and a mechanism for disturbing the waste material.

13. **Tank Failure Due to Vacuum or Degradation**. This accident is initiated by long-term aging and associated degradation or vacuum of an SST to dome failure. It is assumed that these mechanisms present a challenge to the tank integrity. Dome failure would create a pathway for airborne release and a mechanism for disturbing the waste material.

14. **Natural Phenomena—Seismic**. For the purposes of this assessment, a design basis accident with a peak horizontal acceleration of 0.19 *g* and a peak vertical acceleration of 0.12 *g* is assumed to occur per DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*. The expected frequency of such an earthquake is 1×10^{-3}/yr. Such an earthquake could cause multiple occurrences of several types of accidents. For purposes of evaluating the effectiveness of safety SSCs and TSR controls, one or more of the following accident types is assumed to occur:

- Spray leak in a transfer line valve pit
- Seismically induced gas release event (GRE) and deflagration in a waste tank.

Other TWRS facility accidents would occur (i.e., the less than 90-day storage pad failure) but have lesser source terms and consequences in compared with the foregoing accidents. Additionally, other kinds of common mode events such as fires that affect more than one facility are assumed to be bounded by the seismic event.

15. **Spray Leak in Structure or from Overground Waste Transfer Lines**. This accident occurs during a waste transfer operation when the waste is pumped under pressure. During the transfer the containment barrier is breached and respirable-sized aerosols are generated from the spray release. This spray release results from small holes or cracks in the transfer piping, improperly installed transfer jumpers, or defective seals or gaskets. Spray releases can occur in a large number of locations where the piping is exposed to the atmosphere, including the many pits and boxes and the overground waste transfer line.

16. **Spray Leak from Underground Waste Transfer Lines**. This accident is similar to the spray leak described in accident 15 (Spray Leak in Structure or From Overground Waste Transfer Lines) except it occurs in a buried waste transfer line. The accident is initiated by an excavation accident that damages a line while a transfer is under way. The excavating equipment clears away the overlaying earth and breaches the piping. Depending on the breach, the leak can result in a surface pool or spray release. In this case, it is assumed that the piping is nicked in a way that results in a spray release. Other causes of a spray leak from an underground line may be credible but are considered to be bounded by this accident.

17. **Caustic Spray Leak**. This accident scenario is a spray leak from a flexible hose being used to add caustic, sodium hydroxide, to Tank 241-AN-107. The caustic is used to control corrosion. It is added from a tanker truck through an injection skid into the tank through the mixer pump. It is assumed that the pump is running at maximum pressure and that a slit or hole develops in the transfer hose or piping causing a spray release of respirable toxic material.

18A. **Tank Bump**. This accident is a rapid steam pressurization of a waste tank resulting from a specific sequence of events. These events include the following:

- **Initial conditions**—Tank waste material with sufficient heat load (7,600 W [>26,000 Btu/h]) and sufficient hydrostatic head (>6.7 m [>22 ft]) to promote storage of thermal energy.

- **Initiating event**—Equipment failure or operational decision that results in impaired heat transfer from solids in waste to the supernate or from the supernate to the tank ventilation system.

- **Tank waste material heat-up**—Radioactively generated heat builds up in waste tank.

- **Steam generation**—Vapor (steam) is generated in waste when local saturation temperature is reached and is trapped because of the viscosity of sludge and hydrostatic head.

- **Steam release**—Enough steam is generated that it is no longer contained. Physical mechanisms such as agitation might prompt a release.

- **Supernate transport**—The released steam travels through the overlying supernate carrying significant sludge with it. This results in high heat solids and steam contacting waste liquids and transferring energy by way of a condensing effect. After the supernate reaches saturation temperature, the released steam travels into the headspace.

- **Environmental release**—Vapor is released to the environment through unfiltered pathways.

18B. **Unfiltered Release**. This accident consists of unfiltered release from a waste tank with the ventilation fan running. It was assumed that this condition could exist over the course of a year because of an undetected HEPA seal failure. Other failures (e.g., deterioration of the filter) that lead to unfiltered release are possible but yield the same effect.

21. **Subsurface Leak Resulting in Pool**. This accident is initiated by corrosion of the outer and inner transfer piping or by water hammer that breaches the inner pipe and outer encasement. A leak into the surrounding subsurface soil would result and continue until the pumps were shut down and the liquid had drained from the pipe. Liquid waste in the ground mass near the leak would eventually saturate the soil to the point that a pool would form on the ground surface over the leak.

22. **Evaporator Dump**. In this scenario the 242-A Evaporator vessel dumps its contents to Tank 241-AW-102. The thermally hot waste rapidly enters the cooler feed tank and by heating the tank atmosphere causes a rapid expansion of that atmosphere along with loss of power to the tank ventilation system, which pressurizes the dome space. As a result, the HEPA filters are blown out, resulting in an unfiltered release.

23. **Mixing of Incompatible Material—Toxic Vapor Generation**. This accident is addition of incompatible material to waste leading to release of toxic vapors. This involves the addition of caustic (sodium hydroxide) to a low pH waste tank. Toxic vapors such as ammonia could be released whether HEPA filters remain intact or not.

25. **Leak from Railcar/Tank Trailer**. The accident analyzed is a railcar breach as the railcar is about to enter the 204-AR Waste Unloading Facility. The railcar is derailed, overturned, and breached, allowing its entire contents to be spilled onto the ground. The liquid waste is assumed to pool on the surface near the 204-AR Waste Unloading Facility for a period of time before the waste is absorbed by the sandy soil.

26. **Surface Leak Resulting in Pool**. Surface pools can form because of leaks inside transfer system enclosures that result in overflows of enclosures. These accidents form surface pools that can be fractionally resuspended because of wind blowing over the pool's surface. The bounding event selected is overflow of aging waste from a valve pit because aging waste represents the highest dose potential.

28. **Unplanned Excavation/Drilling in Crib/Ditch/Pond**. This accident is initiated by accidentally excavating or drilling into active or abandoned cribs, ditches, or ponds. The excavation or drilling disturbs the waste and brings it to the surface to be released. Contaminated ground surfaces and airborne particulates would be generated from the disturbed site.

29. **Subsurface Leak Remaining Subsurface**. In this accident it is postulated that a structural failure of a single-walled transfer pipe results in a leak to the surrounding soil. A leak of 5% of a 379 L/min (100 gal/min) flow rate for 24 h creates a subsurface plume that does not create a surface pool. Direct-buried single-wall pipe generally is used for salt well pumping, which is operated at very low flow rates.

30. **Sodium Fire**. In this accident it is postulated that sodium stored in the 2727-W Facility is exposed to moisture and air after destruction of the building and loss of storage tank integrity by high wind.

31. **Aboveground Structure Failure**. A wind-induced failure of a flexible receiver bag containing contaminated equipment removed from an underground waste storage tank was postulated. Failure of the bag occurs when the equipment is withdrawn above the riser before sealing occurs. High wind causes the crane or supported equipment to contact and tear the receiver bag.

32. **Steam Intrusion from Interfacing Systems**. In this accident it is postulated that a steam jet transfer of waste inadvertently results in steam entrainment of radioactive aerosols from the waste transfer lines because of failure to shut off the steam supply when required. The radioactive aerosols are released from the receiving tank through unsealed cover blocks and a failed HEPA filter.

Table 3.3.2.3.1-4 lists each analyzed accident and identifies the consequence as estimated by the hazards evaluation compared with the consequence calculated by accident analysis. Generally, the calculated consequences matched the estimated consequence or were less severe.

Accidents described in Addenda 1, 2, 3, and 4 were analyzed separately. However, no new representative accidents, beyond those described above, were identified in the Addenda.

Appendix C lists the analyzed (representative) accidents as developed in the hazard evaluation (Section 3.3.2.3) and lists the hazardous conditions that are represented by each accident. The hazardous conditions represented by each accident have one or more significant characteristics in common. It is important to note that all the hazardous conditions represented by the same accident are not the same in every respect. For example, accident 7 (Fire in Contaminated Area) represents a set of hazardous conditions that includes release from contaminated area because of load drop. This situation allows use of the consequence result from the representative accident to be used to bound the consequences of the load drop hazardous

condition. However, decisions about controls for the load drop hazardous condition cannot use the controls for the fire, but need to address the causes of load drops.

For each hazardous condition listed in Appendix C, the following information is provided:

- The accident release category identifies hazardous conditions that would result in common accident release attributes. This categorization is described in Section 3.3.1.4.
- The identification number is a specific and unique identification number associated with each hazardous condition.
- MAR identification is provided.
- The hazardous condition defines a release of hazardous or toxic material from a particular location due to some cause.
- The cause of the hazardous condition is described.
- The initial frequency and consequence assessment for an accident associated with a particular hazardous condition is provided, assuming no controls were in place.
- Cause group code as previously defined in the methodology section is defined.
- Representative accident number is assigned to a hazardous condition which is represented by the respective analyzed accident.

Supplemental accident analyses for projects not within the original scope of the FSAR are included in the designated addenda, as applicable. The accident analyses for the WRSS are presented in Addendum 1. The accident analyses for the RCSTS are presented in Addendum 2. The accident analyses for the 241-AZ-702 ventilation system are presented in Addendum 3. The accident analyses for the 241-AZ-101 mixer pump test are presented in Addendum 4. Supplemental safety analyses for remediation activities and operations in Tank 241-SY-101 are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

References

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HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-TP-SARP-023, 1997, *Safety Analysis Report for Packaging (On-site) Doorstop Sample Carrier System,* Rev. 0-A, Rust Federal Services, Inc., Richland, Washington.

WHC-SD-TP-SARP-001, 1995, *Sample Pig Transport System Safety Analysis Report for Packaging (On-site)*, Rev. 0-G, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-TP-SARP-002, 1996, *Safety Analysis Report for Packaging Onsite Transfer Cask*, Rev. 0-P, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-TP-SARP-007, 1997, *Safety Analysis Report for Packaging (On-site)*, Rev. 0-F, Westinghouse Hanford Company, Richland, Washington.

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Table 3.3.2.3.1-1. Candidate Accidents Versus Analyzed Accidents. (3 sheets)

Difference between candidate and analyzed accidents		
Candidate accidents	Analyzed accidents	Comments
1. Tank Criticality	1. Nuclear Criticality	Nuclear criticality accident analyses showed that a certain DST criticality was a higher risk than the DCRT criticality selected to be the representative accident. Therefore, the representative accident was changed and the name was slightly modified.
2. Fuel Fire Associated with a DST/SST	2. In-Tank Fuel Fire/Deflagration	Only the name was modified
3. Chemical Reaction in DCRT/DST/SST	3. Mixing of Incompatible Material—Tank Pressurization	Only the name was modified
4. Dome Collapse in a DST	4. Flammable Gas Deflagrations—DST	Accident analyses showed that flammable gas deflagration events were judged to have the potential to do limited damage to the dome while other events have none. Therefore, the name was changed as well as some binning of the hazardous conditions for accidents No. 4, 5, and 9.
5. Dome Collapse in a SST	5. Flammable Gas Deflagrations—SST	Accident analyses showed that flammable gas deflagration events were judged to have the potential to do limited damage to the dome while other events have none. Therefore, the name was changed as well as some binning of the hazardous conditions for accidents No. 4, 5, and 9.
6. High Energy Ventilation/Filter/ Vapor Space Release from DCRT/DST/SST	6. HEPA Filter Failure—Exposure to High Temperature or Pressure	Only the name was modified
7. Fire in a Contaminated Area	7. Fire in Contaminated Area	Same
8. High Energy Vehicle Accident During Transport of Hazardous Material	8. Waste Transport Vehicle Accident	Only the name was modified (not analyzed)
9. Fire or Explosion in DCRT/DST/SST	9. Organic Solvent Fire/Organic Salt-Nitrate Reaction	Accident analyses show that organic solvent fire and organic nitrate reactions do not lead to dome collapse, but gas deflagration might damage the dome. So, gas deflagrations are considered in accident No. 4 and 5, and organic reactions are considered in No. 9. Among these three accidents all important reactions leading to fire or explosion are covered.
10. External Event: High Wind or Tornado	10. Natural Phenomena—High Wind	Only the name was modified
11. External Event: Other	11. Natural Phenomena—Lightning	Only the name was modified
12. DST/SST Dome Collapse from Excessive Weight	12. Tank Failure Due to Excessive Loads	Only the name was modified

Table 3.3.2.3.1-1. Candidate Accidents Versus Analyzed Accidents. (3 sheets)

Difference between candidate and analyzed accidents		
Candidate accidents	Analyzed accidents	Comments
13. DST/SST Dome Collapse from Vacuum or Degradation	13. Tank Failure Due to Vacuum or Degradation	Only the name was modified
14. Multiple DST and/or SST Dome Collapse	14. Natural Phenomena—Seismic	Only the name was modified
15. Spray Leak in Pump Pit/Valve Pit/ Diversion Box etc.	15. Spray Leak in Structure or from Overground Waste Transfer Lines	Only the name was modified
16. Spray Leak Directly to Atmosphere	16. Spray Leak from Underground Waste Transfer Lines	Only the name was modified
17. Spray Leak in Caustic Line	17. Caustic Spray Leak	Only the name was modified
18. Tank Bump or Ventilation Damage Spreading Aerosols	18A. Tank Bump	Tank bump accidents were separated from accidents which involve only ventilation failures because they have a potential for a greater release. Accordingly, candidate accident No. 18 was divided into 18A and 18B.
	18B. Unfiltered Release	Tank bump accidents were separated from accidents which involve only ventilation failures because they have a potential for a greater release. Accordingly, candidate accident No. 18 was divided into 18A and 18B.
19. Leak to Surface		Certain subsurface leaks were judged to result in surface pools leaks. Therefore, candidate accident No. 19 and 21 were combined into analyzed accident No. 21.
20. Misrouting		Only two events of this type were determined to have an S2 consequence or higher and were judged to result in a spray leak. Therefore, candidate accident No. 20 was reassigned to analyzed accident No. 15.
21. Leak to Subsurface	21. Subsurface Leak Resulting in Pool	Certain subsurface leaks were judged to result in surface pools leaks. Therefore, candidate accidents No. 19 and 21 were combined into analyzed accident No. 21.
22. Evaporator Dump or Ventilation/Filter/ Airspace Release	22. Evaporator Dump	Only the name was modified
23. Addition of Incompatible Material to Waste	23. Mixing of Incompatible Material—Toxic Vapor Generation	Only the name was modified
24. Backflow/Overflow from Pit/Sump/Box		Overflows from pits, sumps, boxes, vaults and event tanks were judged to be direct surface releases. Therefore, candidate accident No. 24, 26, and 27 were combined into analyzed accident No. 26.

Table 3.3.2.3.1-1. Candidate Accidents Versus Analyzed Accidents. (3 sheets)

Difference between candidate and analyzed accidents		
Candidate accidents	Analyzed accidents	Comments
25. Leak from Rail/Truck Tanker	25. Leak from Railcar/ Tank Trailer	Only the name was modified
26. Low Energy Leak Directly to Surface	26. Surface Leak Resulting in Pool	Overflows from pits, sumps, boxes, vaults and event tanks were judged to be direct surface releases. Therefore, candidate accident No. 24, 26, and 27 were combined into analyzed accident No. 26.
27. Overflow from DCRT/ DST/SST		Overflows from pits, sumps, boxes, vaults and event tanks were judged to be direct surface releases. Therefore, candidate accident No. 24, 26, and 27 were combined into analyzed accident No. 26.
28. Excavation/Drilling in Pond/Crib/Ditch	28. Unplanned Excavation/ Drilling in Crib/Ditch/ Pond	Only the name was modified
29. Low Energy Leak to Subsurface	29. Subsurface Leak Remaining Subsurface	Only the name was modified
	30. Sodium Fire	This accident was added after new hazard analysis work for facilities that could not be represented by other facility hazards.
	31. Aboveground Structure Failure	This accident was added after new hazard analysis work for facilities that could not be represented by other facility hazards.
	32. Steam Intrusion from Interfacing Systems	This accident was added after new hazard analysis work for facilities that could not be represented by other facility hazards.

Note: Some of the accidents listed above have been reanalyzed for the WRSS, the RCSTS, the 241-AZ-702 ventilation system, and the 241-AZ-101 mixer pump test as described in Addenda 1, 2, 3, and 4, respectively.

DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

Table 3.3.2.3.1-2. Accident Analysis Sections.

Number	Analyzed accidents	FSAR section that addresses analyzed accident
1	Nuclear Criticality	3.3.2.4.1
2	In-Tank Fuel Fire/Deflagration	3.4.2.5
3	Mixing of Incompatible Material—Tank Pressurization	3.3.2.4.12
4	Flammable Gas Deflagrations—DST	3.4.2.2
5	Flammable Gas Deflagrations—SST	3.4.2.2
6	HEPA Filter Failure—Exposure to High Temperature or Pressure	3.3.2.4.2
7	Fire in Contaminated Area	3.3.2.4.3
8	Waste Transport Vehicle Accident	3.4.2.12
9	Organic Solvent Fire/Organic Salt-Nitrate Reaction	3.4.2.4/3.4.2.6
10	Natural Phenomena—High Wind	3.4.2.12
11	Natural Phenomena—Lightning	3.4.2.12
12	Tank Failure Due to Excessive Loads	3.4.2.1
13	Tank Failure Due to Vacuum or Degradation	3.4.2.1
14	Natural Phenomena—Seismic	3.4.2.12
15	Spray Leak in Structure or from Overground Waste Transfer Lines	3.4.2.9
16	Spray Leak from Underground Waste Transfer Lines	3.4.2.9
17	Caustic Spray Leak	3.3.2.4.9
18A	Tank Bump	3.4.2.11
18B	Unfiltered Release	3.3.2.4.2
21	Subsurface Leak Resulting in Pool	3.4.2.8
22	Evaporator Dump	3.3.2.4.4
23	Mixing of Incompatible Material—Toxic Vapor Generation	3.3.2.4.11
25	Leak from Railcar/Tank Trailer	3.3.2.4.6
26	Surface Leak Resulting Pool	3.4.2.7
28	Unplanned Excavation/Drilling in Crib/Ditch/Pond	3.3.2.4.8
29	Subsurface Leak Remaining Subsurface	3.3.2.4.7
30	Sodium Fire	3.3.2.4.10
31	Aboveground Structure Failure	3.4.2.12
32	Steam Intrusion from Interfacing Systems	3.3.2.4.5

Note: The analyzed accidents and cross-references for the WRSS, the RCSTS, the 241-AZ-702 ventilation system, and the 241-AZ-101 mixer pump test are contained in Addenda 1, 2, 3, and 4, respectively.

DST = double-shell tank.
FSAR = Final Safety Analysis Report.
HEPA = high-efficiency particulate air (filter).
RCSTS = replacement cross-site transfer system.
SST = single-shell tank.
WRSS = waste retrieval sluicing system.

Table 3.3.2.3.1-3. Representative Accident Designator Cross Reference. (2 sheets)

Number	Representative (analyzed) accident title	Appendix designators	
		Accident number(s)	Hazardous condition identifier
1	Nuclear Criticality	01	I-PFP-1-AGT-A
2	In-Tank Fuel Fire/Deflagration	02A	EE-05-a
		02B	EE-05-b
3	Mixing of Incompatible Material—Tank Pressurization	03	I-222S-1-RXN-A
4	Flammable Gas Deflagrations—DST	04	ITK-10-b
5	Flammable Gas Deflagrations—SST	05	XS-01-FLOW03
6	HEPA Filter Failure—Exposure to High Temperature or Pressure	06	106C-10J
7	Fire in Contaminated Area	07	CRN-05
8	Waste Transport Vehicle Accident	08	VEH-03
9	Organic Solvent Fire/Organic Salt-Nitrate Reaction	09	I-222S-1-CMP-E
10	Natural Phenomena—High Wind	10	CRN-13-a
11	Natural Phenomena—Lightning	11	NP-03
12	Tank Failure Due to Excessive Loads	12A	CRN-03
		12B	CRN-04
		12C	CRN-11
13	Tank Failure Due to Vacuum or Degradation	13	114SX-06.a.3
14	Natural Phenomena—Seismic	14	NP-07
15	Spray Leak in Structure or From Overground Waste Transfer Lines	15	XS-06-FLOW02
16	Spray Leak from Underground Waste Transfer Lines	16	EE-16
17	Caustic Spray Leak	17	107AN-02-PRES
18A	Tank Bump	18A	102AW-02-TEMP02
18B	Unfiltered Release	18B	114SX-04.c.2.a

Table 3.3.2.3.1-3. Representative Accident Designator Cross Reference. (2 sheets)

Number	Representative (analyzed) accident title	Appendix designators	
		Accident number(s)	Hazardous condition identifier
21	Subsurface Leak Resulting in Pool	21A	XS-07-FLOW02
		21B	XS-07-FLOW06
22	Evaporator Dump	22	102AW-02-PRES 102AW-02-TEMP
23	Mixing of Incompatible Material—Toxic Vapor Generation	23	XS-26-PRES XS-26-TEMP
25	Leak from Railcar/Tank Trailer	25	204AR-01H
26	Surface Leak Resulting in Pool	26	W058-PRES01
28	Unplanned Excavation/Drilling in Crib/Ditch/Pond	28	CDP-10
29	Subsurface Leak Remaining Subsurface	29	102S-01.b3
30	Sodium Fire	30	2727W-06
31	Aboveground Structure Failure	31	ITK-FR-08
32	Steam Intrusion from Interfacing Systems	32	I-242A-6-CMP-A

DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

Table 3.3.2.3.1-4. Estimated Accident Consequence Without Controls Before and After Accident Analyses. (2 sheets)

Analyzed accidents			Consequence Without Controls		
			Hazard analysis (estimated)	Accident analysis (calculated)	Note
	1	Nuclear Criticality	S2	S1	b
	2	In-Tank Fuel Fire/Deflagration	S3	S3	
	3	Mixing of Incompatible Material—Tank Pressurization	S2	S2	
	4	Flammable Gas Deflagrations—DST	S3	S3	
	5	Flammable Gas Deflagrations—SST	S3	S3	
	6	HEPA Filter Failure—Exposure to High Temperature or Pressure	S2	S2	
	7	Fire in Contaminated Area	S2	S2	
	8	Waste Transport Vehicle Accident	–	–	c
	9A	Organic Solvent Fire	S3	S2	b
	9B	Organic Salt-Nitrate Reaction	S3	S3	
	10	Natural Phenomena—High Wind	S3	S2	b
	11	Natural Phenomena—Lightning	S2	S3	a
	12	Tank Failure Due to Excessive Loads	S3	S2	b
	13	Tank Failure Due to Vacuum or Degradation	S3	S0	b
	14	Natural Phenomena—Seismic	S3	S3	
	15	Spray Leak in Structure or from Overground Waste Transfer Lines	S3	S3	
	16	Spray Leak from Underground Waste Transfer Lines	S3	S3	
	17	Caustic Spray Leak	S2	S2	
	18A	Tank Bump	S2	S2	
	18B	Unfiltered Release	S2	S2	
	21	Subsurface Leak Resulting in Pool	S2	S3	a
	22	Evaporator Dump	S2	S1	b
	23	Mixing of Incompatible Material—Toxic Vapor Generation	S2	S1	b
	25	Leak from Railcar/Tank Trailer	S2	S1	b
	26	Surface Leak Resulting in Pool	S2	S3	a
	28	Unplanned Excavation/Drilling in Crib/Ditch/Pond	S2	S1	b
	29	Subsurface Leak Remaining Subsurface	S2	S1	b
	30	Sodium Fire	S2	S1	b
	31	Aboveground Structure Failure	S2	S1	b

Table 3.3.2.3.1-4. Estimated Accident Consequence Without Controls Before and After Accident Analyses. (2 sheets)

Analyzed accidents		Consequence Without Controls		
		Hazard analysis (estimated)	Accident analysis (calculated)	Note
32	Steam Intrusion from Interfacing Systems	S3	S1	b

[a]Analyzed accident consequences greater than Hazard Analysis Estimate.
[b]Analyzed accident consequences less than Hazard Analysis Estimate.
[c]Assessment of consequences not in scope of Final Safety Analysis Report.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

3.3.2.3.2 Defense-in-Depth. The hazard and accident analysis results are used to identify safety SSCs, TSR controls, and other controls for the safe operation of TWRS. The total set of controls identified for each accident (hazardous condition) is considered as the Defense-in-Depth approach for that condition. This section discusses the Defense-in-Depth approach for accidents (hazardous conditions) with the potential for significant consequences for the offsite public, onsite worker, facility worker, and the environment. Details of the controls identified for accidents with potential significant onsite consequences are described in this section; controls for accidents with offsite consequences are described in Section 3.4.2. A summary of the SSCs and TSR controls identified for the accidents analyzed is shown in Table 3.3.2.3.2-1.

A summary of the additional Defense-in-Depth controls is shown in Table 3.3.2.3.2-1. These controls have been allocated to all hazardous conditions with S3, S2, E3, and E2 consequences. In addition, the Defense-in-Depth controls have been allocated to the anticipated hazardous condition with significant facility worker consequences (F3/S1).

To assist in the assessment of the level of safety for TWRS with the controls in place, the hazard analysis included an assessment of the frequency and consequences of the hazardous conditions (S3, S2, and S1/F3) considering the frequency and impact of control failure. This result provides a qualitative estimate of the residual risk for each hazardous condition.

- Protection Against Offsite Consequences—Section 3.4.2 presents analyses of evaluation basis accidents identified in Table 3.3.2.3.1-4 with potentially significant offsite consequences (i.e., S3). The evaluation basis accidents are analyzed to identify the necessary and sufficient set of Safety-Class and Safety-Significant SSCs and TSR controls.

- Protection Against Onsite Consequences—Section 3.3.2.4 presents analyses of evaluation basis accidents identified in Table 3.3.2.3.1-4 with potentially significant onsite consequences (i.e., S2). The evaluation basis accidents are analyzed to identify the necessary and sufficient set of Safety-Class and Safety-Significant SSCs and TSR controls.

The first step in the analytical process is to quantify the consequences and frequency of a postulated accident assuming the absence of existing preventive or mitigative features. As stated in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, assuming the absence of preventive or mitigative features "does not require denying the physical design of facility structures, systems, and components." Accordingly, credit is taken for certain design features, primarily those that are passive.

It is important to understand that an "analysis without controls" is an evaluation of a hypothetical condition as opposed to an evaluation of the current operational configuration of a subject facility. The purpose of performing the analysis without controls is to establish a baseline risk (i.e., a consequence and frequency) that can be compared with the risk guidelines. This comparison puts the relative importance of the need for controls into perspective and defines the need for further analysis.

Consequences for analyses without controls are calculated by not taking credit for mitigative features (e.g., filtered ventilation pathways) during source term development. Frequencies are based on the absence of controls as opposed to the failure of controls at a defined rate and therefore are equal to the initiating event frequencies modified as necessary to account for conditional probabilities. Based on this approach, the frequency of accidents without controls typically falls in the anticipated category (i.e., $>1 \times 10^{-2}$ to $\leq 1 \times 10^{0}$ per year). This should not be misinterpreted as meaning the consequences of an accident without controls can actually occur at a TWRS facility at an anticipated frequency. As stated above, these are evaluations of hypothetical conditions performed to establish a baseline risk.

Once determined, the consequences and frequency of the accident without controls are compared with the risk guidelines. If the consequences are within both the onsite and offsite guidelines at the applicable frequency, no further quantitative analysis is performed for the purpose of defining controls. In such cases, existing controls are typically defined as providing Defense-in-Depth.

If the risk guidelines are exceeded, additional analysis is required to identify Safety-Class or Safety-Significant SSCs and TSR controls that bring the consequences and frequency within the guidelines. In accordance with WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual*, Safety-Class SSCs are required if the offsite radiological guidelines are exceeded. Safety-Significant SSCs are required if the offsite toxicological guidelines or onsite radiological or toxicological guidelines are exceeded.

Consistent with DOE-STD-3009-94, safety SSCs and TSR controls are selected using an iterative process in which credit for preferentially selected controls is incrementally taken and the results compared with the risk guidelines. The end result is an "analysis with controls." In these analyses, consequences and frequencies are determined assuming that the identified controls function as intended. If the controls are mitigative, the accident frequency remains unchanged relative to the analysis without controls and consequences are reduced. If the controls are preventive, the means by which the controls prevent the accident are described and no consequences or frequencies are calculated. Although these analyses make the assumption that the controls function as intended, it is recognized that each identified SSC and TSR control has an associated failure rate. The failure of controls and the associated impact relative to risk guidelines are addressed in Section 3.4.3.1.

Controls were selected on the basis of effectiveness, practicality, and ease of implementation with preference given to the following:

- Controls that would prevent the accident versus those that would mitigate its consequences

- Passive engineered versus active engineered controls

- Engineered controls versus administrative controls

- Existing controls versus new controls.

When comparing the results of analyses without controls and with controls with the guidelines, consideration was given to (1) the margin by which the guidelines were met and (2) the reliability of the selected controls. In cases where the margin was small, the need for additional controls was evaluated. In these evaluations, consideration was given to the degree of conservatism in the consequence calculation. Controls known to be of low reliability were not selected. In cases were the degree of reliability was uncertain, the need for additional controls was evaluated.

Configuration Control of Defense-in-Depth. Defense-in-Depth is an approach to facility safety that builds in layers of defense against the release of radiological and toxicological materials so that no single layer is exclusively relied upon. In keeping with the graded approach concept, no requirement to demonstrate a minimum number of layers of Defense-in-Depth is imposed. However, defining Defense-in Depth as it exists at a given facility is important.

The layers of Defense-in Depth identified for TWRS consists of Safety-Class SSCs, Safety-Significant SSCs, TSR controls, and additional existing components, procedures, and controls that provide Defense-in-Depth. The safety functions performed by Safety-Class SSCs prevent or mitigate releases to the public that would otherwise exceed the offsite radiological risk guidelines or prevent a nuclear criticality. Similarly, safety functions performed by Safety-Significant SSCs prevent or mitigate releases of radiological materials to onsite workers and toxic chemicals to the offsite public and onsite workers. TSR controls formally acknowledge features that are of major significance to Defense-in-Depth and provide a special level of control. The additional existing components, procedures, and controls identified as providing Defense-in-Depth are controlled using the configuration and document control process described in Section 17.4.2.

References

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DOE-STD-3009-94, 1994, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

Wagoner, J. D., 1998b, *Authorization Basis Approval of Justification for Continued Operation (JCO) of Transfer Lines Having Structures with Less Volume than the 241-A-A Valve Pit* (Letter 98-WSD-052 to H. J. Hatch, Fluor Daniel Hanford, Inc., March 17), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC-CM-4-46, 1992, *Nonreactor Facility Safety Analysis Manual*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
1.	Nuclear Criticality 3.3.2.4.1	None required	SL: None required LCS: None required LCO: None required AC: Nuclear criticality safety • Establish CPSs based on CSERs • Procedures for recovery from CPS nonconformance • Criticality training program • For transfers into the tank farm - pH ≥ 8, - plutonium concentration <0.04 g/L averaged over the entire volume of the transferred waste - neutron absorber to plutonium ratio > subcritical mass ratio - Independent verification of documented results • MISF activities prohibited until waste characterized (monitoring and sampling allowed) • CSERs for all cross-site slurry transfers of tank waste from tank to tank	None
2.	In-Tank Fuel Fire/ Deflagration 3.4.2.5	None required	SL: None required LCS: None required LCO: None required AC: Ignition controls (vehicle controls) • Vehicle fuel system protection required within tank farms • Physical barriers to restrict vehicle access • Speed limit controls within tank farms AC: Emergency preparedness (fire)	• Vehicle positioning spotters
3.	Mixing of Incompatible Material - Tank Pressurization 3.3.2.4.12	SS: HEPA filters (one stage required on 244-S, 244-TX, and 244-A)	SL: None required LCS: None required LCO: None required AC: Transfer controls • Compatibility evaluation for pH ≥ 8 before transfer into tank farm (excluding water transfers and drums containing caustic chemicals) AC: HEPA filter controls (244-S, 244-TX, and 244-A) • HEPA filter source term • HEPA filter efficiency	None

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
4.	Flammable Gas Deflagrations - DST 3.4.2.2 See Note 1	SC: DST/AWF primary tank ventilation systems SC: Primary tank leak detection systems SC: DST structure (see Note 3) SC: AWF tank structure (see Note 3)	SL: None required LCS: None required LCO: DST and AWF tank ventilation systems LCO: Primary tank leak detection systems AC: Flammability controls AC: Ignition controls (flammable gas) • Intrusive controls • Flammable gas ignition controls AC: Flammable gas monitoring controls • Manned work activity • Unmanned operations AC: Transfer controls • Ensure appropriate controls applied to final state of tank AC: Emergency preparedness (fire and waste leak) AC: HEPA filter controls • Periodic radiation surveillance • Replacement based on accumulation • Aerosol test upon installation (AWF 241-AZ-702) • Periodic aerosol test (AWF-241-AZ-702) AC: Process instrumentation and measuring and test equipment AC: Excavation Controls	• Flammable gas monitoring instrumentation • Leak detectors, material balances, and tank level monitoring • Flush transfer lines after use • Operate active ventilation systems • See HNF-3737 for Tank 241-SY-101
5.	Flammable Gas Deflagrations - SST 3.4.2.2	SC: SST ventilation systems SC: DCRT ventilation systems SC: 244-AR TK-002 ventilation system SC: SST structure (see Note 3) SC: 244-CR TK-003 ventilation system	SL: None required LCS: None required LCO: SST ventilation systems - active LCO: SST ventilation systems - passive LCO: DCRT ventilation systems LCO: 244-AR TK-002 ventilation system AC: Flammability controls AC: Ignition controls (flammable gas) • Intrusive controls • Flammable gas ignition controls AC: Flammable gas monitoring controls • Manned work activity controls • Unmanned operations controls • DCRT ventilation requirement • Non-GRE facilities AC: Transfer controls • Ensure appropriate controls applied to final state of tank AC: Emergency preparedness (fire and waste leak) AC: HEPA filter controls • Periodic radiation surveillance • Replacement based on accumulation AC: Process instrumentation and measuring and test equipment AC: Excavation Controls	• Flammable gas monitoring instrumentation • Leak detectors, material balances, and tank level monitoring • Flush transfer lines after use • Operate active ventilation systems • Portable exhausters

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
6.	HEPA Filter Failure - Exposure to High Temperature or Pressure 3.3.2.4.2	SS: Ventilation stack CAM interlock systems (This includes CAM interlock systems associated with portable exhausters)	SL: None required LCS: None required LCO: Ventilation stack CAM interlock systems AC: HEPA filter controls • Periodic radiation surveillance • Replacement based on accumulation • Aerosol test upon installation (AWF 241-AZ-702) • Periodic aerosol test (AWF-241-AZ-702)	All TWRS (where installed) except the 204-AR Waste Unloading Facility • HEPA filter low differential pressure interlocks • HEPA filter high differential pressure alarms • Aerosol testing of HEPA filters • Interlock on heater overtemperature • Periodic surveillance of HEPA differential pressure • HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h) 204-AR Waste Unloading Facility • HEPA filter low differential pressure alarm • HEPA filter high differential pressure interlock • Aerosol testing of HEPA filters • Interlock on heater overtemperature • Periodic surveillance of HEPA differential pressure • HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h)
7.	Fire in Contaminated Area 3.3.2.4.3 See Note 1	None required	SL: None required LCS: None required LCO: None required AC: Ignition controls (vehicle controls) • Vehicle fuel system protection required within tank farms • Physical barriers to restrict vehicle access • Speed limit controls within tank farms AC: Emergency preparedness (fire)	• Fire prevention practices • Job control: - respiration protection - contamination control • Vehicle positioning spotters • Vegetation Control Program
8.	Waste Transport Vehicle Accident 3.4.2.12.1	Controls contained in SARPs		

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
9.	Organic Solvent Fire/Organic Salt-Nitrate Reaction 3.4.2.4 3.4.2.6	Organic Solvent Fire SC: SST structure (see Note 3) SC: DST structure (see Note 3) SC: AWF tank structure (see Note 3) Organic Salt-Nitrate Reaction SC: Temperature monitoring systems (see Note 5) SC: SST structure (see Note 3) SC: DST structure (see Note 3) SC: AWF tank structure (see Note 3)	Organic Solvent Fire SL: None LCS/LCO: None AC: Ignition controls (organic solvent) • Intrusive controls • Vehicle controls - Vehicle fuel system protection required within tank farms - Physical barriers to restrict vehicle access - Speed limit controls within tank farms AC: Emergency preparedness (fire) AC: HEPA filter controls • Periodic radiation surveillance • Replacement based on accumulation • Aerosol test upon installation (AWF 241-AZ-702) • Periodic aerosol test (AWF-241-AZ-702) AC: Transfer controls • Ensure appropriate controls applied to final state of tank Organic Salt-Nitrate Reaction* SL: SST waste temperature LCS/LCO: SST waste temperature controls SL: DST and AWF tank waste temperature LCS/LCO: DST and AWF tank waste temperature controls AC: Ignition controls (organic salt-nitrate) • Intrusive controls • Vehicle controls - Vehicle fuel system protection required within tank farms - Physical barriers to restrict vehicle access - Speed limit controls within tank farms AC: Emergency preparedness (fire) AC: HEPA filter controls • Periodic radiation surveillance • Replacement based on accumulation • Aerosol test upon installation (AWF 241-AZ-702) • Periodic aerosol test (AWF-241-AZ-702) AC: Transfer controls • Ensure appropriate controls applied to final state of tank AC: Moisture controls • Interim stabilization • Emergency pumping • Moisture monitoring • Ventilation system changes AC: Process instrumentation and measuring and test equipment *ACs also include flammable gas ignition prevention controls	Organic Solvent Fire: • Vehicle positioning spotters • HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h) • Ventilation stack CAM interlock systems Organic Salt-Nitrate Reaction: • Vehicle positioning spotters • HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h) • SST and DST/AWF primary tank ventilation systems

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
10.	Natural Phenomena - High Wind 3.4.2.12.1	None required	SL: None required LCS: None required LCO: None required AC: Dome loading controls • Hanford Site Hoisting and Rigging Manual for lifts (See Note 2)	• Restrictions on operations during high winds • Compliance with Hoisting and Rigging Manual
11.	Natural Phenomena - Lightning 3.4.2.12.2	None required	SL: None required LCS: None required LCO: None required AC: Ignition controls (lightning) • Intrusive controls	• Lightning protection: - Grounded air terminals - Grounded tank risers and permanently installed instrumentation bonded to risers • Grounding grids (where installed)
12.	Tank Failure Due to Excessive Loads 3.4.2.1	SS: SST structure (100 series tanks only for load drop) (see Note 4) SS: DST structure (see Note 4) SS: AWF tank structure (see Note 4)	SL: None required LCS: None required LCO: None required AC: Dome loading controls • Limits on load height • Hanford Site Hoisting and Rigging Manual for lifts (See Note 2) • Uniform and concentrated load limits	• Restrictions on operations during high winds • SST dome deflection monitoring • Hydrostatic load monitoring • Emergency Preparedness • Establish criteria for tank loads
13.	Tank Failure Due to Vacuum or Degradation 3.4.2.1	SS: SST structure (see Note 4) SS: DST structure (see Note 4) SS: AWF tank structure (see Note 4)	SL: None required LCS: None required LCO: None required AC: None required	• Tank pressure monitors/alarms • Tank farm waste compatibility program • Waste temperature (absolute and delta) monitoring • Tank integrity assessments • SST dome deflection monitoring • Hydrostatic load monitoring • Establish criteria for tank loads
14.	Natural Phenomena - Seismic 3.4.2.12.3	SC: SST structure (see Note 3) SC: DST structure (see Note 3) SC: AWF tank structure (see Note 3)	SL: None required LCS: None required LCO: None required AC: Emergency preparedness (seismic, verify SSC integrity)	• Tank integrity assessments

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
15.	Spray Leak from Waste Transfer System 3.4.2.9 See Note 1	SC: Transfer system covers SC: Above grade portions of Process Pits, Diversion Boxes, Vault Pits, and COBs (physical integrity) (See Note 3) SC: Pressure switch interlock or alarm systems (service water lines, except 204-AR Waste Unloading Facility) SC: Ventilation stack CAM interlock systems (See Item 6.2 of Table 3.4.2.9-3 for additional description of stack CAM in portable exhausters) SC: OGT encasement and connections SC: OGT concrete shielding system SC: 204-AR waste unloading facility structure SC: Backflow prevention devices (204-AR Waste Unloading Facility only) SC: RCSTS entry doors (diversion box and vent station) SC: RCSTS diversion box and vent station emergency pumpout line, air sample line, liner washdown system, and exhauster hookup SC: RCSTS pressure relief valve (244-A lift station) SC: RCSTS rupture disk (244-A lift station) SS: RCSTS inlet air HEPA filter system (one stage on 6241-A and 6241-V SS: Backflow prevention devices	SL: None required LCS: None required LCO: Transfer system covers and RCSTS entry doors LCO: Service water pressure detection systems LCO: Ventilation stack CAM interlock systems LCO: RCSTS pressure relief valve and rupture disk (reserved for slurry line, WT-SLL-3160) LCO: 204-AR Backflow Prevention System AC: Transfer controls (spray leaks) • Transfer system configuration management • 204-AR door closed requirement AC: Encasement seal loop controls AC: Transfer pump administrative lock controls AC: Transfer system cover removal controls AC: Emergency preparedness (waste leak)	General • Leak detection systems (transfer leak detection systems and encasement leak detection systems) • Leak testing of jumpers • Drains in waste transfer system structures Specific to Spray Leaks from Service Water System (Backflow) • Service pit leak detection systems (where installed) • Valve position limit switches/interlocks (salt well systems) (where installed and maintained) • Check valves (salt well systems) Specific to Spray Leaks from Overground Transfer Lines • Heat tracing and Insulation (where provided) Specific to Spray Leaks in 204-AR Waste Unloading Facility • Ventilation system deentrainer, heater, and HEPA filters • HEPA filter low differential pressure alarm • HEPA filter high differential pressure interlock • CAMs in unloading area and mechanical equipment room Specific to Spray Leaks in Actively Ventilated Waste Tanks • Ventilation system deentrainer, heater, and HEPA filters • HEPA filter low differential pressure interlock • HEPA filter high differential pressure alarm

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
16.	Spray Leak from Underground Waste Transfer Lines 3.4.2.10	None required	SL: None required LCS: None required LCO: None required AC: Excavation controls • Excavation permit • Permanent aboveground labeling of waste transfer lines outside tank farms • No transfer through uncovered lines without compensatory controls • Transfers prohibited in vicinity of ongoing excavations • Emergency response actions for terminating waste transfer	• Material balance calculations during waste transfers
17.	Caustic Spray Leak 3.3.2.4.9	None required	SL: None required LCS: None required LCO: None required AC: Caustic transfer controls	• Industrial hygiene requirements (e.g., PPE) • Emergency preparedness
18.A	Tank Bump 3.4.2.11	SS: Temperature monitoring systems SS: Tank level detection systems	SL: None required LCS: None required LCO: SST waste temperature controls LCO: DST and AWF tank waste temperature controls AC: Transfer controls • Ensure appropriate controls applied to final state of tank AC: Process instrumentation and measuring and test equipment	• Active SST ventilation • Primary and annulus DST/AWF tank ventilation • ALCs (where installed) • Cover blocks (or other tank sealing features) • Emergency preparedness
18.B	Unfiltered Release 3.3.2.4.2	SS: Ventilation stack CAM interlock systems	SL: None required LCS: None required LCO: Ventilation stack CAM interlock systems AC: HEPA filter controls • Periodic radiation surveillance • Replacement based on accumulation • Aerosol test upon installation (AWF 241-AZ-702) • Periodic aerosol test (AWF-241-AZ-702)	• HEPA filter low differential pressure interlocks/alarms • Aerosol testing of HEPA filters • Periodic surveillance of HEPA differential pressure

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
21.	Subsurface Leak Resulting in Pool 3.4.2.8	SC: Transfer leak detection systems SC: Pipe encasements SC: RCSTS pressure relief valve (244-A lift station) SC: RCSTS rupture disk (244-A lift station) SS: Tank level detection systems SS: *Salt well flow totalizers* SS: Transfer system covers SS: Above grade portions of Process Pits, Diversion Boxes, Vault Pits, and COBs (splash, splatter and shine) (see Note 4)	SL: None required LCS: None required LCO: Transfer system covers LCO: Transfer leak detection systems LCO RCSTS pressure relief valve and rupture disk (reserved for slurry line, WT-SLL-3160) AC: Transfer controls (pool) • *Transfer system configuration management* • Operating requirements AC: Encasement seal loop controls AC: Emergency preparedness (waste leak) AC: Transfer pump administrative lock controls AC: Transfer system cover removal controls	Unencased Transfer Lines (Bermed and Direct Buried) • *Pressure test annually on active lines that have not completed a transfer within one year*
22.	Evaporator Dump 3.3.2.4.4	None required	SL: None required LCS: None required LCO: None required AC: None required	• Primary ventilation system including HEPA filters • *Cover blocks*
23.	Mixing of Incompatible Material - Toxic Vapor Generation 3.3.2.4.11 See Note 1	None required	SL: None required LCS: None required LCO: None required AC: None required	None
25.	Leak from Rail Car/Tank Trailer 3.3.2.4.6	None required	SL: None required LCS: None required LCO: None required AC: Source inventory controls • Source term inventory limits for railcars and tank trailers shall comply with the safety analysis for packaging and shipping. Control also ensures nonflammable and thermally stable	• Railroad inspection and maintenance • Railcar and tank trailer design • Catch tank • HEPA filtered ventilation system • Leak detection instrumentation • CAMs • Emergency preparedness

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
26.	Surface Leak Resulting in Pool 3.4.2.7 See Note 1	SC: Transfer leak detection systems SC: Above grade portions of Process Pits, Diversion Boxes, Vault Pits, and COBs (physical integrity (see Note 3) SC: Primary tank leak detection systems SC: Pressure switch interlock/alarm systems (service water lines) SC: OGT encasement and connections SC: OGT concrete shielding system SC: Backflow prevention devices (204-AR Waste Unloading Facility only) SC: Transfer system supplemental covers SC: RCSTS pressure relief valve (244-A lift station) SC: RCSTS rupture disk (244-A lift station) SS: Tank level detection systems SS: Salt well flow totalizers SS: Transfer system covers SS: Service water flow totalizers SS: 204-AR waste unloading facility structure SS: Backflow prevention devices SS: Above grade portions of Process Pits, Diversion Boxes, Vault Pits, and COBs (splash, splatter and shine) (see Note 4) SS: RCSTS entry doors (diversion box and vent station) SS: RCSTS diversion box and vent station emergency pumpout line, air sample line, liner washdown system, and exhauster hookup SS: RCSTS inlet air HEPA filter system (one stage on 6241-A and 6241-V)	SL: None required LCS: None required LCO: Transfer system covers and RCSTS entry doors LCO: Service water pressure detection systems LCO: Transfer leak detection systems LCO: Primary tank leak detection systems LCO: RCSTS pressure relief valve and rupture disk (reserved for slurry line, WT-SLL-3160) LCO: 204-AR Backflow Prevention System LCO: Supplemental covers AC: Transfer controls (pool) • Transfer system configuration management • Operating requirements AC: Encasement seal loop controls AC: Emergency preparedness (waste leak) AC: Transfer pump administrative lock controls AC: Tank service water intrusion monitoring program AC: Transfer system cover removal controls AC: Excavation controls • Excavation permit • Permanent aboveground labeling of waste transfer lines outside tank farms • No transfer through uncovered lines without compensatory controls • Transfers prohibited in vicinity of ongoing excavations • Emergency response actions for terminating waste transfer	General • Drains in waste transfer system structures • DCRT/catch tank vault leak detection systems • Encasement leak detection systems Specific to Waste Tank Overflow Caused by Service Water System Leak • Service water system freeze protection • Service pit leak detection systems (where installed) • Waste tank high level alarms Service to Service Water System Leaks (Backflow) • Service pit leak detection systems • Valve position limit switches/interlocks (salt well systems) (where installed and maintained) • Check valves (salt well systems) Specific to Overground Transfer Line Leak Resulting in Pool • Heat tracing and insulation (where provided)
28.	Unplanned Excavation/ Drilling in Crib/Ditch/Pond 3.3.2.4.8	None required	SL: None required LCS: None required LCO: None required AC: None required	• RWP (radiological work permit) • Excavation controls

Table 3.3.2.3.2-1. Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents. (10 sheets)

No.	Representative accident	Safety SSCs	TSR controls	Defense-In-Depth controls
29.	Subsurface Leak Remaining Subsurface 3.3.2.4.7	SS: Transfer leak detection systems SS: Pipe encasements SS: Tank level detection systems SS: Salt well flow totalizers	SL: None required LCS: None required LCO: Transfer leak detection systems AC: Encasement seal loop controls AC: Transfer controls (subsurface plume) • Transfer system configuration management • Operating requirements AC: Transfer pump administrative lock controls	• Hydrostatic testing of direct-buried or bermed piping • Emergency preparedness
30.	Sodium Fire 3.3.2.4.10	SS: 2727-W Building	SL: None required LCS: None required LCO: None required AC: Emergency preparedness (verify SS structure integrity)	• Grounding of building and tanks • Fire detectors • No water service to building • Fire extinguishers and external postings • Nitrogen cover gas system • Annual inspection of building structure
31.	Aboveground Structure Failure 3.4.2.12.1	None required	SL: None required LCS: None required LCO: None required AC: None required	• Hanford Site Hoisting and Rigging Manual for critical lifts (See Note 2) • Restrictions on operations during high winds
32.	Steam Intrusion from Interfacing System 3.3.2.4.5	None required	SL: None required LCS: None required LCO: None required AC: HEPA filter controls • Periodic radiation surveillance • Replacement based on accumulation • Aerosol test upon installation (AWF 241-AZ-702) • Periodic aerosol test (AWF 241-AZ-702)	• Tank pressure monitors/alarms • HEPA filter high differential pressure alarms • Emergency preparedness • HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h) • Aerosol testing of HEPA filters • Periodic surveillance of HEPA differential pressure

Note 1: HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change* identifies additional safety SSCs and controls related to Tank 241-SY-101 remediation activities and operations.

Note 2: DOE/RL-92-36, 1996 *Hanford Site Hoisting and Rigging Manual*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Note 3: Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.

Note 4: Per agreement with DOE-ORP, this Safety-Significant designation is not effective until March 30, 2000.

Note 5: There is an Authorization Basis amendment pending DOE approval that will eliminate the need to designate the Temperature Monitoring Systems as Safety-Class. Therefore, these systems are identified as Safety-Significant.

ALC = air lift circulator.
AC = Administrative Control.
AWF = Aging Waste Facility.
CAM = continuous air monitor.
COB = cleanout box.
CPS = criticality prevention specification.
CSER = criticality safety evaluation report.
DCRT = double-contained receiver tank.
DST = double-shell tank.
GRE = gas release event.
HEPA = high-efficiency particulate air (filter).
LCO = Limiting Condition for Operation.
LCS = Limiting Control Setting.
MISF = miscellaneous inactive storage facility.
OGT = overground transfer.
PPE = personal protective equipment.
RCSTS = replacement cross-site transfer system.
SC = Safety-Class.
SL = Safety-Limit.
SS = Safety-Significant
SSC = structure, system, and component.
SST = Single-shell tank.
SARP = Safety Analysis Report for Packaging.
TSR = Technical Safety Requirement.
TWRS = Tank Waste Remediation System.

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3.3.2.3.3 Worker Safety. In the course of the TWRS hazard analysis process, a number of potential hazardous conditions with effects to only the facility worker were identified. These hazardous conditions were divided into three categories: hazardous conditions involving releases of hazardous material, hazardous conditions involving radiation protection concerns, and hazardous conditions involving common occupational safety concerns. Toxic as well as radioactive material considerations were included in the hazardous material releases. Controls (SSCs, TSRs, and Defense-in-Depth) were identified for anticipated (Frequency Category F3) hazardous material releases. Only those anticipated hazardous material releases that had potential for serious injury or death to the facility worker were required to have an applicable control. Although identification of potential facility worker radiation exposure and occupational safety concerns was not the specific focus of the facility hazard analyses, exposure and occupational safety concerns were recorded and passed on to the Radiation Protection and Industrial Health and Safety programs to ensure that appropriate safeguards are in place to prevent or mitigate the events. However, no concerted effort was made to develop an exhaustive inventory of occupational hazards. Information regarding the presence of hazardous material in facilities was passed on to the Hazardous Material Protection Program.

Protection Against Releases. A list of anticipated hazardous conditions that could result in releases affecting only facility workers (i.e., F3, S1 hazardous conditions with no controls) was developed from the hazard analysis database. This list is presented as Table D-3 (Appendix D). The hazardous conditions were reviewed to determine if they represented potential for serious injury or death to the facility worker. None of the hazardous conditions was determined to have the potential for serious injury or death to the facility worker. However, if such hazardous conditions had been identified, controls beyond those identified for the analyzed accidents identified in Section 3.3.2.3.1 would have been considered.

The list of F3, S1 hazardous conditions was reviewed to determine if any SSCs or TSR controls developed for the analyzed accidents identified in Section 3.3.2.3.1 applied to these hazardous conditions. If applicable SSCs or TSR controls were found, no further review was conducted and the controls were input into the hazard analysis database.

The remaining hazardous conditions without any identified SSCs or TSR controls were reviewed to determine if any Defense-in-Depth controls identified in Section 3.3.2.3.2 were applicable. Applicable Defense-in-Depth controls were input into the hazard analysis database (excluding Cone Penetrometer, Light Duty Utility Arm, 242-A package boilers, and the four Addenda).

Radiation Protection. This section discusses only potential facility worker radiation exposure not related to loss of containment of radioactive material. The HazOp study and PHA performed on the TWRS and its physical interfaces with other facilities to identify hazardous release conditions also identified a number of potential facility worker radiation exposure concerns. Although identification of potential facility worker radiation exposure concerns was not the specific focus of the studies, the exposure concerns were recorded and passed on to the radiation protection program to ensure that appropriate safeguards are in place to prevent or

mitigate the event. These potential facility worker radiation exposure hazardous conditions, along with their identifiers and causes, are presented in Table D-5 (Appendix D). The TWRS Radiation Protection Program is discussed in greater detail in Chapter 7.0 of this safety analysis report.

Occupational Safety. The HazOp study and PHA performed on the TWRS and its physical interfaces with other facilities to identify hazardous release conditions also resulted in the identification of a number of potential facility worker occupational safety concerns. Although identification of potential facility worker occupational safety concerns was not the specific focus of the studies, the concerns were recorded and passed on to the Industrial Health and Safety Program to ensure that appropriate safeguards are in place to prevent or mitigate the event. However, no concerted effort was made to develop an exhaustive inventory of occupational hazards. Potential facility worker occupational safety hazardous conditions along with their identifiers and causes are presented in Table D-6 (Appendix D).

Hazardous Material Protection. Protection of the workers from hazardous materials associated with the TWRS is provided by adherence to the TWRS Hazardous Material Protection Program. The major provisions of the TWRS Hazardous Material Protection Program are summarized in Chapter 8.0.

The TWRS hazard analysis process identified several hazardous materials that are used at or transferred to the TWRS facility or that could be found or generated under various hazardous conditions. The list of the hazardous materials identified during the analyses is presented in Table 3.3.2.3.3-1.

Reference

Resource Conservation and Recovery Act of 1976., 42 U.S.C., 6901, et seq.

Table 3.3.2.3.3-1. List of the Hazardous Materials Identified in the Tank Waste Remediation System Preliminary Hazard Analyses and Hazard and Operability Studies.

Acidic waste containing nitric acid	Oxides of nitrogen*
Ammonia*	Paints
Argon/methane	Polychlorinated biphenyl (PCBs)
Cleaning compounds/sprays	Propane
Diesel fuel	RCRA mixed waste
Gasoline	Sodium hydroxide
Heavy metals including chromium and lead	Sodium nitrite
Flammable gases*	Sodium phosphate
Metallic sodium	Solvents
Organics	

*Hazardous materials that can be generated at the Tank Waste Remediation System.
RCRA = *Resource Conservation and Recovery Act of 1976.*

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3.3.2.3.4 Environmental Protection. The hazard evaluation included a qualitative assessment of the environmental impact of hazardous conditions that could potentially result in an uncontrolled release of radioactive or hazardous material. The results of this assessment are shown in Appendix D. Based on the hazard evaluation, design and operational controls are identified that minimize the potential for hazardous conditions with significant environmental impacts. The controls include the safety SSCs, TSR controls, and additional Defense-in-Depth controls identified for protection of the public, onsite worker, and facility worker because these safety controls are often sufficient to address environmental concerns also. Where the safety controls do not provide adequate protection of the environment, additional environmental controls are identified. This section summarizes the hazard evaluation performed and the controls provided for environmental protection.

Hazardous conditions with potentially severe environmental impacts are listed in Appendix D. Severe environmental impacts result from hazardous conditions with environmental consequences of E3 or E2. These include all hazardous conditions where there is sufficient material and release energy to impact a receptor at the Hanford Site boundary (public) or at 100 m (328 ft) (onsite worker), major leaks from large storage tanks, or liquid releases or leaks outside facility boundaries. The E3 and E2 categories are defined in Table 3.3.1.3-3. The criteria for identifying hazardous conditions by category are listed in Section 3.3.1.3.

For the purpose of identifying required controls, hazardous conditions with the potential for severe environmental consequences (E3 and E2) fall into two classes:

1. Those with the potential for significant health and safety impacts on the public or onsite worker (S3 or S2),

2. Those with the potential for significant health and safety impacts only on the facility worker or no significant impacts on the public, onsite worker, or facility worker (S1 and S0).

For the first class of hazardous conditions with the potential for significant health and safety impacts to the public and onsite worker (S3 and S2), quantitative accident analyses were performed.[1] The causes of these hazardous conditions were addressed by analysis of representative accidents. The representative accidents analyzed are briefly described in Section 3.3.2.3.1. Based on the quantitative accident analysis and the qualitative hazard analysis, safety SSCs, TSR controls, and additional Defense-in-Depth controls were identified to prevent or mitigate the postulated accident. The developed controls for protection of the public and onsite worker in most cases are also sufficient for protecting the environment. Environmental

[1]The accident analysis addressed the effects of atmospheric, surface, and near-surface uncontrolled releases of radioactive and hazardous materials on the public and onsite worker. Analysis of the long-term fate and transport of material released to the vadose zone is not included in this safety analysis report. Such analyses, however, have been performed to assess the potential impact of tank leaks at the Hanford Site. These analyses have modeled the transport and potential consequences of leaks on the aquifer and the Columbia River.

protection is provided by either preventing the release of radioactive or hazardous material or mitigating the amount of material released.

Some of the safety SSC and TSR controls identified by the hazard and accident analyses to protect the public, onsite worker, and facility worker also apply to hazardous conditions in the second class (i.e., hazardous conditions with the potential for significant environmental impacts but with at most only significant facility worker impacts [S1 and S0]). The causes of the hazardous conditions in this class include waste tank corrosion, tank structural degradation, tank wall failure caused by temperature or pressure effects, human error, incompatible waste mixing, flooding, or seismic activity. The allocation of safety SSCs and TSR controls to hazardous conditions with potentially significant environmental impacts but at most only significant facility workers impacts is included in the Hazard Analysis Database.

From a review of the hazardous conditions with severe environmental consequences (E3 and E2) and the allocated safety controls, additional required environmental controls were identified to prevent or minimize the potential for large releases of radioactive or hazardous material that could cause significant environmental impacts. Table 3.3.2.3.4-1 lists specific controls for environmental protection resulting from the hazard evaluation. These environmental design and operational controls prevent or mitigate releases of tank waste to the air and prevent large, uncontrolled releases of tank waste to the environment. These environmental controls are implemented by TWRS operating programs and procedures.

The development of controls for hazardous conditions identified in the FSAR is only a part of the TWRS basis for ensuring environmental protection. Environmental protection also includes compliance with applicable environmental regulations, design and operational controls to prevent or mitigate normal releases of radioactive or hazardous material, and programs to change the state of the tank waste to reduce the risk of environmental releases. These include the following:

- **Regulatory Compliance**. TWRS operates in accordance with applicable environmental regulations that address solid wastes, hazardous materials, water quality, air quality, spill reporting, and transportation. The list of the applicable regulations and a description of the TWRS programs for compliance is contained in Chapter 9.0.

- **Design and Operational Features**. These include the location of the tanks, which provides isolation from the aquifer and the river; the DST design; transfer pipe encasements, process pits, diversion boxes, vault pits, and COBs for collecting any leakage and drainage and returning it to waste or catch tanks.

- **Programs**. There are programs to interim stabilize SSTs (salt well pumping), to perform environmental restoration of contaminated sites, and to provide environmental monitoring of the Hanford Site and surrounding environment.

In summary, environmental controls for protection of the environment from large, uncontrolled releases of radioactive or hazardous material are derived from the hazardous conditions identified in the hazard analysis of TWRS facilities and operations. These environmental controls consist of safety SSCs, TSR controls, and Defense-in-Depth controls that also provide environmental protection and the specific environmental controls in Table 3.3.2.3.4-1. These controls are one part of the overall TWRS environmental basis consisting of environmental regulations, design and operational controls, and programs that ensure protection of the environment. These controls are summarized in Table 3.3.2.3.2-1.

The controls identified to prevent and/or mitigate hazardous conditions (E3 or E2) resulting in large environmental releases apply to potential releases with and without potential significant health impacts to the offsite public (S3), onsite workers (S2), and facility workers (S1). The combination of safety SSCs, TSR controls, and additional Defense-in-Depth controls, environmental controls identified in Table 3.3.2.3.4-1, and compliance-related activities provide adequate protection against large environmental releases from TWRS facilities.

Reference

Wagoner, J. D., 1997, *Clarification of Direction Related to the Generic Implications of the Use of Justification for Continued Operation (JCO) in the Unreviewed Safety Question (USQ) Process and Its Impact on Push Mode Core Sampling (PMCS),* (letter 97-MSD-186 to H. J. Hatch, Fluor Daniel Hanford, Inc., March 8), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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Table 3.3.2.3.4-1. Environmental Controls.

Environmental controls	Comment
HEPA filters and annual aerosol testing	DSTs (including AWF tanks), SSTs, DCRTs, catch tanks[a], 204-AR Waste Unloading Facility, 244-AR Vault
Waste tank confinement	Maintain negative pressure for actively ventilated waste tanks
Tank and pipe corrosion and integrity controls	Includes draining and flushing of lines, cathodic protection, waste pH and temperature (absolute and delta) controls
	Includes maintaining a minimum tank waste level when the ventilation system is operating to prevent uplifting of the tank bottom steel liner.
Leak detection systems	Includes pits, DSTs (including AWF tanks), and SST monitoring wells
In-tank operations controls	Includes design and operating controls on rotary mode core sampling and equipment handling to prevent penetration of the tank
	For push mode core sampling: • Hydraulic safety interlock testing and activation[b] • Modification to core drill trucks prohibited to prevent exceeding design pressure and downward force limits[b]
Spill prevention and response	--

[a]Except catch tanks 241-A-302A, 241-TX-302C, 241-U-301B, 241-UX-302A, and 241-ER-311 which have no HEPA filtration systems.

[b]Defined in Wagoner, J. D., 1997, *Clarification of Direction Related to the Generic Implications of the Use of Justification for Continued Operation (JCO) in the Unreviewed Safety Question (USQ) Process and Its Impact on Push Mode Core Sampling (PMCS)*, (letter 97-MSD-186 to H. J. Hatch, Fluor Daniel Hanford, Inc., March 8), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

AWF = aging waste facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

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3.3.2.3.5 Planned Design and Operational Safety Improvements. This section identifies and briefly describes (1) planned design and operational improvements, (2) planned safety assessments, and (3) planned Authorization Basis programmatic improvements. These planned improvements and assessments are being implemented but will not be complete until after submittal of the FSAR. While the planned safety improvements are derived from the hazard and accident analyses, they are not credited as controls in this FSAR. Because the hazard and accident analyses identified postulated events that may exceed risk guidelines, planned safety assessments to improve understanding of these events and to assess the potential impact of possible additional controls on accident frequency/consequences are described in this section. In anticipation of approval of the FSAR, programmatic changes are being implemented by TWRS Nuclear Safety and Licensing to improve the FSAR's usability and applicability as a key component of the TWRS Authorization Basis.

Planned Safety Improvements. The following safety improvement is planned to reduce the frequency and consequences of potential accidents presently above risk guidelines. Installation of lightning protection is planned to reduce the possibility of a lightning-initiated flammable gas deflagration, organic solvent fire, or organic salt-nitrate reaction.

- Additional grounded air terminals will be installed on 43 existing poles in nine tank farms.

- Necessary corrective actions will be taken to ground tank risers and to bond instrumentation in risers to meet the lightning protection requirements in NFPA 780, *Standard for the Installation of Lightning Protection Systems.*

These planned TWRS design improvements were recommended by the evaluation in WHC-SD-WM-ES-387, *Probability, Consequences, and Mitigation for Lightning Strikes to Hanford Site High-Level Waste Tanks*. As concluded in WHC-SD-WM-ES-387, these lightning protection improvements are for the SSTs only, because a different design makes the DSTs (including the AWF tanks) significantly less vulnerable to lightning effects. The completed system of grounded air terminals on existing poles within the tank farms will intercept and divert some of the lightning flashes that might otherwise affect a tank with its contained waste. Depending on the tank farm, the lightning protection improvement ranges from 0% (for tank farms that do not have poles in place to provide protection) to 40%.

Results of resistance tests on riser grounding and instrumentation bonding are reported in WHC-SD-WM-ER-604, *Lightning Hazards Remediation Summary of Hanford Site Single Shell Tanks*. WHC-SD-WM-ER-604 identifies the risers and instrumentation requiring grounding and bonding and describes the modifications that will be made. Ensuring an adequate ground on tank risers and bonding of instrumentation in the risers provides assurance that the energy from a lighting strike will be diverted to the ground rather than to the tank or waste.

Installation of air terminals and required riser and instrumentation grounding and bonding modifications has been completed.

Planned Safety Assessments. Safety assessments are planned to improve understanding of specific potential accidents and resolve associated safety issues and assess the impact of possible additional controls on the potential frequency and/or consequences of these events.

- **Flammable Gas Safety Issue Resolution**—A strategy for resolution of the Flammable Gas Safety Issue for SSTs and DSTs has been developed (Payne 1999). The first part of the strategy is to develop a flammable gas accident analysis model that provides quantification of the technical uncertainty and risk associated with flammable gas hazards. This analysis model will use waste-type tank groupings and data sets instead of the current approach which relies on facility groupings. After the model is developed, it will be used to complete a refined safety analysis that will include an evaluation to ensure that the controls are consistent with the flammable gas hazard. The overall objective is to optimize control strategies for continued safe operation of the Tank Waste Remediation System. The strategy for resolution of the Flammable Gas Unreviewed Safety Question that remains open for other TWRS ancillary facilities includes obtaining flammable gas sampling data and performing additional engineering and safety analysis to provide a basis for assessing, and potentially revising, the existing control strategies.

- **Organic Waste Tank Safety Issue Resolution**—The TSR controls identified in the FSAR for the organic solvent fire accident provides an interim means of managing the risk of this accident. The organic solvent fire accident is the subject of an ongoing safety issue resolution activity.

- **Inert Atmosphere in Tank Dome Space**—Providing an inert tank atmosphere in the dome space of waste storage tanks has the potential of controlling two accidents: Flammable Gas Deflagrations and Organic Solvent Fire. Both accidents are the subject of safety issue resolution projects. The risk reduction afforded by inerting the tank dome space atmosphere to prevent flammable gas deflagrations and organic solvent fires will be assessed as part of the activities of each safety issue resolution project.

- **Seismic Monitor**—A feasibility study for the installation of a seismic monitor is being planned to reduce the risk associated with seismically induced pool and spray release accidents. The results of the evaluation of the impact of a 200 Area seismic monitor on a seismically initiated accident is described in HNF-SD-WM-CN-119, *Evaluation of the Effectiveness of the Addition of Seismic Monitors Within the 200 Areas.* The potential quantitative benefit derived from a seismic monitor is to reduce the consequences of the subsurface leak resulting in a surface pool accident by providing a positive indication to TWRS operators to terminate transfer pump operation and to take other emergency actions.

  The evaluation in HNF-SD-WM-CN-119 concludes that the seismic monitor is justified based on the qualitative benefits of reliable notification of a seismic event

to initiate emergency response for potential pool and spray leaks and alert TWRS personnel to check the status of safety SSCs (e.g., waste storage tanks, ventilation systems). For pool leaks, the addition of the seismic monitor results in consequences equivalent to subsurface leaks resulting in surface pools with controls. There is currently no quantitative impact assessed on spray leak results. A seismic monitor has the added benefit of providing a quantitative basis for post-seismic engineering analysis of the integrity of TWRS structures by providing data on the ground acceleration experienced during the event.

Preliminary results show a benefit from the installation of a seismic monitor. A feasibility study on the installation of a seismic monitor in the 200 Areas is being developed.

- **Seismic Switches and Vulnerability Study**—The existing intrinsic structural integrity of the Safety-Class SSCs (i.e., SSTs, DSTs, and AWF tanks) and the emergency preparedness TSR controls manage the risk of the postulated seismic event. However, even with these controls, the potential risk of a large seismic event within the evaluation basis exceeds the established risk guidelines. To address this residual risk, seismic monitors have been evaluated for their ability to reduce this residual risk and are now included as a planned safety improvement. However, the addition of seismic monitors will not reduce the risk below the established risk guidelines. Therefore, additional investigation to further address the residual risk is continuing. Specifically, the addition of seismic switches to stop waste transfer pumps will be analyzed on a cost-benefit basis in the future as allowed by fiscal year planning.

  In addition to the assessment of seismic switches, a comprehensive seismic vulnerability assessment would support determination of the effectiveness of controls to prevent or mitigate seismically induced waste transfer accidents. The seismic vulnerability study will assess the ability of TWRS SSCs to survive seismic events. The results of the seismic vulnerability assessment will be used to identify which current SSCs can be considered adequate controls and to identify further safety improvements to control the risk from a potential seismic event. The comprehensive seismic vulnerability study is not currently a funded activity.

- **Steam Line Blanking**—In the past, steam jets were used to transfer waste to TWRS by several of the facilities in the 200 Areas. Currently, only two facilities, the 242-A Evaporator in 200 East Area and PFP in 200 West Area, have the potential to introduce steam into TWRS and cause a steam intrusion accident. The accident analysis results for a steam intrusion accident show results below risk guidelines for both the offsite public and onsite worker. However, this accident can be eliminated by disconnecting or blanking the steam lines used by the 242-A Evaporator and PFP for waste transfers to TWRS.

The steam line blanking could impact operations at the 242-A Evaporator and PFP. Results of an operational impact study will determine the feasibility of blanking or disconnecting the steam lines.

- **Accident Analyses Bases**—A number of known very conservative bases were used in the current FSAR accident analyses. These conservative bases contribute significantly to the consequence results of the accident analyses being above risk guidelines. It is planned to examine these bases and develop reasonably conservative bases to be used in FSAR updates. The major bases exaggerating the accident consequence results are as follows:

  - **The source term used to represent tank waste**. The present methodology to select the dose values for each isotope in the source term was based on selecting the high points of the distribution of values rather than averages. The additional conservatism in the FSAR source terms is described in WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations.* Data obtained by the Characterization Program has made it possible to reassess the method for determining specific source term values. New methodology for determining the radiological source term is being developed.

    An evaluation of the toxicological source term is also in progress. In addition to the new information on solid and liquid compositions from the Characterization Program, there is new information on gases present in SST headspaces. The liquids and solids will be treated separately from the gases in the headspaces, but both will be part of the toxicological source term for the tanks.

  - **The plume transport model**. The present plume transport model used for released material does not account for the effects on plume concentration of lofting or redeposition. Lofting effects can significantly decrease the ground-level concentration of the plume. This effect especially applies to releases resulting from fires or high-energy chemical reactions. Redeposition also decreases plume concentrations as the plume travels from the release point.

The plan is to address these conservatisms by developing the appropriate revised bases during the annual updates of the FSAR. These new bases will be used in reevaluation of the applicable accidents and associated controls.

- **Hazard Analysis of MISFs**—The hazard analysis in the FSAR postulated various types of hazardous conditions with the potential for uncontrolled release of material from MISFs. These included fires and explosions that should bound the

radiological consequences of releases caused by chemical explosions, regardless of the cause. Because data on the constituents and characteristics of MISF contents is very limited, the nature of the toxicological consequences of MISF releases are not well characterized. A control has been identified in the FSAR to prohibit intrusive MISF activities until the waste contained in them is properly characterized. A hazard analysis will be performed for the MISFs as the characterization data becomes available and recommendations will be made for additional actions (including accident analysis) and controls, as appropriate.

- **Planned Authorization Basis Programmatic Improvements**. Programmatic changes are being implemented to improve the FSAR's usability and applicability as a component of the TWRS Authorization Basis.

- **Hazard Analysis Data Base Configuration Management**.

  Nuclear Safety and Licensing has responsibility for configuration management of the hazard analysis database. The configuration management requirements, responsibilities, and procedures are described in HNF-2353, *Nuclear Safety and Licensing Desk Instructions.*

- **TWRS Initial FSAR Amendment Strategy**—It is anticipated that when the approved FSAR replaces HNF-SD-WM-BIO-001, *Tank Waste Remediation System Basis for Interim Operation*, in the TWRS Authorization Basis, there will be approved changes to HNF-SD-WM-BIO-001 that will not be included in the FSAR. These approved changes, including project-specific amendments to HNF-SD-WM-BIO-001 and updates to HNF-SD-WM-TSR-006 (*Tank Waste Remediation System Technical Safety Requirements*) wording, will need to remain part of the Authorization Basis when the FSAR replaces HNF-SD-WM-BIO-001. Technical revisions to HNF-SD-WM-BIO-001 have been incorporated into this FSAR before BIO-to-FSAR transition.

References

HNF-2353, *Nuclear Safety and Licensing Desk Instructions,* Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-SD-WM-BIO-001, 1999, *Tank Waste Remediation System Basis for Interim Operation*, Rev. 1, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-CN-119, 1997, *Evaluation of the Effectiveness of the Addition of Seismic Monitors Within the 200 Areas*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-TSR-006, 1999, *Tank Waste Remediation System Technical Safety Requirements*, Rev. 1, Fluor Daniel Hanford, Inc., Richland, Washington.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, National Fire Protection Association, Quincy, Massachusetts.

WHC-SD-WM-ER-604, 1996, *Lightning Hazards Remediation Summary of Hanford Site Single Shell Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ES-387, 1996, *Probability, Consequences, and Mitigation for Lightning Strikes to Hanford Site High-Level Waste Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-037, 1996, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

3.3.2.4 Accidents with Potential Onsite Consequences. This section details evaluation basis accidents with the potential for significant onsite consequences. Accident frequencies, consequences, and selected controls, if any, are also described in each accident analysis section.

Supplemental accident analyses for projects not within the original scope of the FSAR are included in the designated addenda, as applicable. The accident analyses for the WRSS are presented in Addendum 1. The accident analyses for the RCSTS are presented in Addendum 2. The accident analyses for the 241-AZ-702 ventilation system are presented in Addendum 3. The accident analyses for the 241-AZ-101 mixer pump test are presented in Addendum 4. Supplemental safety analyses for remediation activities and operations in Tank 241-SY-101 are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

Reference

HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

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3.3.2.4.1 Nuclear Criticality. The technical basis for the nuclear criticality safety of waste stored in underground tanks at the Hanford Site is summarized in WHC-SD-WM-TI-725, *Tank Farm Nuclear Criticality Review*. Under current operating conditions, a nuclear criticality accident is incredible in any of the SSTs, DSTs, or DCRTs at the Hanford Site. The plutonium concentration is too low for criticality, the neutron absorbers collocated with the plutonium are sufficient to preclude criticality, and no credible means exist for concentrating sufficient plutonium to go critical.

The technical basis for safe subcritical storage of wastes in SSTs, DSTs, and DCRTs considered the neutronics of the waste tank system, chemical and physical phenomena, and fluid dynamics factors related to initial deposition of wastes in the tanks, aging of the wastes, and behavior of the wastes in storage. This section summarizes the discussion of potential tank neutronics in WHC-SD-SQA-CSA-507, *CSER 96-010: Criticality Parameters for Tank Waste Evaluation*. The phenomena and particle dynamics are described in WHC-SD-WM-TI-757, *Fluid Dynamics, Particulate Segregation, Chemical Processes, and Natural Ore Analog Discussions that Relate to the Potential for Criticality in Hanford Tanks*. More detail is provided in Appendix F.

Collectively, the SSTs and DSTs contain an estimated 500 to 1,000 kg (1,100 to 2,200 lb) of plutonium. Analyses of tank waste samples established that the plutonium content of the waste is primarily associated with the sludge. The maximum measured plutonium concentration in the sludge is 0.35 g/L to 0.7 g/L. A conservative waste model was developed for comparing the plutonium concentration in these samples with that necessary for a criticality to occur. The conservative waste model is based on a conservative selection of the neutronic characteristics of the waste chemicals. Chemical components of waste with a greater ability to absorb neutrons were assumed to be present at lower than expected concentrations. Chemical components with a greater ability to scatter neutrons were assumed to be present at greater than expected concentrations. These two assumptions resulted in a model that minimized the calculated concentration of plutonium needed to go critical. Based on this model, the maximum plutonium concentration limit for assuring the prevention of criticality is set at 2.6 g Pu/L for an infinite system. To illustrate how much plutonium is needed for finite volumes, the model shows that for a sphere 3.7 m (12 ft) in diameter, a concentration of 4 g Pu/L, and a total of 106 kg (233 lb) plutonium would be necessary to go critical.

The conservative waste model also determined the concentration of chemical constituents in the waste (also referred to as neutron absorbers) that would make a criticality impossible. The mass ratios for assured subcriticality of the plutonium is shown in Table 3.3.2.4.1-1.

Based on the preceding discussion, the worst-case sample data of 0.35 g Pu/L to 0.7 g Pu/L is a factor of 4 to 7 below the maximum concentration limit of 2.6 g Pu/L conservatively derived for infinite volumes of tank waste. In most of the SSTs and DSTs, the plutonium concentration in the sludge is less than one percent of 2.6 g Pu/L. This situation reflects the deliberate controls placed on operation of the fuel reprocessing and purification facilities to maintain the plutonium concentration in waste streams at low levels. Additional details are found in Appendix F.

The conservative waste model (CWM) is also based on optimum moderation. Table 3.3.2.4.1-2 provides the hydrogen to plutonium values used, where "hydrogen" is the moderator. The presence of more water than that indicated means the system is overmoderated. Overmoderated systems require more plutonium to go critical than the optimum amount of plutonium given by the model. There is no undermoderated waste.

The above discussion has focused on critical spheres. However, the waste is more likely to be found in layers (or slabs) rather than spheres. If the plutonium layers in the waste are in the shape of a slab, the minimal areal concentration is 2,580 g Pu/m^2 (240 g Pu/ft^2). That is, the total plutonium that is still subcritical in a rectangular solid of any height with a base of 0.093 m^2 (1 ft^2) is 240 g. Even if a series of rectangular solids each having 240 g were side by side, the system would still be subcritical.

Figure 3.3.2.4.1-1 is a summary representation of the conservatism that has been included in the criticality safety analysis of the Hanford Site tank wastes. The figure shows the relationship among current tank conditions, historical operating limits, and subcritical limits as a function of mass and plutonium concentration. The "optimized CWM" subcritical limit represents conservatively modeled waste conditions. The "average waste composition" represents subcritical limits for a waste composition representing an average composition of 19 elements from 28 actual tank samples. All of the cases were calculated using a conservative geometry (i.e., spherical). Figure 3.3.2.4.1-1 shows that even with a high degree of conservatism under neutronically conservative conditions, the tank contents are definitely subcritical.

The chemical makeup of the waste includes sufficient absorbers and dilutants to assure that criticality is not possible. Appendix F describes the waste streams from the plutonium separation and purification plants to the tank farms including the plutonium concentration and the chemical constituents of these waste streams. The chemical processes included the following:

- Bismuth phosphate process (B Plant and T Plant)
- Reduction-oxidation (REDOX) process (S Plant)
- Metal recovery process (U Plant)
- PUREX
- Various processes at PFP.

Each of these processes discharged large quantities of waste to the tank farms. To avoid corrosion of the mild steel tank farm tanks, the waste streams were made alkaline before transfer. These streams had, on the average, plutonium concentrations of less than 0.003 g Pu/L. In addition, each stream contained iron, uranium, manganese, aluminum, or zirconium in quantities that assured subcriticality (Table 3.3.2.4.1-1). Some waste streams contained sufficient chemicals that more than one of the specific elements assured subcriticality.

As discussed in Appendix F, the plutonium in the waste from the processing plants exists in one of the following forms:

- Adsorbed plutonium with iron or aluminum oxyhydroxides
- Solid solution of ions within a crystal lattice
- Mixtures of flocculated oxyhydroxides
- Precipitated plutonium oxyhydroxide
- Liquid solutions.

Each form is discussed below.

Not only was plutonium in the waste streams in close proximity to neutron absorbers such that the subcritical ratios were exceeded, but in many waste streams the absorbers and the plutonium were attached chemically. The process of making the waste alkaline results in the rapid formation of precipitates of these metals. Iron and aluminum precipitates (as oxyhydroxides) adsorb plutonium from the waste because the plutonium forms precipitates more slowly. The adsorbed plutonium is chemically attached to the iron and aluminum precipitate. Both iron and aluminum are good neutron absorbers.

A different coprecipitation mechanism is solid solution formation. In this case, plutonium ion can replace an ion of another metal within a crystalline lattice. Because of the size of the plutonium ion, this can only occur in zirconium-, lanthanum-, or bismuth-bearing waste. Zirconium is a poor absorber of neutrons but can be an effective dilutant in sufficient quantity (zirconium/plutonium mass ratio of greater than 4,000) to preclude criticality.

Flocculation of particles can result in plutonium being effectively bonded with other solids. As such, greater plutonium concentrations are required for criticality than are provided by the conservative waste model.

The maximum solubility of plutonium in the alkaline liquids is less than 0.2 g Pu/L based on experimental and theoretical work. This is much less than the minimum concentration of 2.6 g Pu/L for an optimized infinite system. The liquids capable of a 0.2 g Pu/L concentration are those with a large (about 1 *M*) carbonate concentration and low pH. Extrapolation of the data indicates that larger concentrations might be supportable if the carbonate concentration exceeds 1 *M*. Because experiments show that aging reduces the plutonium concentration in tank liquids by an order of magnitude or more and tank solutions with greater than 1 *M* carbonate do not exist, a criticality cannot occur in waste liquids.

If pure hydrous plutonium oxide formed as a crystalline precipitate when acidic wastes were made alkaline, the plutonium oxide particles would be expected to agglomerate or mix with neutron absorbers. For nuclear criticality to occur for either of the latter cases, large (tens of micrometers in size) plutonium particles with minimal amounts of neutron absorbers must be created and then concentrated hydraulically.

The only way to reach criticality from the existing plutonium concentrations and waste compositions is to concentrate and redistribute the plutonium ions into a more reactive configuration.

The chemical mechanisms for concentrating the plutonium in a waste tank to a concentration and quantity sufficient for criticality would require dissolution of plutonium from the solid phase to the aqueous liquid phase and then selective deposition into a small, compact volume of concentrated solid. For the first step, sorbed plutonium must be desorbed into the aqueous phase of the waste mixture. Plutonium sorption onto oxyhydroxides can be reversed only if the solution composition in contact with the plutonium is dramatically altered. This would involve (1) the addition of organic or inorganic plutonium complexants, (2) a change in the REDOX potential of the solution by adding oxidants, or (3) acidification of the solution.

The supernatant solutions contain high concentrations of dissolved nitrite that act as a reducing agent and keep the dissolved plutonium mainly as Pu(IV). Because Pu(IV) is sorbed more strongly than Pu(V) or Pu(VI), the nitrite helps fix the plutonium onto the oxyhydroxide surfaces. To change the REDOX potential of the supernatant solutions would require the addition of huge quantities of oxidizing or reducing agents to the tanks (enough to destroy the nitrite). Because all additions to the tanks are controlled, this is not a reasonable possibility.

Acidification of wastes in the tanks would cause partial dissolution of the oxyhydroxides on which the plutonium is sorbed and dissolution of some of the plutonium. Large volumes of gases would be generated by the acid reactions with nitrite to produce NO_x gases, with carbonate to produce CO_2, and potentially with the carbon steel tanks to produce hydrogen gas. Such a large increase in gas release would be readily detected so that corrective action could be taken. The available onsite inventories of acids are insufficient to acidify even one waste tank. Accidental, undetected acidification of the wastes is highly unlikely.

Precipitated plutonium oxyhydroxide is likely not a pure species but associated with a flocculation. The flocculation contains other solids and neutron absorbers both of which result in the need for a greater concentration of plutonium to go critical than would otherwise be the case. If the precipitated plutonium hydroxide is a pure phase, a criticality is still not possible as the quantity needed for a thin slab (the reasonably worst-case geometry for this material) is excessive.

The Appendix F presents the analysis of the potentials for mechanical separation to concentrate and redistribute plutonium including:

- Thermal effects
- Selective settling of plutonium-bearing solids as a result of the mixing or transfer operations of mixer pumps or air lift circulators
- Salt well pumping
- Tank leaks

- Waste transfers
- Mixer pump and air lift circulator operations
- Thermal gradients and radiolysis during long-term storage
- Water additions
- Caustic additions.

The Appendix F analyses showed that none of these processes would concentrate and redistribute sufficient plutonium for criticality to occur.

The key assumptions follow:

- Only 500 to 1,000 kg (1,100 to 2,200 lb) of plutonium are currently contained in the tank farms. Future discharges will not significantly increase this total.
- The plutonium is reasonably distributed in all of the tanks.
- Non-aged (i.e., fresh) plutonium-containing liquids with high carbonate (>1 *M*) concentrations do not exist in the tanks and will not be transferred into the tanks.
- The existing and the transferred waste are alkaline. As a result, most of the plutonium is in a stable, solid form along with the important neutron absorbers and the attractors of plutonium (i.e., chemicals that result in attachment to the plutonium because of adsorption, solid solution, flocculation, and attraction of metals by hydroxides).
- Tank farm operations and activities result in mechanical movement and separation of plutonium only. These activities and operations are not designed to cause chemical separation.

No credible scenario has been identified for a criticality in a waste tank, DCRT, catch tank, or 20-ft-dia SST because of normal operations or waste storage. The information in Appendix F shows that it takes a very large number of sequential human errors to result in a criticality caused by a mistransfer from a plutonium separation and purification plant, such as PFP. Though a criticality caused by a mistransfer from PFP is not credible, the consequences of a postulated criticality were still analyzed as discussed below.

The initiating waste transfer for this analysis was chosen to be 500 L (132 gal) of a 10 g Pu/L solution from PFP that is transferred at 4.7 L/s (75 gal/min). The concentration and quantity are based on an estimate of the quantity of plutonium that conceivably could be transferred from PFP, provided that multiple failures occurred. Assumption of transfers of a

higher plutonium concentration would be overly conservative. Lower plutonium concentrations would require too large of a critical volume to occur. A concentration of 10 g Pu/L could be formed into a critical sphere with a reasonable diameter and size.

It was assumed, notwithstanding the inordinate number of failures required (see Appendix F), that a solution containing thousands of grams of plutonium accumulates in PFP waste receiver tank D-8 through a single or repeated and undetected sequential process and upsets to a previously empty tank. If the tank is not empty or other waste is dumped into the tank between the process upsets, the waste would be diluted, causing a decrease in the plutonium concentration. The contents of receiver tank D-8 are then transferred to tank D-5. Both of these tanks have a diameter larger than 3 m (10 ft) and would require over 18 kg (40 lb) of plutonium to achieve an areal density of 2,580 g Pu/m^2 (240 g Pu/ft^2), the minimum for a criticality. Because the postulated waste transfer contains only 5 kg (11 lb) of plutonium, criticality would not occur in either D-8 or D-5 for this transfer. The contents of tank D-5 are then routed to an empty 244-TX DCRT. The transferred waste would not go critical in 244-TX because this tank has an even larger surface area than tank D-5. When the PFP waste is transferred to the DST, the waste is postulated to form a compact sphere in the existing waste. The radius of this sphere was assumed to increase until a critical volume was reached.

Based on previous criticality accidents at other facilities, a criticality accident would have a fission burst followed by a rapid shutdown. The shutdown would occur as a consequence of fission energy release that would disrupt the critical geometry by thermal expansion, density reduction from the formation of very small bubbles, and fissile dilution through mixing from convective currents with expulsion of part of the critical mass. Early in the burst, small bubbles would form. As the burst continued, the amount of dissolved gas might increase enough to support the formation and expansion of larger bubbles. As the burst terminated, a sudden internal pressure relief might occur resulting in rapid steam production and the release of the dissolved gases. The gases and steam, along with the fission gas and a fraction of the waste, might be carried into the headspace of the tank. The increase in the pressure in the headspace would be relieved by venting a fraction of the headspace through HEPA filters. The pressure of the steam might also cause the critical volume to expand and disperse. The tank is large compared with the critical volume, and the expansion would result in dilution of the fissile-bearing volume. The turbulent and chaotic conditions along with the dilution would probably perturb fissile-bearing volume sufficiently that reassembly into a new critical mass would not occur. The postulated DST criticality was therefore modeled as a single burst.

Because the critical volume for a 10 g Pu/L solution has been calculated to be 300 L (79 gal) with a radius of 41.5 cm (16 in.) the transfer of 500 L (132 gal) is potentially enough to reach a critical condition. At the fill rate of 4.7 L/s (1.24 gal/s), it takes 63 seconds to transfer the 300 L (79 gal).

The dose consequences would result from the release of radioactive noble gases, iodine, and aerosolized plutonium and tank waste. The source term for the tank waste and plutonium

identifies the amount of material released to the environment. The methodology and atmospheric constants used with this source term to calculate dose consequences are described in Section 3.4.1.

The radiological dose consequences from the noble gases and iodine are calculated by ratioing from the inventory prescribed in *NRC Regulatory Guide 3.35*, "Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in Fuel Reprocessing Plant" (NRC 1977). The Regulatory Guide fission inventory is based on a series of bursts totaling 10^{19} fissions (350 MJ).

Using documented criticality calculations found in WHC-SD-WM-CN-047, *Calculation Notes That Support Accident Scenario and Consequence Determination of a Waste Tank Criticality,* the postulated criticality resulted in a single burst of 2.8×10^{18} fissions. The noble gas and iodine release as a result of the criticality were ratioed from NRC (1977). The aerosol release was taken to be 0.05% of the solution evaporated as a result of the criticality per NRC (1977). The aerosol was assumed to comprise tank waste and plutonium from the critical mass. The energy release evaporated 8.9 L (2 gal) of liquid that resulted in a release of 15.4 m^3 (544 ft^3) of steam, 0.0045 L of waste, and 45 mg of plutonium into the headspace. The steam created an overpressure of 0.015 atm (6 in. WG). As a result of the venting of the overpressure, 6.6×10^{-5} L of DST waste and 0.66 mg of plutonium (0.015 of the total released to the headspace) were released unfiltered to the atmosphere. The rest was released via filtered pathways. All the noble gases and iodine released to the headspace were released to the atmosphere.

Using this release, the radiological consequences for the tank waste and plutonium, calculated using the methodology described in Section 3.4.1, are given in Table 3.3.2.4.1-3. The toxicological consequence methodology is also described in Section 3.4.1. Using the previously calculated value of 6.6×10^{-5} L of DST liquid released to the environment, the calculated onsite and offsite toxicological consequences are compared with the limits for an "extremely unlikely" event (10^{-6} to 10^{-4}/yr) in Table 3.3.2.4.1-3.

The accident radiological doses and toxicological exposures are less than the offsite and onsite risk guidelines. Although the accident is considered to have a frequency beyond the "extremely unlikely" range (less than 10^{-6}), both the onsite and offsite radiological doses are shown to be acceptable for an accident in the "extremely unlikely" range (frequency of 10^{-6} to 10^{-4} per year). The toxicological sum-of-fractions is well below one, and hence well below the risk guidelines, for both onsite and offsite receptors.

Because the consequences of a hypothetical criticality are below the risk guidelines, it was judged that no safety SSCs are required. TSR controls, however, have been identified to protect key assumptions made in the analysis (Table 3.3.2.4.1-4).

In general, limits are provided on concentration, alkalinity, and neutron absorbers. Tank farms receive wastes from facilities which may contain very low concentrations of plutonium (e.g., B Plant, 222-S Laboratory, and 340 Facility, which collects laboratory wastes in the

300 Area). Shipments from the 340 Facility from mid-1994 to mid-1996, for example, contained plutonium in amounts from a few hundredths of 1 g to 3 g in liquid batches ranging from a few thousand gallons to about 10,000 gal. The facility typically may make a half dozen such shipments per year.

For wastes containing less than 0.001 g Pu/L, neutron absorbers are not necessary and are not required. The maximum expected concentration of dissolved plutonium range from about 0.002 to 0.2 g/L, depending on the hydroxide and carbonate concentrations in the waste solution (Yamaguchi et al. 1994, *Effect of Complexation on Solubility of Pu (IV) in Aqueous Carbonate System*). Generally, the more carbonate that is present, the more plutonium that can be dissolved in this range. By maintaining plutonium concentration in incoming waste streams below the solubility range given, the plutonium would not precipitate unless the solution were intentionally made strongly alkaline (e.g., 2 *M*). The lower the concentration of plutonium, the more difficult it is to precipitate. Even if the plutonium were to precipitate, the total amount of these shipments is small and would not result in a criticality concern.

References

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

NRC, 1977, "Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in Fuel Reprocessing Plant," *Regulatory Guide 3.35*, U.S. Nuclear Regulatory Commission, Washington, D.C.

WHC-SD-WM-CN-047, 1996, *Calculation Notes That Support Accident Scenario and Consequence Determination of a Waste Tank Criticality*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-SQA-CSA-507, 1996, *CSER 96-010: Criticality Parameters for Tank Waste Evaluation*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-725, 1996, *Tank Farm Nuclear Criticality Review*, Rev. 0, Westinghouse, Hanford Company, Richland, Washington.

WHC-SD-WM-TI-757, 1996, *Fluid Dynamics, Particulate Segregation, Chemical Processes, and Natural Ore Analog Discussions that Relate to the Potential for Criticality in Hanford Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Yamaguchi, T., Y. Sakamoto, and T. Ohnuk, 1994, *Effect of Complexation on Solubility of Pu (IV) in Aqueous Carbonate System*. Radiochimica Acta., 66/67.

Figure 3.3.2.4.1-1. Perspective of Hanford Site Waste Tank Subcritical Limits—Plutonium Critical Mass Versus Concentration (Spherical Geometry).

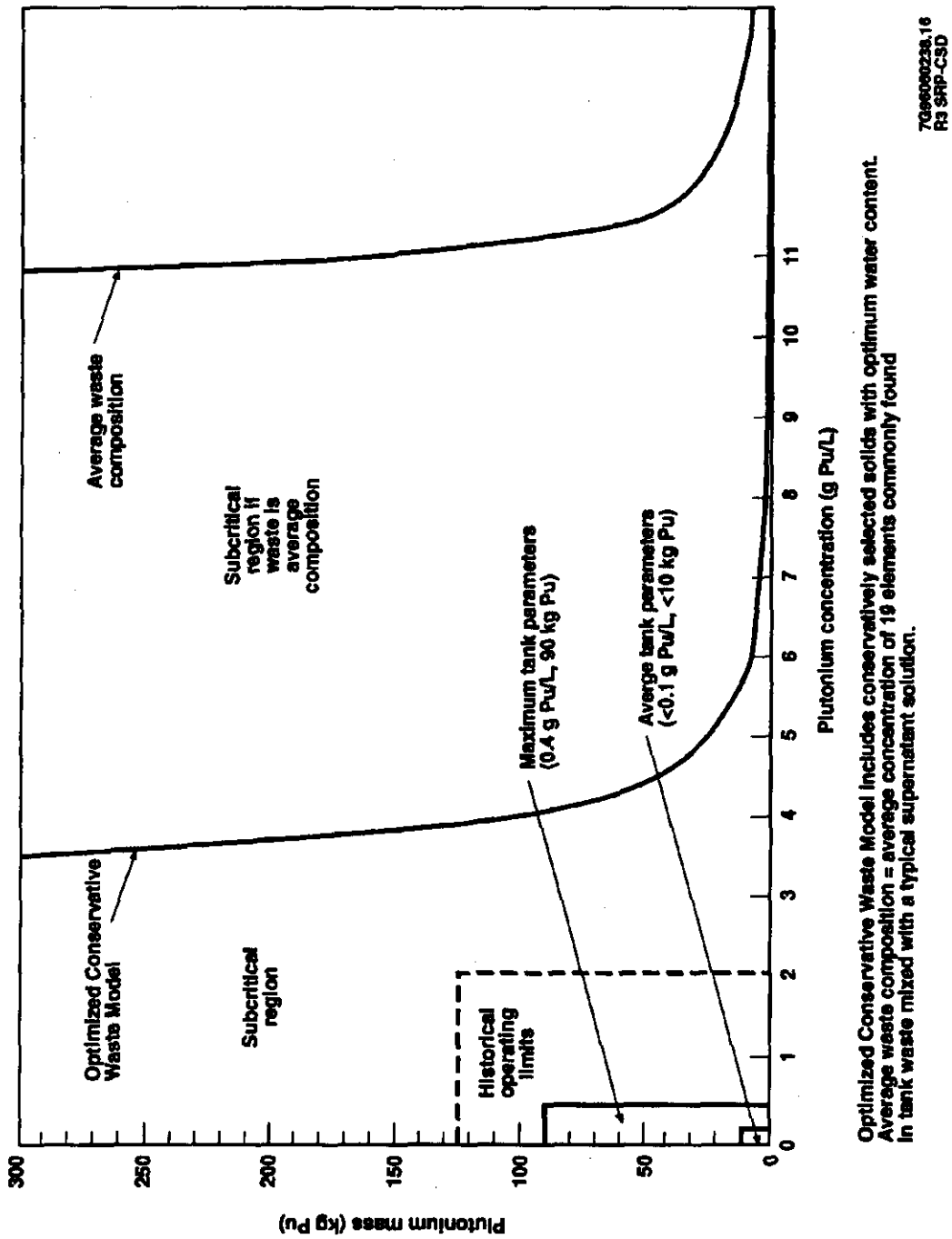

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Table 3.3.2.4.1-1. Mass Ratios for Assured Subcriticality.

Element	Mass ratio of element to plutonium above which criticality is not possible
Aluminum	910
Zirconium	4,000
Chromium	135
Iron	160
Manganese	32
Nickel	105
Uranium (natural)	770

Table 3.3.2.4.1-2. Hydrogen to Plutonium Atom Ratios.

Plutonium concentration, g/L	Optimum hydrogen to plutonium atom ratio used in the conservative waste model	Optimum water, g/L
2.6	100	10
4	500	75
10	1,500	565
30	500	565

Table 3.3.2.4.1-3. Summary of Consequences and Frequency for a Nuclear Criticality Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Nuclear Criticality	4.0 E-02 (4.0 E+00)	1.0 E-01 (1.0 E+01)	2.5 E-05 (2.5 E-03)	4.0 E-02 (4.0E+00)	3.9 E-03	1 (ERPG-3)	1.6 E-07	1 (ERPG-2)	Extremely unlikely*

*Accident is "beyond extremely unlikely." However, the consequences shown here have been compared to the risk guidelines for an "extremely unlikely" accident.

ERPG = Emergency Response Planning Guideline.

SOF = sum-of-fractions.

Table 3.3.2.4.1-4. Summary of Technical Safety Requirement Controls for Nuclear Criticality Accident.

Control	Safety function	Comments
Nuclear Criticality Safety Controls • Establish CPSs based on CSERs • Procedures for recovery from CPS nonconformance • Criticality safety training program • For transfers into the tank farms from non-tank farm facilities[a] - pH $\geq$ 8 - Neutron absorber to plutonium mass ratio > subcritical mass ratio[b] - Plutonium concentration <0.04 g/L averaged over the entire volume of the transferred waste - Independent verification of documented results • MISF activities prohibited until waste characterization[c]	Prevents the occurrence of a nuclear criticality	--

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

[a]Excludes 242-A Evaporator, chemical or water additions, and any transfers made between tank farm facilities.

[b]This condition is not required if plutonium concentration $\leq$0.001 g/L.

[c]Monitoring and sampling is allowed.

CPS = criticality prevention specification.

CSER = criticality safety evaluation report.

MISF = miscellaneous inactive storage facility.

3.3.2.4.2 High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature or Pressure. Passive or active HEPA-filtered ventilation is maintained across SSTs, DSTs, DCRTs, the 204-AR Waste Unloading Facility, the 244-AR Vault, the 213-W Dry Waste Compactor Facility, and 7 of 12 catch tanks (listed in Table 3.3.2.4.2-1). A description of these ventilation systems and facilities is provided in Chapter 2.0.

Potential releases of radioactive and hazardous materials resulting from HEPA filter failures are evaluated in the following sections. An accident analysis of HEPA filter failure caused by exposure to high temperatures and a nonmechanistic consequence analysis of HEPA filter failure caused by overpressurization are presented. The accident analysis of an unfiltered release caused by seal failure, a defective or deteriorated HEPA filter, or improper installation of a HEPA filter is included with the analysis of HEPA filter failure due to high temperature because unfiltered release consequences are developed as part of this accident analysis.

HEPA Filter Failure—Exposure to High Temperature. The hazard analysis identified that high temperatures associated with an external fire (occurring in close proximity to a HEPA filter system) or the failure of an in-line heater (present in some HEPA filter systems) could degrade the ventilation system filters. If the integrity of filters were compromised, the inventory on the filter could be released, followed by an unfiltered release from the tank vapor space. Because the analysis of HEPA filter failure due to high temperature includes the consequences of an unfiltered release pathway, the results also provide the basis for the analysis of unfiltered release events identified in the hazard analysis.

An accident scenario was developed for application to each of the tank farm HEPA filter system configurations shown in Table 3.3.2.4.2-1. The scenario assumes that a fire occurs in or around a ventilation system. The heat from the fire is assumed to degrade the filters. Degradation of the filters is assumed to result in the release of a fraction of the inventory of tank waste accumulated on prefilters (if present) and HEPA filters and to result in an unfiltered release pathway. For actively ventilated systems, it is assumed that the exhaust fans continue to run at the ventilation flow rate defined in Table 3.3.2.4.2-1. It is important to note that the ventilation flow rates listed in Table 3.3.2.4.2-1 represent maximum flow rates that were used in the accident analysis and do not represent minimum flow requirements that need to be protected by controls.

Note that inlet filters such as those in place on some DSTs (including AWF tanks) were not specifically evaluated in this analysis but are still covered (and bounded) by the analysis presented here. Unlike filters placed in the exhaust stream of the primary tank ventilation system, inlet filters are subjected to lower contamination levels because clean (i.e., environmental) air is passing through the filters while the primary tank ventilation system is operating. Inlet filters are only subjected to contamination if the primary tank ventilation system fails to provide sufficient negative pressure to maintain flow or a pressurization of the headspace occurs to vent the tank headspace constituents through the filtered inlet pathway(s). Because the contamination loading on primary tank ventilation system outlet filters is much greater than on the inlet filters, the results of the analysis presented here will bound any potential consequences associated with the release of particulates from any inlet HEPA filters that may be in place on actively ventilated waste tanks.

Heat from the fire is also assumed to release a fraction of the inventory of tank waste accumulated on ventilation system ductwork. The amount of accumulated material is assumed equal to the loading on one stage of HEPA filtration based on conservative engineering judgment (WHC-SD-WM-CN-054, *Waste Tank Ventilation System Waste Material Accumulations*).

The MAR on the HEPA and pre-filters was assumed to have a contact dose rate of less than or equal to 2.0×10^{-3} Sv/h (200 mrem/h). Because this is an assumption for filter loading, it requires a TSR control. The contact dose rate is based on operational history and bounds the contact dose rates observed in the tank farms. WHC-SD-WM-CN-033, *MICROSHIELD Dose Rate Calculations for HEPA Filters and Prefilters*, uses the contact dose rate to back calculate the inventory on the filters for all ventilation systems identified in this section except the 296-P-16 ventilation system which is used in the 241-C Tank Farm, the 296-S-15 ventilation system which is used in the 241-SX Tank Farm, and the 702-A and 702-AZ ventilation systems which are used in the 241-AY and 241-AZ Tank Farms. Specific analyses of the 296-P-16, 296-S-15, 702-A, and 702-AZ ventilation systems are provided in HNF-SD-WM-CN-099, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*.

The event frequency for this overtemperature accident scenario is "anticipated" ($>10^{-2}$ to $\leq 10^{0}$) based on the initiating event frequency for either a heater failure or an external fire. Failure of the heaters in the ventilation system has resulted in high temperatures in the exhaust air and degradation of the filters. The failure of the heater to shut off may create an overtemperature situation and cause the failure of the filters in the ventilation system. An external fire around the ventilation system would likely cause a filter degradation, as analyzed here. This event frequency is consistent with the analysis presented in Section 3.3.2.4.3 that evaluates the consequences of a fire in a contaminated area.

The total consequences of this event are calculated by adding the consequences caused by the amount of respirable material released during the HEPA filter failure and the amount of respirable material released during the subsequent continuous, unfiltered release following the filter failure. Consequences resulting from the unfiltered release pathway were calculated for 12 h (onsite receptor), 24 h (offsite receptor), and 1 yr (onsite and offsite receptors). For the 1-yr unfiltered release to the onsite receptor, the dose is adjusted by an occupancy factor of 0.286 to account for the actual time spent at work.

The consequences created as a result of the annual unfiltered release were calculated because the ventilation systems operate continuously such that the release duration is essentially infinite in the absence of controls. This is in contrast to other potential accidents that have a finite duration. The consequences as a result of the annual unfiltered release show the sensitivity of the analysis to assumptions regarding release duration and were used in conjunction with the 12-h and 24-h consequences to select the necessary and sufficient set of controls.

The airborne release fraction used to determine the amount of respirable material released from the HEPA filter as a result of exposure to high temperature or fire is 1.0×10^{-4}. This bounding value, for fiberglass filters, is based on information presented in Section 5.4.1 of DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, for HEPA filters subjected to thermal stress. This value is

considered applicable and conservative for use in this analysis because the filters used in tank farm ventilation systems are fiberglass and similar to those empirically evaluated in DOE-HDBK-3010-94. The values for HEPA filter release amounts (including prefilters and ductwork accumulation) are taken from calculation notes WHC-SD-WM-CN-062, *HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release*, and HNF-SD-WM-CN-099, and summarized in Table 3.3.2.4.2-2.

The unfiltered release amounts, based on the flow rates shown in Table 3.3.2.4.2-1, were calculated using a partition fraction to determine the amount of contamination in the headspace air. A partition fraction of 1.0×10^{-10} was used for SSTs (with active and passive ventilation), DCRTs, the 204-AR Waste Unloading Facility, and the 244-AR Vault and a partition fraction of 1.0×10^{-8} was used for all DSTs (including AWF tanks). The partition fractions cited here are based on experimental results published in RHO-RE-SA-216, *Characterization of Airborne Radionuclide Particulates in Ventilated Liquid Waste Tanks* for agitated (1.0×10^{-8}) and unagitated (1.0×10^{-10}) tanks under both active and passive ventilation.

It is assumed that no unfiltered release (following the fire or overtemperature event) will occur from the 213-W Dry Waste Compactor Facility or the ventilated catch tanks. The assumption of no unfiltered release from the catch tanks may appear to be an odd assumption because catch tanks may contain at the very least, small amounts of condensate or tank waste. The assumption is justified with the following discussion: passive breathing (with no filters) would be the worst-case accident condition for a catch tank following a fire or overtemperature event that destroys the integrity of the filtration system. Given that the volume of these tanks is small (compared with either SSTs or DSTs), the amount of particulate material in the vapor space that would be vented as a result of long-term, passive breathing would be very, very low. The 213-W Dry Waste Compactor Facility contains no tank waste available for resuspension following the filter failure.

The radiological source terms that were used to evaluate the consequences for each different ventilation system are listed in Table 3.3.2.4.2-2. These waste types each have an inhalation and ingestion dose component that is shown in Tables 3.4.1-1, "Radiological Risk Guidelines," and 3.4.1-2, "Toxicological Risk Guidelines," and are consistent with those published in WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*. The toxicological source terms used are consistent with those chosen to calculate the radiological dose consequence values.

Appropriate dispersion coefficients and breathing rates are applied to the release amounts to calculate the radiological consequences. Toxicological exposure consequences are calculated by treating the HEPA filter failure as a puff-type release and the continuous, unfiltered release as a continuous release. These calculations are presented in WHC-SD-WM-CN-062 and HNF-SD-WM-CN-099.

Table 3.3.2.4.2-3 gives the radiological and toxicological consequences of the accident scenario without controls. The onsite and offsite radiological consequences for SSTs with passive ventilation, DCRTs, 204-AR Waste Unloading Facility, 244-AR Vault, the 213-W Dry Waste Compactor Facility, and the catch tanks are below the risk guidelines for all release durations.

As such, no controls are required for these systems. The onsite and offsite toxicological consequences for all configurations and release durations are below the risk guidelines. These calculations are presented in WHC-SD-WM-CN-062 and HNF-SD-WM-CN-099.

The offsite radiological consequences for the accident scenario without controls, shown in Table 3.3.2.4.2-3, for SSTs (with active ventilation) and DSTs (including AWF tanks) are below the risk guidelines for all release durations. However, the onsite consequences for SSTs (with active ventilation) and DSTs (including AWF tanks) shown in Table 3.3.2.4.2-3 are above the onsite risk guidelines for a release duration of 1 year. Therefore, controls have been developed for SSTs (with active ventilation) and DSTs (including AWF tanks).

Note that the radiological dose consequences for an annual unfiltered release from the 244-AR Vault approach the risk guidelines. No controls have been developed for this facility because the consequences were conservatively calculated using the ventilation flow rate from the canyon exhaust system. The canyon exhaust system is inactive, with no plans for future use. Future activities in the facility are expected to rely on the vessel ventilation system, which has a much lower flow rate when operating at full capacity.

The following Safety-Significant SSC was selected to prevent the releases from exceeding the onsite risk guidelines for SSTs (with active ventilation) and DSTs (including AWF tanks):

- Ventilation Stack CAM Interlock Systems.

The tank farm electrical distribution system is a supporting system for the ventilation stack CAM interlock system.

The accident scenario with controls assumes that a fire occurs in or around the ventilation system and that the HEPA filters fail. Within 10 min of the HEPA failure, it is assumed that a ventilation stack CAM interlock system detects and shuts off the ventilation system for the active-ventilation SSTs and DSTs (including AWF tanks). The only combustion products that may conceivably impact the function of the CAM interlock/alarm would be from the degradation of the HEPA filter media and frame. The HEPA filter media is fiberglass, the frames are fire retardant, and the combustion products would be minimal. In addition, the CAM interlock/alarm is located a significant distance downstream of the filter location and is expected to be outside the fire zone. Other assumptions are documented in WHC-WM-CN-062 and HNF-SD-WM-CN-099.

The control selected has no effect on the frequency. Therefore, the frequencies with controls are the same as frequencies without controls.

The release to the environment with controls consists of the following:

- Material released from HEPA filters is unchanged from that calculated in the accident scenario without controls (see Table 3.3.2.4.2-2 for quantities).

- The unfiltered release following the HEPA filter failure was calculated for only 10 min. The basis for this assumption is that the ventilation stack CAM interlock

system will shut off the ventilation system within 10 min and there would be no forced ventilation. There would, however, be passive ventilation which is about three orders of magnitude lower resulting in insignificant consequences.

The consequence calculations for the release with controls for SSTs (active ventilation only) and DSTs (including AWF tanks) are detailed in WHC-SD-WM-CN-062.

The onsite radiological consequences with controls for SSTs (with active ventilation) and DSTs (including AWF tanks) shown in Table 3.3.2.4.2-4 are below the risk guidelines. The associated calculations are documented in WHC-SD-WM-CN-062 and HNF-WM-CN-099.

The safety SSCs and associated TSR controls for the overtemperature accident on actively ventilated SSTs and DSTs also protect against potential unfiltered release accidents. Table 3.3.2.4.2-3 shows that the annual unfiltered releases from passively ventilated SSTs are significantly below the risk guidelines. Similar consequences may be extrapolated for DSTs under passive ventilation, active ventilation with degraded filters or missing ductwork, or blown seal loops. Each of these instances may provide an unfiltered pathway to the environment. Because the consequences of unfiltered releases are below the risk guidelines, no additional controls are necessary.

Tables 3.3.2.4.2-5 and 3.3.2.4.2-6 list the safety SSCs and TSR controls, respectively, selected to mitigate the risk of HEPA filter failure due to high temperature. For each safety SSC and TSR control, the safety function is described and additional comments are provided as appropriate. The selected safety SSCs and TSR controls apply to permanent and portable ventilation systems.

In addition to the identified safety SSCs and TSR controls, which are further described in Chapters 4.0 and 5.0, respectively, other engineering and Administrative Controls provide further Defense-in-Depth protection for the public and workers against the risk of a HEPA Filter Failure—Exposure to High Temperature. The Defense-in-Depth controls are identified in Table 3.3.2.4.2-7 along with their safety function and additional comments, as appropriate.

HEPA Filter Failure—Exposure to High Pressure. A pressure differential of 0.36 lb/in^2 (10 in. WG) can fail HEPA filters. Upon failure, the inventory on the filters may be released, followed by an unfiltered release from the tank vapor space at the flow rates specified in Table 3.3.2.4.2-1. It is important to note that the ventilation flow rates listed in Table 3.3.2.4.2-1 represent maximum flow rates that were used in the accident analysis and do not represent minimum flow requirements that need to be protected by controls.

Potential accidents have been identified that can raise tank pressures to greater than 0.36 lb/in^2 (10 in. WG). These include: Steam Intrusion from Interfacing Systems (Section 3.3.2.4.5), Flammable Gas Deflagrations (Section 3.4.2.2), Organic Solvent Fire (Section 3.4.2.4), In-Tank Fuel Fire/Deflagration (Section 3.4.2.5), Organic Salt-Nitrate Reaction (Section 3.4.2.6), and Tank Bump (Section 3.4.2.11). A bounding, representative consequence analysis of a HEPA filter failure due to high pressure was performed to provide a common reference for these accidents. For each accident that involves a tank headspace pressurization, the

dose consequences are individually calculated, as appropriate to the accident scenario. The overall dose consequence values, therefore, may not be identical to those presented here (i.e., the unfiltered release may not occur for 12 h, as calculated in this analysis).

It is assumed that an event occurs within a waste tank resulting in sufficient pressure to fail all prefilters and HEPA filters present in the ventilation system configuration. It is further assumed that a fraction of the inventory of tank waste accumulated on filters and ventilation system ductwork is released. Failure of the filters results in an unfiltered release pathway. The material release amounts as a result of pressurization from the various ventilation systems are calculated in WHC-SD-WM-CN-054 and HNF-SD-WM-CN-099 and are summarized in Table 3.3.2.4.2-8.

The airborne release fraction used in WHC-SD-WM-CN-054 to determine the amount of respirable material released from the HEPA filter as a result of exposure to high pressure is 1.0×10^{-2}. This bounding value is based on information presented in Section 5.4.2 of DOE-HDBK-3010-94 for HEPA filters subjected to explosive stresses (shock, blast, and venting).

The potential accidents that can generate high pressures differ in frequency. Therefore, this analysis presents the radiological dose for comparison with all frequency categories (i.e., "anticipated," "unlikely," and "extremely unlikely"). Toxicological exposure consequences are calculated using a frequency-dependent sum-of-fractions methodology. This analysis presents sum-of-fractions values for the anticipated frequency category (i.e., the most conservative).

Table 3.3.2.4.2-9 presents the onsite and offsite radiological and toxicological consequence values, respectively, for releases from failed HEPA filters due to an overpressurization event. These values combine the consequences associated with the release from the filters due to overpressurization with the unfiltered release consequences. The associated calculations are documented in WHC-SD-WM-CN-062 and WHC-SD-WM-CN-063, *Releases From Failed HEPA Filters Due to an Overpressurization Event*, and HNF-SD-WM-CN-099.

The safety SSCs and TSR controls are defined according to the specific accident scenarios that involve a tank pressurization. Those controls specific to this accident scenario are included in this section are detailed in the tables.

To protect a key assumption of the analysis presented here, a control was developed to ensure that HEPA filter loadings (2.0×10^{-3} Sv/h [200 mrem/h]) do not exceed the values assumed in this analysis. A brief summary of the proposed control (i.e., HEPA filter controls) is included in Table 3.3.2.4.2-6. The selected safety SSCs and TSR controls apply to permanent and portable ventilation systems.

Additional controls that provide Defense-in-Depth are shown in the specific accident scenarios that involve an unfiltered HEPA filter and subsequent unfiltered release due to an overpressurization event with those specific to this accident scenario being included in Table 3.3.2.4.2-7.

References

DOE-HDBK-3010-94, 1994, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

RHO-RE-SA-216, 1987, *Characterization of Airborne Radionuclide Particulates in Ventilated Liquid Waste Tanks*, Rockwell Hanford Operations, Richland, Washington.

WHC-SD-WM-CN-033, 1996, *MICROSHIELD Dose Rate Calculations for HEPA Filters and Prefilters*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-054, 1996, *Waste Tank Ventilation System Waste Material Accumulations*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-062, 1996, *HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-063, 1996, *Releases From Failed HEPA Filters Due to an Overpressurization Event*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-016, 1996, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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Table 3.3.2.4.2-1. Filter Configuration in Tank Waste Remediation System Ventilation Systems. (2 sheets)

Facility/vent system	Filter dimension (in.) and configuration	Maximum Flow rate (m^3/s)
241-SX/241-C (SSTs with active ventilation)	24 x 24 x 12[a]	3.30
SSTs with passive breather filters (SSTs with passive ventilation configuration 1)	24 x 24 x 12[b]	6.80 E-04
SSTs with passive breather filters (SSTs with passive ventilation configuration 2)	12 x 12 x 12[b]	6.80 E-04
Double-contained receiver tank	12 x 12 x 12[c]	1.98
241-SY/241-AN/241-AP, 241-AW (DSTs)	24 x 24 x 12[c]	0.55
241-AY/241-AZ (AWF tanks)	24 x 24 x 12[d]	1.89
204-AR Waste Unloading Facility	24 x 24 x 12[e]	0.94
244-AR Vault	24 x 24 x 12[e]	7.08[f]
213-W Dry Waste Compactor Facility	24 x 24 x 12[e]	0.94
Catch tanks[g]	24 x 24 x 12[e]	NA

Note: a, b, c, d, e descriptions consistent with information presented in WHC-SD-WM-CN-062, 1996, *HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release*, Rev. 2, Westinghouse Hanford Company, Richland, Washington, and HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev 1E, Fluor Daniel Northwest, Inc., Richland, Washington. All filter dimensions shown are in inches.

[a]High Temperature Event: The configuration of the 296-S-15 ventilation system (241-SX Tank Farm) used in the safety analysis is four HEPAs and one additional HEPA volume for material coming out of the ventilation ducting: 5 HEPA Volumes. The release from the 296-S-15 system provides the bounding consequences for the accident scenario resulting from ventilation system exposure to high temperatures.

Overpressure Event: The configuration of the 296-P-16 ventilation system (utilized in the 241-C Tank Farm) used in the safety analysis is three HEPAs (including one HEPA-equivalent volume to account for material coming out of the ventilation ducting) and a single de-entrainer: 3 HEPA Volumes + 1 De-entrainer. The release from the 296-P-16 system provides the bounding consequences for the accident scenario resulting from ventilation system overpressure events.

[b]Passive breather HEPA, no prefilter, no second HEPA, and no appreciable material in the ventilation ducting: 1 HEPA Volume.

[c]Two HEPAs, a prefilter, and another volume equal to the prefilter for material coming out of the ventilation ducting: 2 HEPA Volumes + 2 Prefilter Volumes..

[d]High Temperature Event: The 241-A-702 ventilation system is used as the bounding ventilation system configuration for the safety analysis. The configuration of the 241-A-702 ventilation system is 12 HEPAs filters and one additional HEPA volume to account for material coming out of the ventilation ducting: 13 HEPA Volumes. The release from the 241-A-702 system provides the bounding consequences for the accident scenario resulting from ventilation system exposure to high temperatures.

Overpressure Event: The 241-A-702 ventilation system is used as the bounding ventilation system configuration for the safety analysis. The configuration of the 241-A-702 ventilation system is 12 HEPA filters, one additional HEPA volume to account for material coming out of the ventilation ducting, and two de-entrainers: 13 HEPA Volumes + 2 De-entrainers. The release from the 241-A-702 system provides the bounding consequences for the accident scenario resulting from ventilation system overpressure to overpressure events.

Table 3.3.2.4.2-1. Filter Configuration in Tank Waste Remediation System Ventilation Systems. (2 sheets)

[e]Two HEPAs, a prefilter, a low-efficiency filter (treated as a prefilter), and another volume equal to the prefilter for material coming out of the ventilation ducting: 2 HEPA Volumes + 3 Prefilter Volumes.

[f]Flow rate for Canyon Exhaust System.

[g]Catch tanks do not have dedicated active ventilation systems. Two catch tanks have shared ventilation systems. The 241-A-417 and 241-AX-152 are connected to the 241-A-702 ventilation system via a ventilation line. The ventilation systems for the following catch tanks and DCRTs consist of a breather filter similar to the breather filter assemblies on SSTs: 241-A-350, 241-A-417, 241-EW-151, 241-S-304, 241-AZ-151, 241-AZ-154. The following catch tanks have no HEPA filtration systems: 241-A-302A, 241-TX-302C, 241-U-301B, 241-UX-302A, and 241-ER-311.

AWF = Aging Waste Facility.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
NA = not applicable.
SST = single-shell tank.

Table 3.3.2.4.2-2. High-Efficiency Particulate Air Filter Release Amounts from Various Tank Waste Remediation System Ventilation Systems Due to Exposure to High Temperature.

Facility/vent system	Type of waste released	Amount released (L)[a]
241-SX/241-C (SSTs with active ventilation)	SST solids	7.30 E-05
SSTs with passive breather filters (SSTs with passive ventilation configurations 1 and 2)	SST solids (24 x 24 x 12 filter[b])	1.27 E-06
	SST solids (12 x 12 x 12 filter[b])	4.72 E-07
Double-contained receiver tanks	SST liquids	2.28 E-05
241-SY/241-AN/241-AP, 241-AW (DSTs)	DST liquids	9.79 E-06
241-AY/241-AZ (AWF tanks)	AWF liquids	6.40 E-05
204-AR Waste Unloading Facility	DST liquids	2.37 E-05
244-AR Vault	DST liquids	2.37 E-05
213-W Dry Waste Compactor Facility	DST liquids	9.79 E-06
Catch tanks	DST liquids	9.79 E-06

Refer to calculation notes WHC-SD-WM-CN-062, *HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release*, Rev. 2, Westinghouse Hanford Company, Richland, Washington, and HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington, for further details regarding the release amounts shown in this table.

[b]Filter dimensions shown in inches.

AWF = Aging Waste Facility.

DST = double-shell tank.

SST = single-shell tank.

Table 3.3.2.4.2-3. Summary of Consequences and Frequencies Without Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature. (2 sheets)

Accident/facility/ vent system	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite[a]		Offsite[b]		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
HEPA filter failure by fire or heater overtemperature and subsequent unfiltered release from SSTs with active ventilation[d]	5.9 E-03 (5.9 E-01) 7.1 E-02[c] (7.1 E+00)[c]	5.0 E-03 (5.0 E-01)	8.5 E-06 (8.5 E-04) 8.2 E-05[c] (8.2 E-03)[c]	1.0 E-03 (1.0 E-01)	8.9 E-01	1 (ERPG-1)	5.9 E-05	1 (PEL-TWA)	Anticipated
SSTs with passive ventilation configuration 1	4.3 E-06 (4.3 E-04) 1.8 E-05[c] (1.8 E-03)[c]	5.0 E-03 (5.0 E-01)	4.5 E-09 (4.5 E-07) 2.0 E-08[c] (2.0 E-06)[c]	1.0 E-03 (1.0 E-01)	1.5 E-02	1 (ERPG-1)	4.9 E-07	1 (PEL-TWA)	Anticipated
SSTs with passive ventilation configuration 2	2.4 E-06 (2.4 E-04) 1.6 E-05[c] (1.6 E-03)[c]	5.0 E-03 (5.0 E-01)	2.8 E-09 (2.8 E-07) 1.8 E-08[c] (1.8 E-06)[c]	1.0 E-03 (1.0 E-01)	5.7 E-03	1 (ERPG-1)	1.9 E-07	1 (PEL-TWA)	Anticipated
Double-contained receiver tanks	1.8 E-04 (1.8 E-02) 2.1 E-03[c] (2.1 E-01)[c]	5.0 E-03 (5.0 E-01)	2.4 E-07 (2.4 E-05) 2.4 E-06[c] (2.4 E-04)[c]	1.0 E-03 (1.0 E-01)	6.6 E-02	1 (ERPG-1)	2.3 E-06	1 (PEL-TWA)	Anticipated
DSTs	2.7 E-03 (2.7 E-01) 3.3 E-02[c] (3.3 E+00)[c]	5.0 E-03 (5.0 E-01)	3.8 E-06 (3.8 E-04) 3.7 E-05[c] (3.7 E-03)[c]	1.0 E-03 (1.0 E-01)	8.3 E-02	1 (ERPG-1)	5.0 E-05	1 (PEL-TWA)	Anticipated
AWF tanks[e]	2.1 E-03 (2.1 E-01) 2.6 E-02[c] (2.6 E+00)[c]	5.0 E-03 (5.0 E-01)	3.6 E-06 (3.6 E-04) 3.5 E-05[c] (3.5 E-03)[c]	1.0 E-03 (1.0 E-01)	3.8 E-01	1 (ERPG-1)	1.6 E-04	1 (PEL-TWA)	Anticipated

Table 3.3.2.4.2-3. Summary of Consequences and Frequencies Without Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature. (2 sheets)

Accident/facility/ vent system	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite[a]		Offsite[b]		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
204-AR Waste Unloading Facility	4.7 E-05 (4.7 E-03) 5.6 E-04[c] (5.6 E-02)[c]	5.0 E-03 (5.0 E-01)	6.6 E-08 (6.6 E-06) 6.3 E-07[c] (6.3 E-05)[c]	1.0 E-03 (1.0 E-01)	7.0 E-02	1 (ERPG-1)	1.6 E-06	1 (PEL-TWA)	Anticipated
244-AR Vault	3.4 E-04 (3.4 E-02) 4.3 E-03[c] (4.3 E-01)[c]	5.0 E-03 (5.0 E-01)	4.9 E-07 (4.9 E-05) 4.8 E-06[c] (4.8 E-04)[c]	1.0 E-03 (1.0 E-01)	7.6 E-02	1 (ERPG-1)	6.8 E-06	1 (PEL-TWA)	Anticipated
213-W Dry Waste Compactor Facility	6.7 E-07 (6.7 E-05)	5.0 E-03 (5.0 E-01)	5.8 E-10 (5.8 E-08)	1.0 E-03 (1.0 E-01)	2.8 E-02	1 (ERPG-1)	3.3 E-07	1 (PEL-TWA)	Anticipated
Catch tanks	6.7 E-07 (6.7 E-05)	5.0 E-03 (5.0 E-01)	5.8 E-10 (5.8 E-08)	1.0 E-03 (1.0 E-01)	2.8 E-02	1 (ERPG-1)	3.3 E-07	1 (PEL-TWA)	Anticipated

[a]12-h unfiltered release.
[b]24-h unfiltered release.
[c]Annual unfiltered release.
[d]The bounding consequences shown here are for the 296-S-15 ventilation system used in the 241-SX Tank Farm. See the HEPA filter dose contribution results and additional discussion documented in Attachments 5 and 7 of HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington.
[e]See Attachments 5 and 7 of HNF-SD-WM-CN-099 for the HEPA filter dose contribution results for this ventilation system (i.e., 702-A).
AWF = Aging Waste Facility.
DST = double-shell tank.
ERPG = Emergency Response Planning Guideline.
HEPA = high-efficiency particulate air (filter).
PEL = permissible exposure limit.
SOF = sum-of-fractions.
SST = single-shell tank.
TWA = time-weighted average.

Table 3.3.2.4.2-4. Summary of Consequences and Frequencies With Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature.

Accident/facility/vent system	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				With controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
HEPA filter failure by fire or heater overtemperature and subsequent unfiltered release from SSTs with active ventilation[c]	6.7 E-04 (6.7 E-02)	5.0 E-03 (5.0 E-01)	[a]	1.0 E-03 (1.0 E-01)	[a]	1 (ERPG-1)	[a]	1 (PEL-TWA)	Anticipated[b]
SSTs with passive ventilation configuration 1	[a]		[a]		[a]		[a]		
SSTs with passive ventilation configuration 2	[a]		[a]		[a]		[a]		
Double-contained receiver tanks	[a]		[a]		[a]		[a]		
DSTs	3.8 E-05 (3.8 E-03)	5.0 E-03 (5.0 E-01)	[a]	1.0 E-03 (1.0 E-01)	[a]	1 (ERPG-1)	[a]	1 (PEL-TWA)	Anticipated[b]
AWF tanks[d]	1.8 E-04 (1.8 E-02)	5.0 E-03 (5.0 E-01)	[a]	1.0 E-03 (1.0 E-01)	[a]	1 (ERPG-1)	[a]	1 (PEL-TWA)	Anticipated[b]
204-AR Waste Unloading Facility	[a]		[a]		[a]		[a]		
244-AR Vault	[a]		[a]		[a]		[a]		
213-W Dry Waste Compactor Facility	[a]		[a]		[a]		[a]		
Catch tanks	[a]		[a]		[a]		[a]		

[a]An analysis assuming controls was not performed because the consequences without controls were well within the guidelines.
[b]There is no effect on frequency from the controls.
[c]The bounding consequences shown here are for the 296-S-15 ventilation system used in the 241-SX Tank Farm. See Attachment 5 of HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington, for the HEPA filter dose contribution results and additional discussion.
[d]See Attachment 5 of HNF-SD-WM-CN-099 for the HEPA filter dose contribution results for this ventilation system (i.e., 702-A).
AWF = Aging Waste Facility.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SOF = sum-of-fractions.
SST = single-shell tank.

Table 3.3.2.4.2-5. Summary of Safety Structures, Systems, and Components for High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature or Pressure.

Structures, systems, and components	Safety classification	Safety function	Comments
Ventilation stack CAM interlock systems	Safety-Significant	The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the HEPA Filter Failure-Exposure to High Temperature or Pressure accident.*	Applies to single-shell tanks (with active ventilation only) and the primary tank ventilation system on double-shell tanks (including aging waste facility tanks). Control is applicable to permanent and portable ventilation systems.

*The ventilation stack CAM interlock systems must respond to shut down the ventilation systems within 10 min after the failure of the HEPA filters to protect an assumption made in the calculation of the accident scenario consequences with controls.

CAM = continuous air monitor.

HEPA = high efficiency particulate air (filter).

SSC = structure, system, and component.

Table 3.3.2.4.2-6. Summary of Technical Safety Requirement Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature or Pressure.

Control	Safety function	Comments
Ventilation stack CAM interlock systems[a]	Ensure operability of the ventilation stack CAM interlock systems to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM.	Applies to single-shell tanks (with active ventilation only) and the primary tank ventilation system on double-shell tanks (including aging waste facility tanks). Control is applicable to permanent and portable ventilation systems.
HEPA filter controls[b] • HEPA filter source term - Verify periodically that the HEPA filter housing radiation level is ≤2.0 E-03 Sv/h (≤200 mrem/h) on contact - Replace the HEPA filters and prefilters before filter housing radiation levels exceed 2.0 E-03 Sv/h (200 mrem/h).	Reduce consequences from a possible HEPA filter failure by limiting the inventory available	Applies to all HEPA filters, prefilters, and inlet filters in the ventilation system. Also protects accident analysis assumptions regarding HEPA filter release amounts.

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

[a]The ventilation stack CAM interlock systems must respond to shut down the ventilation systems within 10 min after the failure of the HEPA filters to protect an assumption made in the calculation of the accident scenario consequences with controls.

[b]Control also protects key assumptions made in the HEPA Filter Failure-Exposure to High Pressure accident scenario.

CAM = continuous air monitor.

HEPA = high-efficiency particulate air (filter).

Table 3.3.2.4.2-7. Summary of Defense-In-Depth Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature or Pressure. (2 sheets)

Control	Safety function	Comments
HEPA filter low differential pressure interlocks (where installed)	Detect gross breakthrough of filter. Activation of interlock will result in switchover to redundant train or automatic shutdown of exhaust fan.	The control described applies only to the SSTs with active ventilation and the primary tank ventilation system on DSTs (including AWF tanks) and DCRT ventilation systems. Prolonged outages of ventilation system may create a flammable gas hazard. See Section 3.4.2.2 for analysis of flammable gas accidents.
HEPA filter high differential pressure alarms (where installed)	Indicate plugging of HEPA filters, which may be caused by aerosols generated in a spray leak; activation of alarm will notify operator to switchover to redundant train or manually shut down exhaust fan.	The control described applies only to the SSTs with active ventilation and the primary tank ventilation system on DSTs (including AWF tanks) and DCRT ventilation systems. Prolonged outages of ventilation system may create a flammable gas hazard. See Section 3.4.2.2 for analysis of flammable gas accidents.
HEPA filter low differential pressure alarm	Indicative of gross breakthrough of filter, which may result in a release of aerosols.	The control described applies only to the ventilation system in the 204-AR Waste Unloading Facility.
HEPA filter high differential pressure interlock	Indicate plugging of HEPA filters.	The control described applies only to the ventilation system in the 204-AR Waste Unloading Facility.
Aerosol testing of HEPA filters	Ensure the operability of the filters on the ventilation system.	Workers trained in testing the filters. The control described applies to all locations where HEPA filters are used.
Interlock on heater over temperature	Shutdown heater on high temperature indication to protect ventilation system HEPA filters.	The control described applies to the SSTs with active ventilation and the primary tank ventilation system on DSTs (including AWF tanks), DCRT ventilation systems, and the ventilation system in the 204-AR Waste Unloading Facility. Prolonged outages of ventilation system may create a flammable gas hazard. See Section 3.4.2.2 for analysis of flammable gas accidents.

Table 3.3.2.4.2-7. Summary of Defense-In-Depth Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Temperature or Pressure. (2 sheets)

Control	Safety function	Comments
Periodic surveillance of HEPA differential pressure	Ensure the operability of the HEPA filters and the filtration monitoring system	The control described applies to the SSTs with active ventilation and the primary tank ventilation system on DSTs (including AWF tanks), DCRT ventilation systems, and the ventilation system in the 204-AR Waste Unloading Facility.
HEPA filter replacement typically performed at 1.0 E-03 Sv/h (100 mrem/h)	Limit inventory available for release and limit dose rate to workers in the vicinity of the filters	The control described applies to the SSTs with active ventilation and the primary tank ventilation system on DSTs (including AWF tanks), DCRT ventilation systems, and the ventilation system in the 204-AR Waste Unloading Facility.

AWF = Aging Waste Facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

Table 3.3.2.4.2-8. High-Efficiency Particulate Air Filter Release Amounts from Various Tank Waste Remediation System Ventilation Systems Due to Exposure to an Overpressurization Event.

Facility/vent system	Type of waste released	Amount released (L)[a]
241-SX/241-C (SSTs with active ventilation)	SST solids	1.90 E-02
SSTs with passive breather filters (SSTs with passive ventilation configurations 1 and 2)	SST solids (24 x 24 x 12 filter)[b]	1.27 E-04
	SST solids (12 x 12 x 12 filter)[b]	4.72 E-05
Double-contained receiver tanks	SST liquids	2.28 E-03
241-SY/241-AN/241-AP, 241-AW (DSTs)	DST liquids	9.79 E-04
241-AY/241-AZ (AWF tanks)	AWF liquids	3.60 E-02
204-AR Waste Unloading Facility	DST liquids	2.37 E-03
244-AR Vault	DST liquids	2.37 E-03
213-W Dry Waste Compactor Facility	DST liquids	9.79 E-04
Catch tanks	DST liquids	9.79 E-04

Refer to calculation notes WHC-SD-WM-CN-054, *Waste Tank Ventilation System Waste Material Accumulations*, Rev. 0, Westinghouse Hanford Company, Richland, Washington, and HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington, for further details regarding the release amounts shown in this table.

[b]Filter dimensions shown are in inches.

AWF = Aging Waste Facility.

DST = double-shell tank.

SST = single-shell tank.

Table 3.3.2.4.2-9. Summary of Consequences and Frequencies Without Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Pressure from a Pressurized Release Event and a Continuous, Unfiltered Release. (2 sheets)

Accident/facility/vent system	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite[a]		Offsite[b]		Onsite[d]		Offsite[d]		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
241-SX/241-C (SSTs with active ventilation[a])	5.3 E-02 (5.3 E+00) 1.2 E-01[c] (1.2 E+01)[c]	5.0 E-03 (5.0 E-01)	4.9 E-05 4.9 E-03) 1.2 E-04[c] (1.2 E-02)[c]	1.0 E-03 (1.0 E-01)	2.3 E+02	1 (ERPG-1)	7.2 E-03	1 (PEL-TWA)	Anticipated
SSTs with passive ventilation configuration 1	3.1 E-04 (3.1 E-02) 3.3 E-04[c] (3.3 E-02)[c]	5.0 E-03 (5.0 E-01)	2.8 E-07 (2.8 E-05) 3.0 E-07[c] (3.0 E-05)[c]	1.0 E-03 (1.0 E-01)	1.5	1 (ERPG-1)	4.8 E-05	1 (PEL-TWA)	Anticipated
SSTs with passive ventilation configuration 2	1.2 E-04 (1.2 E-02) 1.4 E-04[c] (1.4 E-02)[c]	5.0 E-03 (5.0 E-01)	1.0 E-07 (1.0 E-05) 1.2 E-07[c] (1.2 E-05)[c]	1.0 E-03 (1.0 E-01)	5.7 E-01	1 (ERPG-1)	1.8 E-05	1 (PEL-TWA)	Anticipated
Double-contained receiver tanks	4.5 E-04 (4.5 E-02) 2.4 E-03[c] (2.4 E-01)[c]	5.0 E-03 (5.0 E-01)	4.8 E-07 (4.8 E-05) 2.6 E-06[c] (2.6 E-04)[c]	1.0 E-03 (1.0 E-01)	6.4	1 (ERPG-1)	7.5 E-05	1 (PEL-TWA)	Anticipated
DSTs	2.7 E-03 (2.7 E-01) 3.3 E-02[c] (3.3 E+00)[c]	5.0 E-03 (5.0 E-01)	3.8 E-06 (3.8 E-04) 3.7 E-05[c] (3.7 E-03)[c]	1.0 E-03 (1.0 E-01)	2.9	1 (ERPG-1)	7.9 E-05	1 (PEL-TWA)	Anticipated
AWF tanks[e]	2.7 E-03 (2.7 E-01) 2.7 E-02[c] (2.7 E+00)[c]	5.0 E-03 (5.0 E-01)	4.1 E-06 (4.1 E-04) 3.5 E-05[c] (3.5 E-03)[c]	1.0 E-03 (1.0 E-01)	1.0 E+02	1 (ERPG-1)	1.4 E-03	1 (PEL-TWA)	Anticipated
204-AR Waste Unloading Facility	2.1 E-04 (2.1 E-02) 7.2 E-04[c] (7.2 E-02)[c]	5.0 E-03 (5.0 E-01)	2.0 E-07 (2.0 E-05) 7.7 E-07[c] (7.7 E-05)[c]	1.0 E-03 (1.0 E-01)	6.9	1 (ERPG-1)	8.2 E-05	1 (PEL-TWA)	Anticipated

Table 3.3.2.4.2-9. Summary of Consequences and Frequencies Without Controls for High-Efficiency Particulate Air Filter Failure—Exposure to High Pressure from a Pressurized Release Event and a Continuous, Unfiltered Release. (2 sheets)

Accident/facility/vent system	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite[a]		Offsite[b]		Onsite[d]		Offsite[d]		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
244-AR Vault	9.7 E-04 (9.7 E-02) 4.4 E-03[c] (4.4 E-01)[c]	5.0 E-03 (5.0 E-01)	6.3 E-07 (6.3 E-05) 4.9 E-06[c] (4.9 E-04)[c]	1.0 E-03 (1.0 E-01)	6.9	1 (ERPG-1)	8.7 E-05	1 (PEL-TWA)	Anticipated
213-W Dry Waste Compactor Facility	6.7 E-05 (6.7 E-03)	5.0 E-03 (5.0 E-01)	5.8 E-08 (5.8 E-06)	1.0 E-03 (1.0 E-01)	2.8	1 (ERPG-1)	3.3 E-05	1 (PEL-TWA)	Anticipated
Catch tanks	6.7 E-05 (6.7 E-03)	5.0 E-03 (5.0 E-01)	5.8 E-08 (5.8 E-06)	1.0 E-03 (1.0 E-01)	2.8	1 (ERPG-1)	3.3 E-05	1 (PEL-TWA)	Anticipated

[a]12-h unfiltered release.
[b]24-h unfiltered release.
[c]Annual unfiltered release.
[d]The values presented include the contribution from a continuous release at a constant rate.
[e]Values calculated in HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington.

AWF = Aging Waste Facility.
DST = double-shell tank.
ERPG = Emergency Resource Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
SST = single-shell tank.
TWA = time-weighted average.

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3.3.2.4.3 Fire in Contaminated Area. Numerous contaminated areas exist within TWRS facilities that are susceptible to releasing hazardous material during a fire. A significant number of these contaminated areas are associated with the waste transfer system. Contaminated areas in the waste transfer system that are routinely accessed include valve pits, pump pits, and diversion boxes. These structures, although mainly underground, do extend aboveground, presenting a hazard associated with the fuel tanks of vehicles operating within close proximity.

The hazard analysis performed for the tank farms identified several causes for a fire in a contaminated area. Causes included human error in positioning a crane load, electrical failure of a pump motor, or a vehicle being driven over a pit cover, rupturing the fuel tank (see Section 3.3 and WHC-SD-WM-FHA-020, *Tank Farms Fire Hazards Analysis* for a complete description of the hazards investigated).

Evaluation of the hazards and associated causes allowed the identification of an accident scenario (without controls) that represents a set of hazardous conditions related to fires in contaminated areas. In the accident scenario analyzed, a human error occurs when a crane is positioned too near a pit such that the fuel tank of the crane or nearby support vehicle hits the pit curb and spills fuel into the open pit. An ignition source is present and the fuel in the pit catches fire. Convection from the fire sweeps the hazardous material out of the pit into the atmosphere where it is transported away from the accident location by wind and other atmospheric dispersion phenomena. A valve pit was chosen for this accident scenario because it is larger than most other types of pits and has a drain arrangement that may hold significant quantities of residual waste.

Variations of this accident scenario in which burning fuel enters a waste storage tank have been analyzed and are presented in Sections 3.4.2.4 and 3.4.2.5.

A frequency of "anticipated" was qualitatively assigned to this accident scenario (without controls). Investigation showed that the frequency of such an event occurring based on one location and one vehicle would be 1.0×10^{-6}/yr. The frequency analysis was based on the number of miles per year traveled by a single crane or support vehicle near a single pit, as well as U.S. Department of Transportation statistics involving vehicle-related fires (WHC-SD-WM-CN-056, *Fire in a Contaminated Area*). Within the TWRS complex, however, there are more than 100 vehicles and more than 100 contaminated areas that would support a much higher frequency (i.e., anticipated) for this accident scenario. The occurrence reporting database includes entries where vehicles within tank farms have struck risers and ruptured the vehicle's fuel tank.

The MAR in this accident scenario (without controls) is the quantity of residual contamination present in a valve pit assuming a drain in the floor of the pit protrudes 2.54 cm (1 in.) above the floor. This is a reasonable and conservative assumption because the drains in some valve pits are known to be at this level above the pit floor to provide a detectable liquid surface for a leak detector element. The floor slopes from the pit walls to the drain, and the pit is calculated to contain dried residue from 42.0 L (11.1 gal) of material (WHC-SD-WM-CN-056). This is a very conservative assumption because it is unlikely that this quantity of waste material would be present in an open pit. Typically, actions are taken to reduce contamination (e.g., by flushing with water) before lifting bails or cover blocks are removed.

The source term used in this accident scenario is made up of 67 vol% AWF liquids and 33 vol% AWF solids. The inhalation ULD for this mixture is calculated to be 5.62×10^5 Sv/L. The use of this specific source term is a conservative assumption because this is a bounding source term for all possible waste transfers. As discussed in the preceding paragraph, actions typically undertaken would likely reduce the concentration (and quantity) of contamination present in the pit.

The airborne release fraction used to determine the amount of respirable material released during the fire is 2.0×10^{-3}. This value is based on information presented in Section 3.1 of DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, regarding the effects of thermal stress on aqueous solutions or air-dried salts under gasoline fire on a porous or otherwise absorbing (i.e., cracks, depressions) surface. Because the introduction of gasoline into the pit would result in the mixing of waste with the gasoline, the chosen value is considered to be appropriately conservative for use in this analysis. Additionally, this assumption bounds the release of powders and the release of contamination from unyielding surfaces (DOE-HDBK-3010-94) caused by thermal stress.

The total amount of respirable material resuspended from the fire is calculated to be approximately 8.4×10^{-2} L (2.2×10^{-2} gal). The fire in the pit is assumed to last for less than 2 h, allowing the use of the acute value of the atmospheric dispersion coefficient (χ/Q) to evaluate the dose consequences to both the onsite and offsite receptors. Because the calculation of the respirable quantity released is not sensitive to the duration of the fire, this ensures that consequences are calculated conservatively.

Toxicological exposure consequences are conservatively calculated assuming the total amount of respirable material (8.4×10^{-2} L [2.2×10^{-2} gal]) is released over a 15-min (900-s) timeframe consistent with methodology recommendations in WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*. This results in a respirable material release rate of 9.3×10^{-5} L/s.

Table 3.3.2.4.3-1 contains a summation of the radiological and toxicological consequence values for the fire in a contaminated area without controls. The radiological consequence (without controls) to the onsite receptor exceeds the onsite risk guidelines for an accident frequency in the anticipated category. The offsite radiological consequences, however, are well within the risk guidelines. Note that the onsite radiological guidelines are exceeded regardless of the frequency.

The toxicological exposure consequence results (without controls) are well within the risk guidelines for offsite receptors but slightly over the risk guidelines for an onsite receptor.

Because the onsite radiological consequences (without controls) exceed the risk guidelines, SSCs and TSR controls are necessary to mitigate the risk associated with this accident scenario. TSR controls are summarized in Table 3.3.2.4.3-2.. Some of the controls presented in Table 3.3.2.4.3-2 (i.e., Ignition Controls) are preventive rather than mitigative and, therefore, preclude the event from occurring. Because the selected controls included in Table 3.3.2.4.3-2

(both preventive and mitigative) prevent the accident from occurring, no consequences with controls were calculated. See Section 3.4.3 for an assessment of the residual risk associated with the potential failure of controls.

Additional controls that provide Defense-in-Depth are shown in Table 3.3.2.4.3-3.

References

DOE-HDBK-3010-94, 1994, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-SD-WM-CN-056, 1996, *Fire in a Contaminated Area*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-FHA-020, 1996, *Tank Farms Fire Hazards Analysis*, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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Table 3.3.2.4.3-1. Summary of Consequences and Frequencies for Fire in Contaminated Area Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Fire in Contaminated Area	5.3 E-01 (5.3 E+01)	5.0 E-03 (5.0 E-01)	4.4 E-04 (4.4 E-02)	1.0 E-03 (1.0 E-01)	1.2 E+00	1 (ERPG-1)	6.3 E-03	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.3.2.4.3-2. Summary of Technical Safety Requirement Controls for Fire in Contaminated Area.

Control	Safety function	Comments
Ignition controls • Vehicle controls - Vehicle access within the tank farms shall be limited to vehicles whose fuel systems are protected from damage caused by potential collisions with tank structures* - Physical barriers shall be established around tank structures outside the tank farm boundary to restrict vehicle access in the vicinity of aboveground waste tank structures. - Establish controls to limit vehicle speeds within the tank farms	Prevent vehicle fuel system damage (i.e., fuel system leaks) in the event of collisions with tank structures within the tank farms.	--
Emergency Preparedness Program with the following key element: • Response procedures	Mitigate the consequences of a fire in contaminated area.	--

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington..

*Vehicle fuel system protection may include mechanical protection such as a skid plate on the fuel tank or reservoir tanks physically located higher than risers or vehicles axles.

Table 3.3.2.4.3-3. Summary of Defense-In-Depth Controls for Fire in Contaminated Area.

Control	Safety function	Comments
Fire prevention practices	Fire prevention	Program contains a number of provisions that would prevent fires in a pit from causes other than ruptured fuel tanks
Job control - respiratory protection	Facility workers will use masks when working in areas with the potential for airborne contamination	Provides protection for facility workers that would be closest to the accident location
Job control - contamination control	Survey and cleanup of areas with loose surface contamination	For the scenario analyzed, would reduce the concentration and quantity of contamination in the valve pit
Vehicle positioning spotters	Spotters provide additional level of control in positioning cranes/vehicles	Reduces probability of analyzed accident
Vegetation control program	Prevent range fires from impacting tank farm facilities	--

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3.3.2.4.4 Evaporator Dump. During a loss of electrical power, the 242-A Evaporator is engineered to dump its contents to Tank 241-AW-102 located in the 241-AW Tank Farm. This engineered dump event is the limiting case for a sudden uncontrolled drain of hot evaporator waste to a waste tank. An evaporator dump pressurizes the tank vapor space and causes a potential uncontrolled release of contaminants to the environment.

The purpose of the 242-A Evaporator is to reduce through evaporative concentration the volume of wastes requiring storage in the DSTs. The 242-A Evaporator receives a mixed blend of feed via underground piping from Tank 241-AW-102 located in the 241-AW Tank Farm. The feed consists of liquid wastes from chemical processing operations and saturated supernate pumped to Tank 241-AW-102 from the DSTs in the 241-AN, 241-AW, 241-AP, 241-AY, and 241-SY tank farms. The chemical composition of the evaporator feed varies from run to run because the mixture of waste solutions ranges from essentially water to saturated supernate. At the evaporator, the feed from Tank 241-AW-102 is blended with the main process slurry stream flowing to the reboiler. In the reboiler, the mixture is heated to the operating temperature, normally 37.8 to 76.8 °C (100 to 170 °F). The heated slurry stream flows from the reboiler to the vapor-liquid separator, which is maintained at a pressure of 35 to 85 torr. Under this reduced pressure, a fraction of the water in the heated slurry flashes to steam. The slurry returns to the reboiler completing the process circuit. The process is continuous with typical stream flow rates of 340 to 530 L/min (90 to 140 gal/min) from the feed tank, 76 to 230 L/min (20 to 60 gal/min) for the condensate and 150 to 340 L/min (40 to 90 gal/min) for the slurry discharge.

The operating capacity, including the separator, reboiler, and recirculation loop, is 85,200 to 94,600 L (22,500 to 25,000 gal). The discharged product of the evaporator contains essentially the same chemicals and radionuclides as the feed, but at higher concentrations because water is boiled off in the evaporator. An exception is the volatile compounds, such as ammonia, for which the product concentration is lower.

The hazard analysis performed for the DSTs identified a potential hazardous condition involving the low energy release of radioactive and hazardous vapors and aerosols to the atmosphere during the uncontrolled dump of the evaporator.

For the evaporator dump scenario without controls, a common mode loss of electrical power to both the 242-A Evaporator and the 241-AW Tank Farm is postulated. The 242-A Evaporator, as engineered, discharges its content in slurry form through a separate line to feed Tank 241-AW-102. The thermally hot evaporator content mixes as it is dumped into the relatively cooler feed tank waste while spreading across the surface of the existing tank waste. The hot waste spreads across the surface of the existing waste with a layer depth of 0.6 m (2 ft) and a temperature of 55.8 °C (132.5 °F) (the average of the evaporator waste and tank waste temperatures). The 0.6-m (2-ft) layer and 55.8 °C (132.5 °F) temperature are conservative. The falling evaporator waste will actually mix with, and be cooled by, the DST waste at a depth below the waste surface as opposed to forming a hot pool that spreads over the surface of the DST waste and directly heats the vapor space.

The vapor space gas heats as energy is transferred from the waste surface to the vapor space. Heat transfer and evaporation from the falling waste is not modeled in the analysis because the heat transfer was qualitatively found to have minimal effect. At the same time, the vapor space volume decreases as the waste level in the tank increases with the addition of evaporator waste. The decrease in vapor space volume and simultaneous increase in vapor space temperature causes an increase in the tank vapor space pressure. The pressure is relieved by the vapor space gas venting through both filtered and unfiltered pathways. The ventilation system for Tank 241-AW-102 is assumed to have failed as a result of the loss of electrical power.

A maximum volume of 98,421 L (26,000 gal) is dumped through a dump line 25.4-cm (10-in.) in diameter (WHC-SD-WM-SAR-023, *242-A Evaporator/Crystallizer Safety Analysis Report*). The DST waste temperature is assumed to be 18 °C (65 °F) with a vapor space temperature of 13 °C (55 °F). The maximum allowable temperature for the evaporator vessel is 93 °C (200 °F) (WHC-SD-WM-SAR-023). The assumed and maximum allowable temperatures give the greatest temperature differential between the vapor space and the evaporator waste to maximize (1) the heat transfer to the vapor space and (2) the vapor space pressure increase resulting from the higher waste temperature.

The tank vapor space pressure reaches a maximum of approximately 2,200 Pa (9 in. WG) within the first 12 min and then returns to near atmospheric pressure. This pressure does not challenge the structural integrity of the HEPA filters. A small amount of venting continues for 2 h as the vapor space gas continues to be heated by the dumped evaporator waste.

Based on three unusual occurrence reports related to evaporator dumps in the past, this accident scenario is qualitatively assigned an annual frequency category of "anticipated."

The total amount of tank waste released to the environment is the integral of the product of the exhaust flow and vapor space aerosol concentration. WHC-SD-WM-SAR-023 has an administrative control that defines the bounding radionuclide inventory for the evaporator waste. The evaporator ULD, 7.7×10^3 Sv/L, based on the WHC-SD-WM-SAR-023 inventory limit, was calculated in WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*. The toxicological composition of the waste was assumed to be equivalent to DST liquids from WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*. No credit is taken for HEPA filters. The headspace is assumed to have a partition fraction of 1.0×10^{-8}. The maximum differential pressure allowable on the HEPA filter is 2,491 Pa (10 in. WG). As long as the tank vapor space pressure remains below 2,491 Pa (10 in. WG), the HEPA filter differential pressure maximum is not challenged.

The aerosol release fraction and respirable fraction are taken from the DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions For Nonreactor Nuclear Facilities*, for the free-fall of a concentrated aqueous solution for fall distances 3 m (9.8 ft) or less to a hard surface. For this situation, the median aerosol release fraction is 1×10^{-6} with a respirable fraction of 0.3. Because the evaporator dump is impacting a liquid surface instead of a hard surface, the use of the median aerosol release fraction and

respirable fraction is considered acceptable even though the falling distance may be more than 3 m (10 ft). The kinetic energy of the falling liquid is dissipated by the viscous forces as the dump liquid flows down through the DST liquid waste instead of going into the generation of aerosol. The lower surface-to-volume ratio for the continuous stream as the evaporator waste falls will also contribute to a reduction in the release produced from shear forces.

The release rate times the aerosol concentration is summed for the entire accident to get the total amount of radiological material released in terms of evaporator liquid (liters). Table 3.3.2.4.4-1 summarizes the radiological and toxicological consequence values for the evaporator dump accident scenario without controls. The supporting calculations are documented in WHC-SD-WM-CN-060, *Calculation Notes that Support Accident Scenario and Consequence Determination of the Evaporator Dump*. The radiological and toxicological consequences for both the offsite and onsite receptors of the evaporator dump accident scenario without controls are below the risk guidelines. Consequently, no safety SSCs or TSR controls have been identified. Table 3.3.2.4.4-2 identifies Defense-in-Depth controls for the uncontrolled discharge of the contents of 242-A Evaporator to Tank 241-AW-102.

References

DOE-HDBK-3010-94, 1994, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

WHC-SD-WM-CN-060, 1996, *Calculation Notes that Support Accident Scenario and Consequence Determination of the Evaporator Dump*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SAR-023, 1995, *242-A Evaporator/Crystallizer Safety Analysis Report*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-037, 1996, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Table 3.3.2.4.4-1. Summary of Consequences and Frequency of an Evaporator Dump Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Evaporator Dump	4.4 E-04 (4.4 E-02)	5.0 E-03 (5.0 E-01)	3.7 E-07 (3.7 E-05)	1.0 E-03 (1.0 E-01)	4.6 E-02	1 (ERPG-1)	3.9 E-05	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.3.2.4.4-2. Summary of Defense-in-Depth Controls for 242-A Evaporator Dump to Tank 241-AW-102.

Control	Safety function	Comment
Primary tank ventilation system including HEPA filters	Mitigates the release of radiological or toxicological materials by decreasing the release by means of unfiltered pathways	--
Cover blocks	Protects against releasing radiological or toxicological materials through unfiltered pathways	--

HEPA = high-efficiency particulate air (filter).

3.3.2.4.5 Steam Intrusion from Interfacing Systems. Steam jets were used to transfer waste to the tank farms by several of the process and laboratory facilities in the 200 Areas. Facilities using steam jets included the PFP, 222-S Laboratory, 242-A Evaporator, PUREX Facility, T Plant, and the 244-AR Vault. Currently, only two facilities have the potential to introduce a steam intrusion hazard at the tank farms. These facilities are the 242-A Evaporator (in 200 East Area) and the PFP (in 200 West Area).

In the scenario without controls, a liquid waste transfer to a DST is initiated from a process facility using a steam jet as the motive force to move the liquid. After the waste has been transferred, the steam jet is not shut off and pure steam is routed to the headspace of the receiving tank. This may result from operator error or equipment failure. It is assumed that 90 lb/in.^{2} gauge saturated steam is exhausted into the headspace of a partially full DST at a flow rate of 2,400 lb_m/h. This flow rate is considered to bound steam jet transfers from both the facilities identified with steam intrusion potential. Calculations in HNF-SD-WM-CN-044, *Calculation Notes That Support Accident Scenario and Consequence Development for the Steam Intrusion from Interfacing Systems Accident,* show that for the transfer line analyzed (560 ft of Schedule 40, 10-inch pipe), it would take approximately 12 min to heat the pipe to a temperature that would support steam flow into the headspace of the tank.

Even though the DST likely would be actively ventilated to control other hazards associated with waste storage (i.e., flammable gas), no credit is taken for active ventilation in this scenario. Note that the analysis shows that even if the tank is actively ventilated, the flow rate of steam into the tank is much greater than the air flow rate normally provided by an active ventilation system.

Both DSTs and DCRTs may receive steam jet waste transfers. A DST was chosen to be analyzed because it has a potentially larger headspace (allowing for more particulate in a release). Lesser consequences would be calculated for a DCRT, given the reduced headspace available.

Each facility using process steam has the required equipment (e.g., pressure-reducing valves) to ensure that the steam used for a particular process is at the correct pressure (e.g., 90 lb/in.^{2} gauge). The use of a higher steam pressure in this analysis would only show a heat up of the headspace air occurring faster (the enthalpy of 225 lb/in.^{2} gauge steam is slightly higher than 90 lb/in.^{2} gauge steam) resulting in less than a 5% increase in the 15-min average flow rate.

The operational history of the tank farms was the single factor considered when a frequency of "anticipated" (10^{-2} to 10^0/yr) was qualitatively assigned to the accident scenario without controls. Although the occurrence reporting database does not include any entries for steam intrusions, operational history has shown that a scenario such as postulated for the analysis has occurred and is still possible today (because of steam jets used for transferring waste). The frequency of this accident will diminish as the use of steam jets from process facilities is further limited by ongoing and future decontamination and decommissioning activities.

The steam introduction into the tank headspace is analyzed using the ideal gas law and thermodynamic principles. During each analyzed time interval, steam (i.e., mass and energy) is

added to the headspace, which increases both the temperature and pressure of the tank headspace. At each interval, the new temperature and pressure of the tank headspace are calculated to determine the amount of heat and headspace constituents (air and steam) that is vented through unfiltered pathways. Conservatively, no heat transfer to or from the tank walls or waste surface is assumed to occur.

Analysis (HNF-SD-WM-CN-044) shows that at the assumed steam parameters (90 lb/in.^{2} gauge and 2,400 lb_m/h) and tank conditions (initial headspace temperature, T_{HS} = 150 °F and no active ventilation), pressurization of the tank headspace is possible. By the time that steam starts to rain out of the tank headspace ($T_{HS} \approx 292$ °F), the pressure in the dome increases to approximately 18 lb/in.^{2} absolute. This is sufficient pressure to fail the HEPA filters that are in the shutdown ventilation system.

To conservatively calculate the source term from this accident scenario, the entire volume of contaminated air that was initially present in the headspace ($V_{HS} = 1.10 \times 10^5$ ft^3 of air) is assumed to be vented directly to the atmosphere without being filtered. This is the volume associated with a DST that is approximately half-full. The half-full tank scenario is presented in this section because the accident consequences are more severe than for a tank full of waste. The consequences calculated for the empty tank were similar to those for the half-full tank (HNF-SD-WM-CN-044). No credit is taken for the HEPA filters in mitigating the release, but the radiological and toxicological materials previously trapped by the HEPA filters are included in the release.

The partition fraction used to determine the amount of contamination in the headspace air is 1.0×10^{-8}. This is the value for waste storage tanks under active ventilation and is based on information in RHO-RE-SA-216, *Characterization of Airborne Radionuclide Particulate in Ventilated Liquid Waste Tanks*. This is considered to be a conservative value because a major assumption in this analysis is that the tank is under passive ventilation, although this value would account for any material that may have been suspended during the waste transfer, and subsequent line heating from the steam flow that occurred before the start of this accident scenario. From the same reference, a partition fraction of 1.0×10^{-10} can be inferred for use with long-term, passively ventilated tanks. The amount of respirable material calculated to be released from the headspace venting is 3.11×10^{-2} L.

Additionally, because it is possible to pressurize the tank headspace to a point that would rupture contaminated HEPA filters present in the ventilation system that is shut down, this quantity is added to the total released. The values for HEPA filter release amounts (including prefilters and ductwork accumulation) are taken from calculation note WHC-SD-WM-CN-054, *Waste Tank Ventilation System Waste Material Accumulations*. Because this accident scenario was performed for a DST, the amount released (based on a HEPA filter inventory of DST liquids) is 9.79×10^{-4} L. The amount released is based on a release fraction of 1.0×10^{-2} (WHC-SD-WM-CN-054) and is considered conservative because the filter media likely would be at least moist (if not soggy) from being exposed to a sizeable steam flow (or very humid atmosphere), allowing less contamination to be released in a rupture event.

The resulting airborne source term in the accident scenario was determined by adding the fractions released from the vented headspace air and the HEPA filter rupture. The amount of airborne source term calculated in this scenario totals 3.21×10^{-2} L. It is assumed that the airborne source term both entrained in the headspace and present on the HEPA filters is made up of DST liquids. DST liquids were considered appropriate because the accident scenario without controls involved a DST and because DST liquids bound the source term for AWF liquids. Additionally, the use of this source term is consistent with calculations performed in determining the amount of respirable material released from the HEPA filter failure, as discussed previously. Any solid particulates that may have been entrained in the headspace from the waste transfer before the onset of this accident are assumed to have settled out of the headspace before the pressurized release occurs. This assumption is reasonable because the incoming steam takes a relatively long period (in excess of 15 min) to create the induced pressurization resulting in radiological and toxicological consequences. All of the resulting airborne source term is conservatively assumed to be released in a short period such that this is considered an acute release. Appropriate dispersion coefficients and breathing rates are applied to develop the radiological consequences (see Section 3.4.1 for methodology and values).

Toxicological consequences are calculated using as a peak release, the total respirable amount of waste produced during venting of the headspace air and the HEPA filter rupture (3.21×10^{-2} L). This ensures that toxicological consequences are developed conservatively for both the onsite and offsite receptors.

When the upset steam flow is discovered and the steam supply is shut off, the steam in the steam-filled headspace will condense to water. With the steam condensation, the pressure in the tank will decrease, potentially creating a negative pressure in the tank. However, because of the length of time of the accident, the tank's walls and dome would be near the same temperature as the headspace gas at the end of the accident. Heat loss from a passively ventilated tank by conduction through the covering soil is very slow, allowing the headspace pressure to easily remain equalized with the atmospheric pressure.

Table 3.3.2.4.5-1 contains a summation of radiological and toxicological consequence values for the steam intrusion from interfacing systems, which are within the risk guidelines; therefore, no SSCs have been designated Safety-Class or Safety-Significant. A consequence analysis with controls was not performed for this accident because the consequences of this accident without controls are below the risk guidelines. Note that if the steam lines used by the 242-A Evaporator and PFP are blanked or physically disconnected from the tank farms, this accident is eliminated.

Table 3.3.2.4.5-2 provides a summary of the TSR controls selected to protect the analysis key assumption related to HEPA filter loading (i.e., HEPA filter controls).

Table 3.3.2.4.5-3 contains a list of controls that provide Defense-in-Depth for potential steam intrusions from interfacing systems.

References

HNF-SD-WM-CN-044, 1997, *Calculation Notes That Support Accident Scenario and Consequence Development for the Steam Intrusion from Interfacing Systems Accident*, Rev. 2, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

RHO-RE-SA-216, 1987, *Characterization of Airborne Radionuclide Particulate in Ventilated Liquid Waste Tanks*, Rockwell Hanford Operations, Richland, Washington.

WHC-SD-WM-CN-054, 1996, *Waste Tank Ventilation System Waste Material Accumulations*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table 3.3.2.4.5-1. Summary of Consequences and Frequencies for Steam Intrusion from Interfacing Systems Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Steam Intrusion from Interfacing Systems	4.9 E-04 (4.9 E-02)	5.0 E-03 (5.0 E-01)	7.6 E-07 (7.6 E-05)	1.0 E-03 (1.0 E-01)	4.2 E-01	1 (ERPG-1)	3.7 E-04	1 (PEL-TWA)	Anticipated

PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.3.2.4.5-2. Summary of Technical Safety Requirement Controls for Steam Intrusion from Interfacing Systems.

Control	Safety function	Comments
HEPA filter controls • HEPA filter source term - Verify periodically that the HEPA filter housing radiation level is ≤2.0 E-03 Sv/h (≤200 mrem/h) on contact - Replace the HEPA filters and prefilters before filter housing radiation levels exceed 2.0 E-03 Sv/h (200 mrem/h).	Reduce consequences from a possible HEPA filter failure by limiting the inventory available	Applies to all HEPA filters, prefilters, and inlet filters in the ventilation system. Also protects accident analysis assumptions regarding HEPA filter release amounts.

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

HEPA = high-efficiency particulate air (filter).

Table 3.3.2.4.5-3. Summary of Defense-In-Depth Controls for Steam Intrusion from Interfacing Systems.

Control	Safety function	Comments
Tank pressurization monitors/alarms	Alarms and monitors notify operations personnel that the tank is being pressurized	Alarm may allow time for shut down of transfer operation and evacuation of tank farm
HEPA filter high differential pressure alarms	Alarms notify operations personnel of saturated filter situation	Possibly allows time to shut down steam jet transfer operation
Emergency preparedness	Decreases the consequences to facility workers and onsite personnel	Outlines proper steps for evacuating area and mitigating the consequences to personnel
HEPA filter replacement typically performed at 1.0 E-03 Sv/h (100 mrem/h)	Limits inventory available for release and limits dose rate to workers in the vicinity of the filters	--

HEPA = high-efficiency particulate air (filter).

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3.3.2.4.6 Leak from Railcar/Tank Trailer. The 204-AR Waste Unloading Facility receives shipments by railcar or tank trailer of liquid radioactive waste for transfer to the tank farms. The liquid radioactive waste is generated at facilities not directly connected by piping to the tank farms (e.g., T Plant, 222-S Laboratory, 340 Facility, and PNNL 325 Laboratory). The railcar or tank trailer is unloaded within the shielded canyon of the 204-AR Waste Unloading Facility. The unloading canyon is maintained at a negative pressure, and the canyon ventilation exhaust passes through two HEPA filters before being released through a roof-mounted stack. The liquid radioactive waste is pumped via transfer line directly from the railcar or tank trailer to a DST. Floor drains in the unloading canyon are routed to a catch tank located in a pit under the unloading canyon. See Chapter 2.0 for a detailed description of the 204-AR Waste Unloading Facility.

The hazard analysis performed for the 204-AR Waste Unloading Facility identified potential hazardous conditions involving the accidental release of liquid radioactive waste from a railcar or tank trailer. Large liquid releases were postulated to occur both outside and inside the 204-AR Waste Unloading Facility from accidents caused by railcar derailment, railcar or tank trailer collisions, and corrosion or other degradation mechanisms causing railcar or tank trailer leak or failure. The hazard analysis determined that these hazardous conditions could have significant onsite consequences.

A railcar accident that causes the release of the entire railcar contents to the ground outside the 204-AR Waste Unloading Facility is the bounding representative accident. This accident is considered bounding for several reasons. The total radionuclide inventory allowed in a railcar is higher than a tank trailer based on (a) the shipping requirements for the railcar (WHC-SD-RE-SAP-013, *Safety Analysis Report for Packaging, Railroad Liquid Waste Tank Cars*) and tank trailer (WHC-SD-TP-SEP-011, *Safety Evaluation for Packaging for the 222-S Laboratory Cargo Tank*), and (b) the capacity of the railcar, 75,700 L (20,000 gal), and tank trailer, 18,925 L (5,000 gal). In addition, a release outside the 204-AR Waste Unloading Facility results in higher consequences because leaks inside the facility must first fill and overflow both the catch tank and pit, which have a combined capacity of 17,030 L (4,500 gal).

The railcar accident scenario, without controls, assumed that the entire contents of a railcar outside the facility spill from a height of 1.0 m (3.3 ft), splash upon impact with the ground, and form a pool before being absorbed into the soil. A fire was not postulated because the waste is not flammable and is thermally stable.

An annual frequency of unlikely (10^{-4} to 10^{-2} /yr) was qualitatively assigned to the railcar accident scenario. National and Hanford Site specific railroad accident statistics and calculations performed in WHC-SD-RE-SAP-013 and in WHC-SD-WM-CN-021, *204-AR Facility Rail Accident Analysis*, indicate that the frequency of railcar accidents resulting in large spills is less than 1×10^{-4} /yr Thus, the unlikely frequency category is considered appropriately conservative for the railcar accident scenario.

The MAR assumed to be spilled was calculated on the basis of the maximum railcar radionuclide content allowed by WHC-SD-RE-SAP-013. Waste generators that ship by railcar are required to calculate the maximum shipment volume on the basis of the waste radionuclide concentration to ensure compliance with the shipment limits in WHC-SD-RE-SAP-013. That is, for waste with high concentrations of radionuclides, a lower volume of waste is allowed in the railcar. To calculate accident consequences in accordance with the methodology described in Section 3.4.1, the railcar MAR must be equated to waste in a SST, a DST, or an AWF tank. The maximum allowed railcar radionuclide inventory per WHC-SD-RE-SAP-013 is equal to 2,123 L (561 gal) of DST liquids (WHC-SD-WM-CN-003, *Calculation Notes That Support Accident Scenario and Consequence Development for the Leak from a Railcar/Tank Trailer at the 204-AR Waste Unloading Facility*).

To evaluate the sensitivities to spill volume, radiological dose consequences were calculated for both a large spill, 75,700 L (20,000 gal), at low radionuclide concentrations and a small spill at high concentrations (i.e., equivalent to DST liquids concentration) (WHC-SD-WM-CN-003). The analyses showed that, as long as the total radionuclide inventory spilled remained the same, the dose consequences were not sensitive to pool size or wetted soil area and dose consequences for splashing were independent of spill volume.

The toxicological composition of the waste delivered to the 204-AR Waste Unloading Facility is not considered in the railcar or the tank trailer safety assessments (WHC-SD-RE-SAP-013 and WHC-SD-TP-SEP-011). Thus to evaluate the toxicological consequences of the railcar accident scenario, the waste was conservatively assumed to be equivalent to the chemical composition of DST liquids. A review of the chemical constituents of wastes that are sent to the 204-AR Waste Unloading Facility indicated that this assumption is reasonable.

To calculate the accident consequences, three release fractions or rates were applied to the MAR:

- Suspension of liquid from falling and splashing
- Evaporation and resuspension of liquid from the surface pool created on the soil
- Resuspension of liquid of the pool that was absorbed into the soil.

All values for these release fractions are from DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. The calculations indicated that (a) the dominant contributors to the airborne source term were suspension of liquid from splashing and resuspension of contaminated, wetted soil and (b) the quantity of liquid waste evaporated and resuspended from a pool was small (WHC-SD-WM-CN-003).

The resulting airborne source term in the railcar accident scenario was determined by adding the fractions released from (a) the immediate suspension of liquid from splashing, (b) the evaporation and resuspension of liquid from the pool that was assumed to exist for 2 h, and (c) the subsequent resuspension of the contaminated, wetted soil for either 10 h (onsite receptor consequences) or 22 h (offsite receptor consequences). The *MICROSHIELD* (Grove 1992) and

MICROSKYSHINE (Grove 1987) computer codes were used to calculate the direct, or skyshine, exposure to the onsite receptor in addition to the airborne source term.

Table 3.3.2.4.6-1 gives the radiological and toxicological consequence values for the railcar accident scenario. The consequence values shown in the table are within the risk guidelines. Therefore, no 204-AR Waste Unloading Facility SSCs have been designated Safety-Class or Safety-Significant. A TSR control is required, however, to protect the analysis assumption that waste transported to the 204-AR Waste Unloading Facility via railcar complies with WHC-SD-RE-SAP-013 requirements, especially the limit on total railcar radionuclide content and that the waste is not flammable and is thermally stable. A similar TSR control ensures that waste shipments made by tank trailer are in accordance with criteria established by WHC-SD-TP-SEP-011 and 49 CFR 173.403, "Definitions;" 49 CFR 173.425, "Transport Requirements for Low Specific Activity (LSA) Radioactive Materials;" and 49 CFR 173.435, "Table of A_1 and A_2 Values for Radionuclides." A summary of the TSR controls is presented in Table 3.3.2.4.6-2.

Table 3.3.2.4.6-3 indicates additional controls that provide Defense-in-Depth for potential railcar and tank trailer leaks at the 204-AR Waste Unloading Facility.

References

49 CFR 173, "Shippers - General Requirements for Shipments and Packagings," *Code of Federal Regulations.*

49 CFR 173.403, Subpart I, "Definitions," *Code of Federal Regulations.*

49 CFR 173.425, Subpart I, "Transport Requirements for Low Specific Activity (LSA) Radioactive Materials," *Code of Federal Regulations.*

49 CFR 173.435, Subpart I, "Table of A_1 and A_2 Values for Radionuclides," *Code of Federal Regulations.*

DOE-HDBK-3010-94, 1994, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

Grove, 1987, *MICROSKYSHINE*, Grove Engineering, Inc., Rockville, Maryland.

Grove, 1992, *MICROSHIELD*, Version 4, Grove Engineering, Inc., Rockville, Maryland.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-CM-2-14, 1996, *Hazardous Material Packaging and Shipping Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-RE-SAP-013, 1993, *Safety Analysis Report for Packaging, Railroad Liquid Waste Tank Cars*, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-TP-SEP-011, 1994, *Safety Evaluation for Packaging for the 222-S Laboratory Cargo Tank*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-003, 1996, *Calculation Notes That Support Accident Scenario and Consequence Development for the Leak from a Railcar/Tank Trailer at the 204-AR Waste Unloading Facility*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-021, 1996, *204-AR Facility Rail Accident Analysis*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table 3.3.2.4.6-1. Summary of Consequences and Frequencies for a Leak from a Railcar/Tank Trailer Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Leak from Railcar/Tank Trailer	8.5 E-03 (8.5 E-01)	5.0 E-02 (5.0 E+00)	4.7 E-06 (4.7 E-04)	5.0 E-03 (5.0 E-01)	5.4 E-01	1 (ERPG-2)	1.5 E-03	1 (ERPG-1)	Unlikely

ERPG = Emergency Response Planning Guideline.
SOF = sum-of-fractions.

Table 3.3.2.4.6-2. Summary of Technical Safety Requirement Controls for Potential Railcar/Tank Trailer Leaks at the 204-AR Waste Unloading Facility.

Control	Safety function	Comments
Source inventory controls • Verify the following before accepting waste at the 204-AR Waste Unloading Facility: - Railcar waste receipts shall conform to the container, volume, radioactive loading, and administrative control criteria established by WHC-SD-RE-SAP-013 - Tank trailer waste receipts from the 222-S Laboratory shall conform to the container, volume, radioactive loading, and administrative control criteria established by WHC-SD-TP-SEP-011 and 49 CFR Parts 173.403, 173.425, and 173.435. - Waste receipts shall be nonflammable and thermally stable	Protect key accident analysis assumptions	--

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

49 CFR 173.403, Subpart I, "Definitions," *Code of Federal Regulations*.

49 CFR 173.425, Subpart I, "Transport Requirements for Low Specific Activity (LSA) Radioactive Materials," *Code of Federal Regulations*.

49 CFR 173.435, Subpart I, "Table of A_1 and A_2 Values for Radionuclides," *Code of Federal Regulations*.

WHC-CM-2-14, 1996, *Hazardous Material Packaging and Shipping Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-RE-SAP-013, 1993, *Safety Analysis Report for Packaging, Railroad Liquid Waste Tank Cars*, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-TP-SEP-011, 1994, *Safety Evaluation for Packaging for the 222-S Laboratory Cargo Tank*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table 3.3.2.4.6-3. Summary of Defense-in-Depth Controls for Potential Railcar and Tank Trailer Leaks at the 204-AR Waste Unloading Facility.

Control	Safety function	Remarks
Railroad inspection and maintenance	Prevent railcar derailments caused by poor track conditions	The Hanford Site railroad system is inspected and maintained on a preventive maintenance schedule consistent with commercial standards The track inside the 204-AR Waste Unloading Facility unloading canyon is not inspected, unless requested. Because this track is set in concrete, adjustments are not normally required
Railcar and tank trailer design	Prevent leaks or spills of waste	All connections to the railcar and tank truck are located on the top of the tanks, minimizing spills and leaks There are no valves or connections located on the railcar or tank trailer that would make a damaging leak possible
Catch tank	Collect and contain waste spilled in the facility	The catch tank and its associated pit have a combined holding capacity of approximately 17,030 L (4,500 gal)
HEPA-filtered ventilation system	Mitigate the consequences of accidents resulting in airborne radioactivity	The 204-AR Waste Unloading Facility ventilation system provides two-stage HEPA filtration for unloading canyon effluents. An interlock shuts down the exhaust fan upon high-differential pressure or high radiation
Leak detection instrumentation	Detect leaks during waste transfer operations	Leak detection instrumentation in the catch tank pit and level detection in the catch tank alert operators of off-normal conditions
Continuous air monitors	Detect airborne radioactivity	Continuous air monitors in the unloading canyon alert operators to increased radiation levels from leaks
Emergency preparedness	Mitigate the consequences of leaks or spills	Emergency response plans and procedures are in place to respond to and mitigate the consequences of spills inside and outside the facility

HEPA = high-efficiency particulate air (filter).

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3.3.2.4.7 Subsurface Leak Remaining Subsurface. A network of interconnected transfer equipment is used to transfer liquid waste in the tank farms. The transfer equipment network mainly comprises encased pipelines (with some single-walled lines still in use), valve pits, pump pits, and direct-buried and double-contained catch tanks. Although the majority of transfer activities are performed in and around the DSTs, a significant portion of transfer operations is devoted to removal of the supernatant and interstitial liquids left in the SSTs. See Chapter 2.0 for a description of the components, equipment, and transfer activities associated with tank farm operations.

The hazard analysis performed for the tank farms identified causes that could result in a low energy subsurface leak that remains subsurface. Causes considered included waste leaks from cracked or broken pumps, valves, and related transfer pits. Single-walled and encased line leaks (caused by corrosion, structural fatigue, or other factors) during waste transfers or waste transfers from processing facilities to either DCRTs or diversion boxes were also considered as potential locations for waste leaks. Structural failures of SSTs, DSTs, DCRTs and associated containments also may lead to waste leaks to the environment.

The radiological dose consequences associated with a subsurface plume created as a result of a low energy subsurface leak would be maximized if a leak developed during the transfer of waste through single-walled, direct-buried transfer piping. This scenario (without controls) is considered bounding because a leak in the transfer pipe will go directly into the soil (i.e., no encasement) and limited soil shielding is provided because the transfer line is direct-buried at only 1 m (3.3 ft).

In the scenario without controls, waste is transferred through a single-walled, direct-buried pipe at a nominal flow rate of ~379 L/min (100 gal/min) for 24 h. This nominal flow rate is consistent with that assumed in the subsurface leak resulting in surface pool (Section 3.4.2.8). A leak develops in the transfer pipe and releases 5% of the total volume transferred over a 24-h period (i.e., 27,250 L [7,200 gal]). The leak volume of 5% is based on engineering judgment; and the key parameter needed to calculate the radiological dose in this analysis is the total volume of waste leaked, not the transfer flow rate or leak rate. Larger leak volumes may create a surface pool, which is analyzed separately (Section 3.4.2.8). The leaked waste in this scenario was assumed to create a subsurface plume, not a surface pool, thereby increasing the likelihood that the condition would remain undetected by a facility worker.

The subsurface plume of the waste leak is assumed to be 15.24 cm (6 in.) below the soil surface. Fifteen centimeters (6 in.) of soil cover was assumed because lesser soil cover would likely be detected or form a pool, which is analyzed separately. Greater soil cover would provide more shielding from the source and, therefore, reduce the direct, skyshine, and bremsstrahlung radiation dose consequences.

The operational history of the tank farms and the age and condition of the transfer lines were considered when a frequency of anticipated (10^{-2} to 10^{0}/yr) was qualitatively assigned to this accident scenario. Pipeline failures during prior operations are documented in the occurrence reporting database.

Assuming that the amount of waste leaked from the transfer pipe is 27,250 L (7,200 gal) and the soil has a void fraction of 0.40, the contaminated soil volume is calculated to be 68.1 m^3 (2,406.4 ft^3).

Although it is difficult to predict the true shape of the contaminated underground soil plume that would be created as a result of the transfer line leak, it is necessary to fashion the contaminated soil volume into a common geometric shape for dose rate analysis. Along with the applicable assumptions stated, the following three volumetric shapes are considered in this analysis as representative of the shape of the contaminated soil volume: (1) a horizontal cylinder (leaked waste preferentially moves along the transfer line), (2) a vertical cylinder (leaked waste expands in a vertical cylindrical shape), and (3) a sphere (leaked waste moves in all directions from a central point).

The source term used in this scenario is made up of 67 vol% SST liquids and 33 vol% SST solids. This is a conservative source term for this accident scenario because only SST liquids and solids are transferred through single-walled, buried transfer pipes.

The total radiological dose to the onsite receptor from this accident scenario consists of the direct (line-of-sight), skyshine, and associated bremsstrahlung radiation components for a period of 12 h (consistent with the methodology presented in Section 3.4.1).

There is no inhalation dose to either the onsite or offsite receptors because the surface soil is not wetted by leaked waste (i.e., no resuspension of waste particles).

For each assumed geometry, radiation dose rates are calculated for the onsite receptor (a receptor located at 100 m [328 ft] from the leak point). Line-of-sight and skyshine dose rate contributions were calculated using the *MICROSHIELD* (Grove 1992) and *MICROSKYSHINE* (Grove 1987) computer codes, respectively (see Appendix H). The receptor dose starts after the full subsurface plume has been created.

For the onsite receptor, two sets of *MICROSHIELD* and *MICROSKYSHINE* runs are made. The first set of runs is made to calculate the dose contribution from the important gamma emitters (^{137m}Ba and ^{154}Eu) and the second set of runs is made to calculate the dose contribution from bremsstrahlung radiation produced during the decay of $^{90}Sr/^{90}Y$. In all computer calculations, the composition of the soil is considered to be equivalent to that of concrete with a density of 1.6 g/cm^3 (100 lb/ft^3).

The offsite receptor receives insignificant dose from this accident scenario. Neither the onsite nor offsite receptors receive toxicological exposure consequences from this accident scenario, because the surface soil is not wetted.

Table 3.3.2.4.7-1 contains a summation of the radiological dose consequence values for the subsurface leak remaining subsurface. These consequence values are based on the overall dose rate from the direct, skyshine, and associated bremsstrahlung components to onsite workers from the contaminated soil evaluated as a horizontal cylinder (WHC-SD-WM-CN-004,

Calculation Notes That Support Accident Scenario and Consequence Development for the Subsurface Leak Remaining Subsurface Accident). The horizontal cylinder geometry resulted in the highest radiological dose consequences of all the geometries evaluated.

The consequence values shown in Table 3.3.2.4.7-1 for the accident scenario without controls are well below the risk guidelines. Even though the radiological dose consequences do not exceed the risk guidelines, controls have been identified to protect the facility worker. Pipe encasements, as a passive control, and other active systems such as transfer leak detection systems,[1] tank level detection systems, and salt well flow totalizers have been designated Safety-Significant SSCs. Table 3.3.2.4.7-2 provides a listing of the Safety-Significant SSCs along with their respective safety functions.

For safety SSCs that require electrical power (i.e., transfer leak detection systems and tank level detection systems), a supporting SSC, the tank farm electrical distribution system, is required to ensure that the chosen safety SSCs have electrical power to perform their intended safety functions.

In addition to the Safety-Significant SSCs identified, a specific TSR, in the form of Transfer Controls, has been established to mitigate the consequences to the facility worker. Table 3.3.2.4.7-3 provides details associated with the TSR controls necessary to mitigate the risk associated with the accident scenario. See Section 3.4.2.7.5 for additional discussion of how the selected controls prevent or mitigate hazardous conditions and accidents caused by waste transfer misrouting.

Table 3.3.2.4.7-4 contains a list of additional controls that provide Defense-in-Depth for potential subsurface leaks that remain subsurface.

References

Grove, 1987, *MICROSKYSHINE*, Grove Engineering, Inc., Rockville, Maryland.

Grove, 1992, *MICROSHIELD*, Version 4, Grove Engineering, Inc., Rockville, Maryland.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-SD-WM-CN-004, 1996, *Calculation Notes That Support Accident Scenario and Consequence Development for the Subsurface Leak Remaining Subsurface Accident*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[1]No credit was taken in the safety analysis for the containment of waste by the primary waste transfer piping. Based on the age and condition of the existing waste transfer piping and operating experience reflected in the occurrence reports, a system evaluation of the primary waste transfer piping could not demonstrate the capability of ensuring a safety function of waste containment.

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Table 3.3.2.4.7-1. Summary of Consequences and Frequencies for a Subsurface Leak Remaining Subsurface Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Subsurface Leak Remaining Subsurface	6.4 E-04 (6.4 E-02)	5.0 E-03 (5.0 E-01)	NA[a]	1.0 E-03 (1.0 E-01)	NA[b]	1 (ERPG-1)	NA[b]	1 (PEL-TWA)	Anticipated

[a]The offsite receptor receives insignificant radiological dose from this accident scenario

[b]There are no toxicological exposure consequences to either the onsite or offsite receptors from this accident scenario because the surface soil is not wetted.

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.3.2.4.7-2. Summary of Safety Structures, Systems, and Components for Subsurface Leak Remaining Subsurface.

Structures, systems, and components	Safety classification	Safety function	Comments
Pipe encasements	Safety-Significant	The safety function of the waste transfer system pipe encasement is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface accident.	Prevents/mitigates significant facility worker hazard
Transfer leak detection systems	Safety-Significant	The safety functions of the transfer leak detection system are to detect the presence of a leak of tank waste in transfer-associated structures, and to either provide an alarm to alert operators to take mitigative action, or to provide an interlock to shutdown waste transfer pump operation, limiting the volume of the waste leak and thus decreasing the consequences of the Subsurface Leak Remaining Subsurface accident.	Prevents/mitigates significant facility worker hazard
Tank level detection systems	Safety-Significant	The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route, and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks and/or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface accident.	Prevents/mitigates significant facility worker hazard
Salt well flow totalizers	Safety-Significant	The safety function of the salt well flow totalizers is to provide the total salt well flow parameter used in periodic material balance calculations during waste transfer operations. These calculations enable operators to terminate the waste transfer operation if waste leaks and/or mistransfers are detected, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface accident.	Prevents/mitigates significant facility worker hazard

Table 3.3.2.4.7-3. Summary of Technical Safety Requirement Controls for Subsurface Leak Remaining Subsurface.

Control	Safety function	Comments
Transfer leak detection systems	Ensure operability of the transfer leak detection system in physically connected transfer-associated structures during waste transfers.	Prevents/mitigates significant facility worker hazard
Transfer Controls • Transfer System Configuration Management		Prevents/mitigates significant facility worker hazard
- Establish and maintain controlled status of waste transfer systems as-built and jumper configuration	Prevents mistransfers into waste transfer-associated structures.	
- Perform waste transfer operations by approved procedures	Prevents mistransfers into waste transfer-associated structures.	
- Perform independent route verification during transfer setup (includes items such as verification of correct pump and correct valve alignment)	Prevents mistransfers into waste transfer-associated structures.	
- Install aboveground labeling of direct-buried (single-walled) piping systems	Supports radiation surveillance activity.	
- Perform double valve isolation on interconnected lines	Prevents mistransfers into waste transfer-associated structures.	
• Operating Requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	
- Perform ground-level radiation surveillance on single-walled, direct-buried lines during waste transfer operations	Periodic radiation surveillance will allow for early detection of leaks and mitigate the radiological dose consequences to the facility worker.	
- Monitor for increasing level in all tanks (including catch tanks) physically connected to the waste transfer route, during a waste transfer through a waste transfer system	Monitoring interconnected tanks for level increases provides a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	
Encasement seal loop controls (i.e., isolation valves are not in the closed position)	Ensure that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure	Prevents/mitigates significant facility worker hazard
Transfer pump administrative lock controls	Eliminates motive force for unplanned transfers	Prevents/mitigates significant facility worker hazard

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

Table 3.3.2.4.7-4. Summary of Defense-in-Depth Controls for Subsurface Leak Remaining Subsurface.

Control	Safety function	Comments
Hydrostatic testing of direct-buried or bermed piping	Provide a greater level of assurance of transfer line integrity before actual transfer of waste	Prevents/mitigates significant facility worker hazard
Emergency preparedness	Plans and procedures are in place to respond to emergency conditions	Mitigates significant facility worker hazard

3.3.2.4.8 Unplanned Excavation/Drilling in Crib/Ditch/Pond. Liquid radioactive and toxicologically contaminated wastes produced by Hanford Site facilities and operations have been disposed of in various TWRS cribs, ditches, or ponds located in the 200 East and 200 West Areas. As a result of past waste disposal practices, these TWRS facilities contain large quantities of contaminated soils.

The contaminated soils in cribs, ditches, and ponds normally do not present a hazard because the contaminated soils are buried under a large overburden of uncontaminated soils. See Chapter 2.0 for a more detailed description of cribs, ditches, and ponds.

An inadvertent excavation, such as a planned excavation that is performed in the wrong location, or a drilling activity in a crib, ditch, or pond may expose receptors to radiological or toxicological hazards. The exposure would result from respirable dust particles suspended during and immediately following the unplanned excavation.

From an evaluation of the recorded radiological inventories for ditch 216-U-14 and cribs 216-U-16, 216-U-17, and 216-Z-20, crib 216-Z-20 was identified as having the largest inventory of radioactive contamination (WHC-SD-WM-CN-053, *Excavations in Hanford Ponds, Cribs, or Ditches*). Therefore, to assess the potential consequences of an inadvertent excavation in a crib, ditch, or pond, an accident scenario (without controls) was developed for crib 216-Z-20. Table 3.3.2.4.8-1 lists the main dose contributors and associated concentrations of the radiological inventory for crib 216-Z-20. Similarly, Table 3.3.2.4.8-2 lists the toxicological constituents and concentrations assumed present in the soils of crib 216-Z-20.

Only operational history of the tank farms was considered when a frequency of "anticipated" (10^{-2} to 10^{0} /yr) was qualitatively assigned to the accident scenario (without controls). Numerous entries in the occurrence reporting database demonstrate that planned excavation operations have been performed in unintended areas. Some of these events have resulted in unexpected and uncontrolled personnel exposure from active transfer lines and other subsurface equipment. Planned excavations both by machine (i.e., backhoe) and by hand have occurred in unintended areas.

For the accident analysis (without controls), the crib was postulated to be excavated with a backhoe at a rate of 1 bucket of contaminated soil every 2 min for 12 h. This rate would result in approximately 120 m^3 (4,238 ft^3) of soil being excavated. Because actual excavation operations are not likely to be performed continuously for 12 h (1 work shift), this assumption is conservative. Crib 216-Z-20 was estimated to contain a total contaminated soil volume of 2,400 m^3 (84,755 ft^3). All the excavated material was conservatively assumed to come from the crib; and no credit was taken for the overlying uncontaminated soil that must be excavated to reach the contaminated soils (WHC-SD-WM-CN-053). The soil overburden in the crib was estimated to be as much as 60,000 m^3 (2,118,882 ft^3).

The total respirable material released during the unplanned excavation event was calculated by adding the fractions released during the excavation (i.e., falling from the backhoe bucket) and the subsequent resuspension of contaminated soils by the wind during and following the excavation (i.e., from the piles created by the backhoe).

The airborne release fraction used to determine the amount of respirable material released during the excavation is 6.0×10^{-4}. This value is based on a model presented in Section 4.4.3.1.3 of DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, for a free-fall spill of powder from a height of less than 3 m (10 ft). This information is considered applicable and conservative for this scenario because the model considers a wide range of masses spilled, a powdered (i.e., dry) material, and a fall height consistent with this scenario. Considering the amount of material excavated in this scenario, all the excavated material is unlikely to be powder dry and less material would likely be suspended. Thus, this release fraction is conservative.

The conservative airborne release rate used to determine the amount of respirable material released from the freshly excavated soils (piles) during and subsequent to the excavation is 4.0×10^{-5}/h. This value (DOE-HDBK-3010-94) is based on resuspension rates experimentally measured from a homogeneous bed of powder exposed to ambient conditions (normal process facility ventilation flow or less, or nominal atmospheric conditions 2 m/s [7 ft/s] with gusts up to 20 m/s [66 ft/s]). This value is considered appropriate for use because of the similarity of experimental test conditions to this accident scenario and because the release rate value is specifically appropriate for freshly deposited material in the immediate aftermath of an event. Larger material resuspension rates may be possible with wind speeds greater than 20 m/s (66 ft/s); however, the value of the atmospheric dispersion factor χ/Q, decreases as the wind speed increases. As a result, the largest doses to a receptor occur under low wind speeds.

The total amount of respirable material resuspended was calculated to be approximately 1.01×10^{-1} m^3 (3.57 ft^3) over 12 h and 1.58×10^{-1} m^3 (5.58 ft^3) over 24 h. The entire volume of the excavated soils was assumed to be available for resuspension for 24 h from the start of the excavation activity. This is considered a very conservative assumption because only the soils near the surface of the dirt piles would be exposed to the wind.

Because the inventory in crib 216-Z-20 differs significantly from tank waste, the tank waste ULDs (presented in Table 3.4.1-9) are not applicable to the scenario. Therefore, to calculate the consequences, the total radiological dose present in the contaminated crib soil was calculated to be 1.37×10^7 Sv (1.37×10^9 rem) (Table 3.3.2.4.8-3). The unit dose per cubic meter of contaminated crib soil was found by dividing the total dose by the total contaminated soil volume (2,400 m^3) resulting in a unit dose per cubic meter of 5.71×10^3 Sv/m^3 (5.71×10^5 rem/m^3). The concentration of the radiological inventory in the contaminated crib soil was assumed representative of the excavated material. Only 5% of the soil in the crib was considered to be excavated in the accident scenario (without controls).

As shown in Table 3.3.2.4.8-2, the concentrations of the toxicological constituents are in the parts per billion range. Airborne concentrations of these chemicals resulting from excavation

would be at most in the parts per billion range to the onsite receptor. Given this, toxicological exposure consequences to both the onsite and offsite receptor are considered negligible and are not quantified in this analysis.

The doses to the onsite and offsite receptors were evaluated for 12 h and 24 h, respectively. The appropriate dispersion coefficients and breathing rates were applied to develop the radiological dose consequences (see Section 3.4.1 for methodology and values).

Table 3.3.2.4.8-4 contains a summary of the radiological consequence values for the unplanned excavation or drilling in a crib, ditch, or pond. The consequence values shown in the table are well within the risk guidelines; therefore, no SSCs have been designated Safety-Class or Safety-Significant. A consequence analysis with controls was not performed for this accident because, for this accident, the consequences without controls are below the risk guidelines.

Table 3.3.2.4.8-5 contains a list of controls that provide Defense-in-Depth for potential unplanned excavations/drilling in cribs, ditches, or ponds.

References

DOE-HDBK-3010-94, 1994, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

EPA-520/1-88-020, 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, U.S. Environmental Protection Agency, Washington, D.C.

HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC-SD-WM-CN-053, 1996, *Excavations in Hanford Ponds, Cribs, or Ditches*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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Table 3.3.2.4.8-1. Radioactive Isotopes and Inventory Considered Present in Crib 216-Z-20.

Isotope	Inventory* Bq (Ci)	Concentration Bq(Ci)/m^3*
^{239}Pu	3.81 E+10 (1.03 E+00)	1.6 E+07 (4.3 E-04)
^{240}Pu	3.81 E+10 (1.03 E+00)	1.6 E+07 (4.3 E-04)
^{241}Pu	8.03 E+10 (2.17 E+00)	3.3 E+07 (9.0 E-04)
^{241}Am	3.85 E+10 (1.04 E+00)	1.6 E+07 (4.3 E-04)

*Based on a contaminated soil volume of 2,400 m^3 (84,755 ft^3) in crib 216-Z-20.

Table 3.3.2.4.8-2. The Toxicological Constituents and Concentrations Considered Present in Crib 216-Z-20.

Analyte	Average concentration (parts per billion)	Maximum concentration (parts per billion)
Mercury	1.28	20
Lead	28	319
Chromium	54	380
Cyanide	51	246
Hydrazine	59	88
Carbon tetrachloride	4,352	8,700
Cyclohexane	670	900
Tetrachlorethane	410	1,200
Phenol	37	80

Table 3.3.2.4.8-3. The Total Radiological Dose from Contaminated Soil in Crib 216-Z-20.

Isotope	Inventory (Bq)[a,b]	Dose factor (Sv/Bq)[c]	Dose (Sv)[d,e]
^{239}Pu	3.81 E+10	1.16 E-04	4.42 E+06
^{240}Pu	3.81 E+10	1.16 E-04	4.42 E+06
^{241}Pu	8.03 E+10	2.23 E-06	1.79 E+05
^{241}Am	3.85 E+10	1.20 E-04	4.62 E+06
Total			1.37 E+07

[a]Based on a contaminated soil volume of 2,400 m^3 (84,755 ft^3) in crib 216-Z-20.

[b]To convert becquerels to curies, multiply by 2.7×10^{-11}.

[c]Values taken from EPA-520/1-88-020, 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, U.S. Environmental Protection Agency, Washington, D.C.

[d]To convert Sv to rem, multiply by 100.

[e]Dose calculated by multiplying the inventory by the dose factor.

Table 3.3.2.4.8-4. Summary of Consequences and Frequencies for an Unplanned Excavation or Drilling in Cribs, Ditches, and Ponds Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Unplanned Excavation/Drilling in Crib/Ditch/Pond	1.1 E-03 (1.1 E-01)	5.0 E-03 (5.0 E-01)	1.1 E-06 (1.1 E-04)	1.0 E-03 (1.0 E-01)	Negligible	1 (ERPG-1)	Negligible	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.3.2.4.8-5. Summary of Defense-in-Depth Controls for Unplanned Excavations or Drilling in Cribs, Ditches, and Ponds.

Control	Safety function	Remarks
Excavation controls detailed in Hanford Site procedures	To ensure that excavation activities are performed in the right location with the correct equipment and properly trained personnel	While the control cited may not prevent the accident analyzed from occurring, it would create a higher level of confidence in excavation activities occurring in the correct location
Radiological work permit	To ensure Radiological Work Permit application of radiological survey requirements of HSRCM-1, *Hanford Site Radiological Control Manual,* for entry to, working in, and concluding work at known or suspected contaminated areas	The control cited may not be effective in preventing the analyzed accident from occurring

HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3.3.2.4.9 Caustic Spray Leak. Sodium hydroxide is added as needed to adjust the concentration of hydroxide (OH^-) ions in the waste tank contents to minimize corrosion. Sodium hydroxide solution is either procured from an offsite vendor and transported in 15,140-L (4,000-gal) tanker trucks to the tank farms or mixed onsite. The caustic solution may be as strong as 19 *M* (50 wt%) and may be transferred into a given tank by way of a mixer pump or directly through an available riser.

A pressurized spray leak of caustic solution during a transfer to a waste tank could disperse a significant amount of respirable sodium hydroxide particles. These particles may cause potentially significant onsite consequences. This analysis will estimate the maximum NaOH air concentrations at the onsite and offsite receptor locations should a spray leak develop. No radioactive materials are associated with this event.

A caustic spray release accident is also possible at the 204-AR Waste Unloading Facility where sodium hydroxide additions can be made during waste transfers. That accident was analyzed in WHC-SD-WM-CN-085, *Consequence Evaluation of a Caustic Spray Leak in the 204-AR Facility*. The consequences were found to be within the risk guidelines, both onsite and offsite, and to be bounded by the consequences of the caustic spray leak analyzed here.

The initiating event is assumed to be a crack in a circumferential weld at a flange or fitting in the transfer piping. The crack width is assumed to produce the maximum respirable release rate with a maximum length equal to one pipe diameter. The release continues until an operator stops the transfer and depressurizes the system.

The lightest piping used for transferring NaOH solution is 25.4-mm (1-in.) Schedule 10 commercial steel pipe with a wall thickness of 2.77 mm (0.109 in.). The largest pipe or hose used is 51-mm (2-in.) cross-linked polyethylene hose with a wall thickness of 10 mm (0.4 in.). The maximum pressure the system can be subjected to is 862 kPa (125 lb/in.^{2} gauge). The highest temperature at which the tank truck is loaded is 49 °C (120 °F). It is assumed that the concentration of the solution ranges from 5 to 50% NaOH. The postulated maximum release rate corresponds to a crack with a minimum depth equal to the lightest (Schedule 10) pipe wall thickness of 2.77 mm (0.109 in.) and a maximum length equal to one pipe diameter, i.e., 25 mm (1 in.). The width of the crack was optimized to produce the maximum NaOH release rate as respirable particles using the SPRAY Code (WHC-SD-GN-SWD-20007, *A Model for Predicting Respirable Releases from Pressurized Leaks*).

Particles less than about 10 μm tend to remain suspended in the air for long distances; whereas, particles larger than 10 μm released from a non-elevated source tend to fall out within the first 50 to 100 m (164 to 328 ft) of travel. The size of the liquid particles will decrease in transit by evaporation of the liquid component. Ultimately, only a smaller particle of the solid material previously in liquid solution will remain. Therefore, the small particle fraction of the spray release, a function of solution concentration and crack width, was determined by using the initial diameter of a solution particle (with the given solid fraction) that will shrink to 10 μm by

evaporation. The leak rate and atomization efficiency increases with decreasing viscosity, and hence with increasing temperature. Therefore, the high end of the temperature range for this liquid (50 °C [122 °F]) was assumed.

A parametric study was performed using the SPRAY Code to determine the worst-case solution concentration within the expected range of 5 to 50% NaOH. The worst-case small particle release rate was calculated over a range of NaOH concentrations. These calculations accounted for variation in viscosity and density with concentration. Results of the calculations indicated that a 12% solution was optimal regarding NaOH release rate as small particles. For this case, the unevaporated particle size range was ≤20.3 μm, and the respirable NaOH release rate was 1.68 g/s. Standard roughness and flow parameters for steel pipe were assumed. For the cases where critical flow developed in the crack, friction factors for laminar flow were assumed for conservatism.

The caustic spray leak scenario without controls was assigned a frequency of occurrence in the anticipated range (10^{-2} to 10^{0}/yr). This frequency category was assigned because only a single failure (e.g., crack in pipe, weld failure, loose piping connection) is required for the event to occur. The associated risk guidelines for onsite and offsite receptors are ERPG-1 and PEL-TWA, respectively. Both criteria are 2 mg/m^3 for NaOH (WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*).

The onsite and offsite consequences from small particles of NaOH calculated using the sum-of-fractions methodology from WHC-SD-WM-SARR-011 are shown in Table 3.3.2.4.9-1. The details of the foregoing analysis are contained in WHC-SD-WM-CN-065, *Consequence Analysis of a NaOH Solution Spray Release During Addition to Waste Tank*.

The sum-of-fractions calculated for the offsite receptor is far less than the toxicological risk criterion of 1. However, because the criterion is exceeded at the onsite receptor location, TSR controls have been selected to mitigate the risk from potential caustic spray leaks. These TSR controls, along with the appropriate safety function, are described in Table 3.3.2.4.9-2. Polyethylene (or similar) sleeving around delivery system piping provides secondary containment that minimizes sprays from dispersing because of failures of the primary pressure boundary. Controls on delivery system pressure and minimum pipe thickness protect assumptions made in the analysis. The caustic transfer controls do not apply to the 204-AR Waste Unloading Facility (based on the facility-specific analysis documented in WHC-SD-WM-CN-085). Table 3.3.2.4.9-2 provides operational assumptions for caustic delivery at the 204-AR Waste Unloading Facility to protect the validity of the analysis.

Considering the controls listed in Table 3.3.2.4.9-2, a spray leak with controls was analyzed. Because the liquid being transferred is relatively cool (<50 °C) and is at relatively low pressure (≤125 lb/in.^{2} gauge), standard 4 mil polyethylene (or similar material) sleeving was determined to have ample strength to contain the spray. However, the sleeving would not be expected to be pressure tight, and the solution would still leak out. This leak would produce a minor local cleanup problem, but there would be no significant aerosol release. The aerosol release rate for the spray with controls was estimated by calculating how much mist generated

inside the plastic sleeving could be displaced from the sleeving by the solution leaking out of the pipe. The maximum total solution leak rate, which occurs at a solution concentration of 50%, and a maximum transient air loading of 1 g/m^3, would force 7.18 x 10^{-5} g/s of solution or 3.59 x 10^{-2} mg/s of NaOH, out of the sleeving in the form of a respirable aerosol. The resulting receptor concentrations were found to be 1.22 x 10^{-3} mg/m^3 and 1.02 x 10^{-6} mg/m^3 for the onsite and offsite receptors, respectively. Both concentrations are negligible compared with the risk guidelines of 2 mg/m^3 for both receptors. Refer to WHC-SD-WM-CN-065 for calculations.

No safety SSCs are needed either to mitigate or to prevent the consequences associated with this accident scenario.

The Defense-in-Depth controls are described in Table 3.3.2.4.9-3.

References

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-SD-GN-SWD-20007, 1994, *A Model for Predicting Respirable Releases from Pressurized Leaks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-065, 1996, *Consequence Analysis of a NaOH Solution Spray Release During Addition to Waste Tank*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-085, 1996, *Consequence Evaluation of a Caustic Spray Leak in the 204-AR Facility*, Rev. 0, Fluor Daniel Northwest, Inc., Richland, Washington.

WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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Table 3.3.2.4.9-1. Summary of Consequences and Frequency of a Caustic Spray Leak Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Caustic Spray Leak	NA	5.0 E-03 (5.0 E-01)	NA	1.0 E-03 (1.0 E-01)	2.9 E+01	1 (ERPG-1)	2.4 E-02	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
NA = not applicable.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.3.2.4.9-2. Summary of Technical Safety Requirement Controls for Caustic Spray Leaks.

Control	Safety function	Comments
Caustic Transfer Controls		Controls also protect key accident analysis assumptions.
• Polyethylene (or similar) sleeving around delivery piping (standard 4 mil.)	• Mitigate the consequences of a spray leak	The caustic transfer controls do not apply to the 204-AR Waste Unloading Facility. This is based on current caustic delivery operations (i.e., caustic solution is mixed within the building and then transferred through designated, permanent piping within the building). Caustic transfer controls would apply if current caustic delivery operations change (i.e., caustic solution is transported to the facility by tanker truck and then transferred into the building through temporary piping)."
• Caustic delivery system pressure ≤125 lb/in.^{2} gauge.	• Reduce the consequences of a leak by reducing the leak rate	
• Steel pipe shall be Schedule 10 or heavier wall thickness; polyethylene hose or other delivery piping shall be designed for appropriate pressure delivery. Caustic transfer piping shall have a wall thickness of ≥0.109 in.	• Reduce the consequences of a leak by reducing the leak rate	

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

Table 3.3.2.4.9-3. Summary of Defense-in-Depth Controls for Caustic Spray Leaks.

Control	Safety function	Remarks
Industrial hygiene requirements (e.g., personal protective equipment [PPE])	To prevent or minimize consequences to a worker from a hazardous material release	The TWRS Hazardous Materials Protection (HMP) program is a collection of industrial hygiene programs designed to protect workers against the type and magnitude of hazards identified in Chapter 3.0, "Hazard and Accident Analysis." See Chapter 8.0, "Hazardous Material Protection," for a discussion of the HMP program
Emergency preparedness	To mitigate the consequences of leaks or spills	Emergency response plans and procedures are in place to respond to and mitigate the consequences of accidental leaks or spills of hazardous material. See Chapter 15.0, "Emergency Preparedness Program," for a discussion of the emergency preparedness program.

HMP = hazardous materials protection.
PPE = personal protective equipment.
TWRS = Tank Waste Remediation System.

3.3.2.4.10 Sodium Fire. The 2727-W Sodium Storage Facility is a pre-engineered 8.5-m (28-ft) x 26-m (84-ft) steel building about 80 m (260 ft) north of the 16th Street rail crossing in the 200 West Area. The facility houses five horizontally mounted stainless steel tanks containing varying amounts of solid sodium. Two of the tanks are full, one is half full, and the remaining two contain only residual heels (Teynor 1995). The tanks are 7.1 m (23 ft 3 in.) long x 4.3 m (14 ft) outside diameter (including insulation). These are very substantial stainless steel tanks (having been used as shipping containers for the sodium) with an insulating layer of refractory brick approximately 30 cm (1 ft) thick covered by aluminum sheathing. The trace heaters installed on the sodium storage tanks are not operational. The sodium is protected from contact with air by a nitrogen cover gas system. The sodium, which was originally used as primary coolant in the Hallam Nuclear Power Facility in Hallam, Nebraska, is slightly contaminated with ^{22}Na with a half life of 2.58 yr.

WHC-SD-WM-TI-759, *Hazard Evaluations for the Tank Waste Remediation System Final Safety Analysis Report*, documents findings of the hazard analysis for the 2727-W facility. The 2727-W facility hazard analysis postulated several scenarios for release of NaOH. Based on the current facility design, the only credible scenario (without controls) is a high wind-initiated building collapse leading to failure of one tank and subsequent sodium fire. The analysis is designed to produce a bounding estimate for all the release scenarios discussed in the facility hazard analysis. The radiological source term evaluation is nonmechanistic in that it assumes the release of the entire facility inventory of ^{22}Na to conclusively show that the amount of ^{22}Na present in the sodium is below the level of concern. The total, current 2727-W facility ^{22}Na inventory is estimated to be approximately 0.005 Ci (1.85×10^8 Bq) in the total sodium inventory of approximately 125,000 kg (276,000 lb) (WHC-SD-WM-TI-759). This analysis is described in detail in WHC-SD-WM-CN-045, *Consequence Analysis of a Postulated NaOH Release from the 2727-W Sodium Storage Facility*.

The postulated initiating event is a high wind that causes major damage to the 2727-W Building. The building is rated for a 958 Pa (20 lb/ft^2) wind load (WHC-SD-WM-TI-759), which translates to a 113 km/h (70 mi/h) fastest mile wind speed (ANSI A58.1, *American National Standard - Minimum Design Loads for Buildings and Other Structures*).

Falling building material breaks off a large pipe connection into a tank in such a way that the resultant tank opening faces skyward. After tank damage, the wind decreases to a low speed and heavy rain begins. The building roof fails in such a way that rain is channeled into the tank opening.

The rain that channels into the open tank (from which the nitrogen cover gas has escaped) causes a vigorous sodium-water reaction that generates large amounts of hydrogen and heat. The hydrogen is assumed to ignite and cause an explosion within the tank that further damages and opens the upper half of the tank. The explosion results in a sodium fire that covers the entire upper surface of the sodium in the tank. This scenario (without controls) occurs in the half-full tank to maximize the exposed sodium area in the tank. Insufficient energy is expected to be available to damage the other tanks.

The rain stops and the wind speed remains low to minimize washout of releases and maximize downwind exposures to the sodium combustion product release that is converted entirely to NaOH in the moist air.

The 113 km/h (70 mi/h) fastest mile wind speed has a frequency of exceedance of approximately 2 x 10^{-3}/yr in the 200 East and 200 West Areas (UCRL-53526, *Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites*). Given the occurrence of major building damage from the high wind, the remainder of the scenario leading to the limiting sodium fire is very conservatively estimated to have a probability of 1%. This implies an overall frequency of approximately 2.0 x 10^{-5}/yr, placing this postulated accident (without controls) within the "extremely unlikely" frequency category.

The postulated maximum release rate corresponds to a sodium pool fire with a size equal to the internal tank dimensions (i.e., 3.7-m [12-ft] diameter x 6.1-m [20-ft] effective length based on the 30-cm [1-ft] insulation thickness) and the volume of the tank (Teynor 1995). The maximum area of the fire is then 22.3 m^2 (240 ft^2). No credit was taken for any fire suppression effects by the remains of the top half of the tank or presence of any N_2 cover gas. The standard open pool sodium burn rate of 10.8 g/m^2-s (8 lb/ft^2-h) with an aerosol release fraction of 35% were used (Foust 1978). Data on open sodium fires (Johnson et al. 1979) indicates that about 90% of the sodium combustion product is Na_2O with about 9% Na_2CO_3 and less than 1% NaOH. Because of the ability of Na_2O to react with water to form NaOH, however, all of the sodium released from the fire comes off as NaOH with 1 g of sodium producing 1.74 g of NaOH. The resulting maximum NaOH release rate is

$$(22.3\ m^2)(10.8\ g/m^2s)(0.35)(1.74) = 147\ g/s.$$

The 147 g/s maximum NaOH release rate causes a very high local particulate concentration. The largest particulate concentration that typically can be supported in the air at a point away from the source is approximately 100 mg/m^3. Data from actual open sodium fires of approximately this size indicates that, because of rapid agglomeration and fallout of the combustion particles in the first 50 to 100 m (164 to 328 ft), the air concentration at 100 m (328 ft) downwind is actually much lower than 100 mg/m^3 (less than about 20 mg/m^3 [see WHC-SD-WM-CN-045]). Because the effects of short-range fallout cannot be quantified, 100 mg/m^3 is typically conservatively assumed at a distance of at least 100 m (328 ft) downwind of a heavy particulate source (ANSI N46.1, *American National Standard - Guidance for Defining Safety-Related Features of Nuclear Fuel Cycle Facilities*). The concentration at the offsite receptor was calculated to be 0.083 mg/m^3.

For an accident categorized as "extremely unlikely," the onsite receptor toxic limit is ERPG-3. Sodium hydroxide, classified as a corrosive/irritant, has an ERPG-3 onsite toxic limit of 100 mg/m^3 (WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*). Likewise, for an "extremely unlikely" accident, the offsite receptor toxic limit is ERPG-2, which is 40 mg/m^3 for NaOH.

The release of the entire facility inventory of ^{22}Na would produce an inhalation dose of 4.3×10^{-6} Sv (4.3×10^{-4} rem) to the onsite receptor at 100 m (328 ft) and 3.6×10^{-9} Sv (3.6×10^{-7} rem) to the offsite receptor at the near bank of the Columbia River. Both doses are negligible. The corresponding risk guidelines for the extremely unlikely frequency range are 1.0×10^{-1} Sv (1.0×10^{1} rem) and 4.0×10^{-2} Sv (4.0 rem) for the onsite and offsite receptors, respectively.

Consequences and frequencies for the sodium fire without controls are summarized in Table 3.3.2.4.10-1. Because the sodium fire scenario without controls resulted in radiological dose and toxicological exposure consequences that did not exceed the risk guidelines, an accident scenario with controls was not developed.

No onsite or offsite risk guidelines are exceeded. However, a control is necessary to protect building design features credited in the analyses. The 2727-W building structure has been designated as a Safety-Significant SSC (Table 3.3.2.4.10-2). This control ensures that the building will not fail unless the fastest wind speed reaches 113 km/h (70 mi/h). Table 3.3.2.4.10-3 lists the TSR controls developed to protect and support the classification of the Safety-Significant 2727-W Building structure.

The Defense-in-Depth controls that may mitigate the risk associated with the sodium fire scenario are listed in Table 3.3.2.4.10-4.

References

ANSI A58.1, 1982, *American National Standard - Minimum Design Loads for Buildings and Other Structures*, American National Standards Institute, New York, New York.

ANSI N46.1, 1980, *American National Standard - Guidance for Defining Safety-Related Features of Nuclear Fuel Cycle Facilities*, American Nuclear Society, La Grange Park, Illinois.

Foust, O. J., e.d., 1978, *Sodium - NaK Engineering Handbook*, Vol. III, Gordon and Breach, New York, New York.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

Johnson, R. P., C. Guderjahn, H. A. Morewitz, C. T. Nelson, and J. Otter, 1979, "Atmospheric Fallout of Sodium Combustion Aerosols," in *Proceedings of the International Meeting on Fast Reactor Safety Technology*, Seattle, Washington.

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UCRL-53526, 1985, *Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites*, Rev. 1, University of California Research Laboratory, Berkeley, California.

WHC-SD-WM-CN-045, 1996, *Consequence Analysis of a Postulated NaOH Release from the 2727-W Sodium Storage Facility*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-759, 1996, *Hazard Evaluations for the Tank Waste Remediation System Final Safety Analysis Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table 3.3.2.4.10-1. Summary of Consequences and Frequencies for Sodium Fire Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Sodium Fire	4.3 E-06 (4.3 E-04)	1.0 E-01 (1.0 E+01)	3.6 E-09 (3.6 E-07)	4.0 E-02 (4.0 E+00)	1.0 E+00	1 (ERPG-3)	2.1 E-03	1 (ERPG-2)	Extremely unlikely

ERPG = Emergency Response Planning Guideline.
SOF = sum-of-fractions.

Table 3.3.2.4.10-2. Summary of Safety Structures, Systems, and Components for Sodium Fire.

Structures, systems, and components	Safety classification	Safety function	Comments
2727-W Building	Safety-Significant	The safety functions of the 2727-W building are to withstand high winds and to protect the stored sodium tanks from vehicle collisions, thus preventing a sodium fire and decreasing the frequency of the Sodium Fire accident.	Building designed to wind loading of 20 lb/ft^2 and the foundation wall is 0.9 m (3 ft) above grade.

Table 3.3.2.4.10-3. Summary of Technical Safety Requirement Controls for Sodium Fire.

Control	Safety function	Remarks
Emergency Preparedness Program with the following key element • Verify 2727-W building structural integrity following significant, relevant, natural phenomena events (e.g., high winds)	To ensure building structural integrity and foundation height	Building designed to wind loading of 20 lb/ft^2 and the top of the foundation wall is 0.9 m (3 ft) above grade.

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

Table 3.3.2.4.10-4. Summary of Defense-in-Depth Controls for Sodium Fire.

Control	Safety function	Remarks
Grounding of building and tanks	To prevent damage from lightning	The metal building is grounded by interconnected 2.4 m (8 ft) grounding rods in six locations (grounding grid). Each sodium tank is grounded to the building grounding grid
Fire detectors	Fire detection	Two fire detectors are connected to a weatherproof external master fire alarm cabinet
No water service to building	To prevent exposure of tanks to leaks	There is no water or steam service to the building
Fire extinguishers and external postings	Fire fighting	Two dolly-mounted fire extinguishers suitable for metal fires are located in external shelters on the north and south ends of the building. Signs posted outside the building clearly direct that no water is to be used to fight fires
Nitrogen cover gas system	To preclude oxidation of the sodium	The headspace of each tank is supplied with pressurized (14 to 69 kPa [2 to 10 lb/in.^{2} gauge]) nitrogen gas to prevent any air-sodium reaction. A gas pressure monitoring system is connected to each tank through an externally mounted weatherproof control panel
Annual inspection of building structure	To ensure building structural integrity and foundation height	Building designed to wind loading of 20 lb/ft^2 and the top of the foundation wall is 0.9 m (4 ft) above grade.

3.3.2.4.11 Mixing of Incompatible Material—Toxic Vapor Generation. For corrosion control purposes, mild steel tanks shall remain above 0.01 *M* OH (hydroxide concentration). If the hydroxide concentration falls below 0.01 *M* in the TWRS storage facilities, including DSTs and DCRTs, that are constructed of mild steel, caustic (NaOH) may be added in order to bring the hydroxide concentration within the corrosion controls.

The hazard analysis performed for the tank farms identified hazardous conditions related to the mixing of incompatible material resulting in generation of a toxic vapor. The addition of caustic to adjust hydroxide concentration is judged to be the most severe case of mixing materials to cause an intentional pH change. The addition of caustic to adjust pH from less than 9.27 to greater than 9.27 will most likely be performed in a DCRT rather than in a DST.

The accident scenario without controls assumes a rapid uncontrolled addition of caustic (sodium hydroxide) to liquid waste of low pH in a DCRT, resulting in the release of ammonia as a result of the solution becoming more basic. This scenario is considered representative because liquids pumped from the SST farms tend to be low pH solutions and require the addition of caustic. This addition of caustic occurs in a DCRT. A bounding release rate of ammonia from a waste tank was determined using the following assumptions:

1. The ammonia concentration in the liquid is at the maximum value for any SST: 0.05 *M*. This maximum ammonia concentration was selected based on a review of SST supernate grab sample results (HNF-SD-WM-CN-118, *Calculation of Flammable Gas Mixtures in Double-Contained Receiver Tanks*, Appendix A).

2. The partial pressure of ammonia above the surface of the waste is a function of pH and ammonia concentration (as a dissolved gas NH_3 or as an ion NH_4^+ or NH_4OH).

3. The release rate is based on a ventilation flow rate of 7.1 m^3/min (250 ft^3/min). It is further assumed that the ammonia can be removed from solution fast enough to maintain the concentration at the value determined in assumption 2 above and that the concentration of ammonia within the open volume affected by the ventilation flow is at the maximum value determined in assumption 2 above.

This release rate was applied to DCRT 244-TX. This combination produces the bounding case. Ammonia releases from other tanks are discussed below.

Although some DSTs have a larger ventilation flow (14.2 m^3/min to 113 m^3/min [500 ft^3/min to 4,000 ft^3/min] per tank farm, the average DST has a ventilation flow of about 7.1 m^3/min [250 ft^3/min]). Because DSTs 241-AP-101, 241-AP-107, and 241-SY-101 have larger ammonia concentrations in solution (0.11 *M* according to PNNL-11237, *Evaluation of the Potential for Significant Ammonia Releases from Hanford Waste Tanks*, versus 0.05 *M*), sodium hydroxide is added to these DSTs using a mixer pump in order to raise the pH of all the waste at the same time. This results in a much slower release of ammonia than additions of sodium hydroxide to DCRTs. In addition, the assumption of uniform concentration within the ventilated

volume is much more true for a DCRT than for a DST or SST because both the volume of the ventilated space and the height of the space are less. The only other tank of concern is tank 241-C-106 because of its very large ventilation rate (68 m^3/min [2,400 cfm]).

The ventilation flow rate for tank 241-C-106 is about 10 times that used in this analysis. However, the ammonia release from tank 241-C-106 is quite small as the only free liquid is the few thousand gallons of water added each month for cooling. This is evidenced by the fact that the present headspace ammonia concentration in tank 241-C-106 (about 5 ppm) when multiplied by the vent flow rate yields an ammonia release rate that is an order of magnitude less than that calculated for this analysis. The high ventilation 241-C-106 case is therefore bounded by the DCRT accident analysis presented here.

Supplemental safety analyses and controls required for Tank 241-SY-101 remediation activities and operations are documented in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

In the scenario without controls, supernate at a pH less than 9.27 is transferred from an SST to a DCRT. Consistent with current operational practices, DST wastes are not transferred to DCRTs. Caustic addition is made in the DCRT to raise the pH of the SST supernate to 0.01 *M* OH or about pH 12. The solubility of ammonia that is contained in the waste is sensitive to the pH level. For this analysis, the maximum concentration of ammonia in SST liquid waste is 0.86 g/L (WHC-SD-WM-CN-074, *Chemical Reaction in a DCRT Leading to a Toxic Release*). An increase in pH to 9.27 will lead to a reduction in ammonia solubility and ammonia release from the waste. Above pH 9.27, the ammonia solubility remains constant.

The equilibrium relationship between ammonium hydroxide and dissolved ammonia gas in the waste is given by the following equation:

$$NH_4OH \Leftrightarrow NH_3 + H_2O$$

As discussed previously, the solubility of ammonia in an aqueous solution is constant above a pH of 9.27. Above a pH of 9.27, the partial pressure of ammonia is only a function of the ammonium hydroxide concentration in the waste and is given by the following equation (from WHC-SD-WM-CN-074):

$$\log_{10}(P_{NH_3}/[NH_4OH]) = -1.75$$

where:

P_{NH_3} = partial pressure of ammonia in atm.
$[NH_4OH]$= molar concentration of ammonium hydroxide.

This accident has been qualitatively assigned a frequency of "anticipated" because measurements in the supernate of some SSTs is less than 9.27. SSTs with pH measurements or estimates less than 9.27 will require salt well pumping for interim stabilization. Therefore, it is anticipated that SST supernates with pH less than 9.27 will be transferred to DCRTs and will require caustic addition to adjust the pH.

The ammonium concentration in the waste was taken as the highest concentration of ammonia recorded for an SST (0.86 g/L or 0.05 *M* NH_3). At pH above 9.27, this results in a partial pressure of ammonia of 8.89×10^{-4} atm. This partial pressure represents a concentration of 0.69 mg NH_3/L in the tank vapor space. This concentration was assumed to be the concentration of ammonia to be released from the DCRT by the DCRT ventilation system.

It is recognized that the partial pressure of ammonia and the corresponding calculated ammonia concentration are related to an equilibrium situation. The ammonia concentration as calculated is the peak concentration existing anywhere in the tank vapor space, with the DCRT ventilation system operating or not operating. Thus it is conservative to assume the peak concentration is the average concentration in the tank vapor space and the ventilation system is operating to discharge the ammonia to the environment. The release of ammonia from the DCRT is affected by the ventilation flow rate (7.1 m^3/min [250 ft^3/min]) and the atmospheric dispersion coefficients for onsite and offsite considerations.

No onsite or offsite radiological dose consequences exist. The estimated peak ammonia concentration is 2.8 mg/m^3 onsite, and 2.3×10^{-3} mg/m^3 offsite. The supporting calculations are documented in WHC-SD-WM-CN-074. Table 3.3.2.4.11-1 shows the calculated sum-of-fractions for the ammonia concentrations onsite and offsite.

The onsite and offsite calculated sum-of-fractions for the ammonia concentrations are below the risk guidelines for an anticipated event (i.e., an ERPG-1/PEL-TWA of 17 mg/m^3 (WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*). Accordingly, no SSCs or TSR controls are required. Because the consequences of the accident scenario without controls are well below the risk guidelines, no additional consequence analysis (i.e., accident scenario with controls) was performed. The ammonia concentration in the tank may be as high as 5.3 g/L before the risk guidelines are exceeded using the assumptions related to this analysis.

No Defense-in-Depth controls have been identified that will further reduce the risk associated with this accident scenario.

References

HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-CN-118, 1997, *Calculation of Flammable Gas Mixtures in Double-Contained Receiver Tanks*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

PNNL-11237, 1996, *Evaluation of the Potential for Significant Ammonia Releases from Hanford Waste Tanks*, Pacific Northwest National Laboratory, Richland, Washington.

WHC-SD-WM-CN-074, 1997, *Chemical Reaction in a DCRT Leading to a Toxic Release*, Rev. 0-A, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Table 3.3.2.4.11-1. Summary of Toxicological Consequences for the Mixing of Incompatible Material—Toxic Vapor Generation Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Mixing of Incompatible Material-Toxic Vapor Generation	NA*	5.0 E-03 (5.0 E-01)	NA*	1.0 E-03 (1.0 E-01)	1.6 E-01	1 (ERPG-1)	1.3 E-04	1 (PEL-TWA)	Anticipated

*The radiological consequences of this accident are bounded by the radiological consequences calculated for the Mixing of Incompatible Material—Tank Pressurization accident presented in Section 3.3.2.4.12.

ERPG = Emergency Response Planning Guideline.
NA = not applicable.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

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3.3.2.4.12 Mixing of Incompatible Material—Tank Pressurization. The exhaust fan in an actively ventilated tank system maintains a negative air pressure inside the primary tank to prevent unfiltered air emissions from escaping from the tank. The air exhausted from the tank passes through a heater, prefilter, and HEPA filters. The exhaust air is monitored for radiation before being released into the environment. The mixing of incompatible materials in a tank could result in a chemical reaction that produces enough internal pressure to force aerosols and vapors out of the tank. Because DCRTs have smaller headspace volumes than other actively ventilated tank systems and thus would be subject to overpressure more easily, DCRTs were used in this accident analysis. The mixing of incompatible materials may lead to a simple overpressurization, which is relieved by the ventilation system.

A mistransfer of incompatible waste to a DCRT was identified in the hazard analysis performed for the tank farms as an initiating event for a hazardous material release. Based on the hazard analysis performed for the FSAR and research conducted in the development of this accident scenario, it was determined that this scenario applies only to DCRTs 244-A, 244-S, and 244-TX. In the analysis, the mistransfer of nitric acid leads to a chemical reaction and subsequent release of radioactive and toxic aerosols to the environment. Incompatible materials that potentially could be transferred to TWRS facilities were studied to determine a bounding scenario. Nitric acid additions were found to result in the highest pressures.

Nitric acid can be added to tanks in the following ways:

Case 1. Unneutralized transfer from PFP (PFP error that is not detected in time).

Case 2. Inadvertent nitric acid addition to a DCRT when intending to add NaOH (for pH adjustment 416 L [110 gallons] NaOH is typically used)

Case 3. Inadvertent nitric acid addition when intending to add NaOH to a DST for pH control.

Case 4. Inadvertent addition of nitric acid to an SST during flushing when intending to add water with NaOH in it.

Case 1 (at 416 L [110 gal] transferred) and Case 2 are the worst cases based on the following logic.

When NaOH is added for pH control (Case 3), in some cases mixer pumps are used to stir the waste. The representative accident assumes a "mistransfer," which means "the operation is normal in every respect except the wrong chemical is used." The operation of the mixer pump would effectively mix the contents so that the heat is dissipated. Assuming the tank is not stirred, the following scenario is considered: 18,925 L (5,000 gal) of 12.2 *M* HNO_3 is added instead of NaOH. If the initial liquid were 8 *M* NaOH, 28,860 L (7,625 gal) of 8 *M* NaOH solution is all that would be needed to make the caustic neutralization reaction go to completion. If the initial waste temperature were 49°C (120 °F) or less, no boiling would occur.

In Case 4 not much waste is present to dissipate the heat and there is about an order of magnitude more headspace volume than the largest DCRT. Water is not normally transferred at 379 L/min (100 gal/min) as is assumed to be the case for the DCRT. The combination of minimal, but sufficient, waste in the SST to react with the nitric acid and the large headspace volume available for pressurization results in a much lower overall tank headspace pressure. For the cases when the DCRT is ½ or 1/3 full, there is enough waste to fully react. These results are the same as those postulated above.

Therefore, the case analyzed for 416 L (110 gal) of nitric acid added to 54.4 °C (130 °F) waste is the worst case. The remaining cases result in no boiling.

The accident scenario without controls assumes the addition of 416 L (110 gal) of 57 wt% nitric acid to a basic waste tank solution in a DCRT will result in a chemical reaction that will release radioactive and toxic aerosols to the environment. A 416 L (110 gal) transfer of 57 wt% nitric acid is the bounding volume that will be transferred from a single source based on a survey of sources capable of transferring to a DCRT. The receiving DCRT contains waste that is sufficiently basic to completely neutralize the incoming acid. This ensures that the effect of the heat of the reaction is maximized. Heating of the waste causes vaporization and, consequently, a pressurized buildup of aerosols in the tank headspace. No credit is taken in the accident scenario without controls for HEPA filtration such that the aerosols are released directly to the atmosphere.

This accident (without controls) has been qualitatively assigned a frequency of "anticipated" based on the operational history of mistransfers in tank farm facilities. At least five occurrence reports between 1972 and 1996 involved mistransfers.

The scenario is postulated as follows: 416 L (110 gal) of 12.2 *M* nitric acid from PFP are transferred to 244-TX DCRT. The transfer rate is 4.7 L/s (75 gal/min), and the fact that 12.2 *M* nitric acid will severely corrode the transfer piping (making it unlikely that all of the transferred acid will get to the DCRT) is ignored. The 244-TX DCRT is empty except for a heel of liquid waste containing 10 *M* NaOH. The quantity of liquid waste is chosen to be that which can completely react with the transferred acid. The temperature of the waste in the DCRT is assumed to be 54.4 °C (130 °F) because this waste is only about 6 cm (2.5 in) deep and has been cooled by the tank and vault ventilation flow. The temperature of 54.4 °C (130 °F) is a conservatively high estimate of the temperature (WHC-SD-WM-SARR-010, *Heat Removal Characteristics of Waste Storage Tanks*).

A volume of 416 L (110 gal) of 57 wt% nitric acid (12.2 *M*) is calculated to be completely neutralized by 508 L (134 gal) of basic waste at 10 *M* OH^- (maximum hydroxide concentration allowed under DCRT corrosion control limits). This complete neutralization maximizes the heat generation and heating of the waste. The energy released by the reaction heats both the waste and the acid to the boiling point which, in this case, is taken to be 115 °C (240 °F) based on the boiling point of 12.2 *M* nitric acid and 10 *M* sodium hydroxide solutions, and in the worst case, boils as much as 25 kg (55 lb) of reactants. Only 55% of this boiled-off material is calculated to be waste, and thus only 14 kg (31 lb) of waste boils. Of this, 22% condenses on the DCRT walls.

The source term used in this accident scenario is two-thirds DST liquids and one-third DST solids. An airborne release fraction of 2.0×10^{-3} and a respirable fraction of 1.0 are based on those associated with "Boiling (continuous surface breaking of bubbles of the bulk liquid with <30% of the volume of the liquid as bubbles) of Aqueous Solutions in Flowing Air" from DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. The leak path factor (as defined in Section 3.4.1) is taken as 1.0 because for the accident scenario without controls, the HEPA filters are not credited. Applying the fraction that does not condense, airborne release fraction, respirable fraction, and leak path factor to the 14 kg (31 lb) of waste affected by boiling results in 0.022 kg (0.05 lb) of waste released outside of the DCRT. The release is assumed to last less than 1 h.

The tank is pressurized as a result of this event. The tank pressure gradually rises because of the evaporation of the liquid and waste. As the tank pressure increases, there is forced flow out of the DCRT. The peak pressure in the tank is about 5 lb/in.^{2} gauge, assuming flow only through the vent line from the tank to the filters. Flow from other possibly open pathways to the vault or other tanks is not considered. The exhaust line frictional loss was doubled in the calculation to account for uncertainty and to be conservative. The boil-off rate was considered to be directly proportional to the acid addition rate. That is, the total energy of the reaction was determined. The total energy was divided by the time over which the transfer took place. This assumes instantaneous reaction time and boil-off time. Condensation was considered, as was mixing of the steam in the air. The aerosol generated by boiling was released either because of forced flow caused by tank pressurization or ventilation flow sweeping the DCRT.

The onsite and offsite radiological dose and toxicological exposure consequences of incompatible waste tank pressurization without controls are listed in Table 3.3.2.4.12-1. The associated calculations for those consequences are documented in HNF-SD-WM-CN-073, *Chemical Reaction in a DCRT*. The offsite radiological dose and toxicological exposure consequences are below the risk guidelines, but the onsite radiological dose and toxicological exposure consequences are above the guidelines. Controls are therefore required.

The accident scenario with controls credits a transfer control that requires a compatibility evaluation for pH $\geq$ 8 before transfer into a tank farm. This control effectively prevents the accident. For the bounding scenario analyzed, the HEPA filters would likely fail because of the overpressurization and therefore were not credited. In less severe scenarios, however, the HEPA filters would serve to mitigate the release. Accordingly, one stage of HEPA filters have been designated as Safety-Significant for the 244-A, 244-S, and 244-TX DCRTs as shown in Table 3.3.2.4.12-2.

As the control on pH prevents the accident, no onsite and offsite radiological dose and toxicological exposure consequences for the accident scenario with controls are presented. See Section 3.4.3 for an assessment of the residual risk associated with the potential failure of controls.

TSRs have been established to control the pH on incoming transfers and to control the source term and efficiency of the HEPA filters on the 244-A, 244-S, and 244-TX DCRTs (Table 3.3.2.4.12-3). No Defense-in-Depth controls have been identified that will further reduce the risk associated with this accident scenario.

References

DOE-HDBK-3010-94, 1994, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities,* U.S. Department of Energy, Washington, D.C.

HNF-SD-WM-CN-073, 1997, *Chemical Reaction in a DCRT,* Rev. 2, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements,* Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-SD-WM-SARR-010, 1995, *Heat Removal Characteristics of Waste Storage Tanks,* Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table 3.3.2.4.12-1. Summary of Consequences and Frequencies for Mixing of Incompatible Material—Tank Pressurization Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Mixing of Incompatible Material-Tank Pressurization	4.0 E-02 (4.0 E+00)	5.0 E-03 (5.0 E-01)	2.7 E-05 (2.7 E-03)	1.0 E-03 (1.0 E-01)	3.0 E+01	1 (ERPG-1)	7.8 E-02	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.3.2.4.12-2. Summary of Safety Structures, Systems, and Components for Mixing of Incompatible Material—Tank Pressurization.

Structures, systems, and components	Safety classification	Safety function	Comments
HEPA filter units (Minimum One Stage)	Safety-Significant	The safety function of the DCRT ventilation system HEPA filter unit (one stage) is to provide HEPA filtration of DCRT headspace gases before their release to the environment, thus decreasing the consequences of the Mixing of Incompatible Material-Tank Pressurization accident.	This control has been elevated from Defense-in-Depth to Safety-Significant based on a potential significant reduction in consequences. Only applies to the 244-A, 244-S, and 244-TX DCRTs.

DCRT = double-contained receiver tank.
HEPA = high-efficiency particulate air (filter).

Table 3.3.2.4.12-3. Summary of Technical Safety Requirement Controls for Mixing of Incompatible Material—Tank Pressurization.

Control	Safety function	Comments
Transfer controls • Ensure chemical additions are ≥ pH of 8 prior to transfer into tank farms*	Prevent heat generation due to acid/base reactions	Significantly reduces the event probability
HEPA filter controls • HEPA filter source term - Verify periodically that the HEPA filter housing radiation level is ≤2.0 E-03 Sv/h (≤200 mrem/h) on contact - Prefilters before filter housing radiation levels exceed 2.0 E-03 Sv/h (200 mrem/h). • HEPA filter efficiency - Verify HEPA filter nominal particulate removal efficiency is ≥ 99.95% by performing an aerosol test with the design air flow through the filter. - Perform aerosol test after installation and periodically thereafter. - Establish controls for replacement of the HEPA filters.	Reduce consequences from a possible HEPA filter failure by limiting the inventory available Ensures filtering efficiency of HEPA filters	Only applies to the 244-A, 244-S, and 244-TX DCRTs. Also protects accident analysis assumptions regarding HEPA filter release amounts.

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

*Excludes water additions and drums containing caustic chemicals.

DCRT = double-contained receiver tank.

HEPA = high-efficiency particulate air (filter).

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3.4 ACCIDENT ANALYSIS

Results of the analyses of the potential accidents identified in Section 3.3.2.3.1 are described in the following subsections. The consequence calculation methods common to the analyses are summarized in Section 3.4.1, including a discussion of receptor locations and exposure pathways, radionuclide and hazardous chemical inventories and associated ULD and sum-of-fraction values, atmospheric dispersion, and the equations used to calculate downwind radiological and toxicological consequences.

Results of the analyses of evaluation basis accidents with the potential for significant offsite consequences are presented in Section 3.4.2. Evaluation basis accidents are analyzed to identify the necessary and sufficient set of Safety-Class and Safety-Significant SSCs and TSR controls. This is accomplished by performing an analysis in which no credit is taken for preventive or mitigative controls. The results of the analyses without controls are compared with risk guidelines. If the guidelines are exceeded, safety SSCs and TSR controls that reduce the event frequency or consequences and ensure the guidelines are met are identified. Analyses with controls that assume the identified controls are functioning as intended are then performed.

Supplemental accident analyses for projects not within the original scope of the FSAR are included in the designated addenda, as applicable. The accident analyses for the WRSS are presented in Addendum 1. The accident analyses for the RCSTS are presented in Addendum 2. The accident analyses for the 241-AZ-702 ventilation system are presented in Addendum 3. The accident analyses for the 241-AZ-101 mixer pump test are presented in Addendum 4. Supplemental accident analysis for remediation activities and operations in Tank 241-SY-101 are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

Analyses of beyond evaluation basis accidents are presented in Section 3.4.3. Beyond evaluation basis accidents are analyzed to qualitatively assess residual risk. For operational beyond evaluation basis accidents, the assessment is accomplished by reanalyzing the evaluation basis accidents and assuming failure of the identified safety SSCs and TSRs. For certain accidents, more severe conditions than those assumed in the evaluation basis accident (e.g., a larger release of stored hydrogen) are also postulated in the beyond evaluation basis assessment. The beyond evaluation basis assessment approach is consistent with the guidance in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, which states that operational beyond evaluation basis accidents are simply those operational accidents with more severe conditions or equipment failures than are estimated for the corresponding evaluation basis accident. For natural phenomena beyond evaluation basis accidents, residual risk is assessed by evaluating the impact of a low frequency (and therefore more severe) event.

References

DOE-STD-3009-94, 1994, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

3.4.1 Methodology

This section summarizes the general calculation methods used to quantify the radiological and toxicological consequences of postulated accidents. Consequence calculation methods specific to individual postulated accidents are summarized in the individual analyses presented in Sections 3.3.2.4, 3.4.2, and 3.4.3. In this section and Sections 3.3.2.4 and 3.4.2, reference is made to computer programs used in support of the analyses. A summary description of these computer programs is presented in Appendix H.

Postulated accident consequences are combined with the postulated accident frequency and compared with the radiological and toxicological risk guidelines. Tables 3.4.1-1 and 3.4.1-2 show these guidelines. Section 3.4.1.3 explains the basis used in estimating the frequency category of postulated accidents with and without controls.

For comparison with the risk guidelines, the radiological and toxicological consequences of accidents must be calculated at the location of the maximum onsite and offsite individual. The maximum onsite and offsite individuals are defined in WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual*, as follows.

- **Maximum Onsite Individual**–The hypothetical onsite receptor located 100 m (328 ft) from the point of release or at the facility boundary and in the direction from the point of release at which the maximum dose occurs. This receptor represents the onsite worker for the purpose of reporting the consequences of postulated accidents.

- **Maximum Offsite Individual**–The hypothetical receptor located at or beyond the Hanford Site boundary location at the distance and in the direction from the point of release at which the maximum dose occurs. This receptor represents the public for the purpose of reporting the consequences of postulated accidents.

For TWRS facility accidents, the maximum onsite individual is located at 100 m (328 ft) when radioactive or hazardous material is released at ground level. A ground-level release has been assumed for all the TWRS facility accidents analyzed.

The distances from TWRS facilities to the Hanford Site boundary are shown in Table 3.4.1-3. To ensure the maximum dose consequences at the Site boundary, the computer program GXQ (WHC-SD-GN-SWD-30002, *GXQ Program User's Guide*, and WHC-SD-GN-SWD-30003, *GXQ Program Verification and Validation*) calculated the maximum dose factor (usually called atmospheric dilution factor). For TWRS facilities, this maximum occurs at the near bank of the Columbia River at a distance of either 8,760 m (28,740 ft) to the north or 8,690 m (28,510 ft) to the north-northwest, depending on the duration of the release. The output files from the GXQ code runs are included in WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments.*

Under normal circumstances, public access is provided through the Hanford Site on Washington State Highways 240, 24, and 243. Because DOE controls the land on either side of State Highway 240, public usage is considered to be transient (Scott 1995). An assessment of the consequences of postulated accidents on State Highway 240 transients to develop needed emergency response is summarized in Chapter 15.0.

3.4.1.1 Radiological Consequence Calculation Methodology.

3.4.1.1.1 Radionuclide Inventory. Computer modeling was used to identify and estimate the total inventory of radioactive materials contained in fuel from the Hanford Site production reactors. Reduction factors were applied to the total inventory to account for PUREX. Reduction factors also were applied to other isotopes (e.g., cesium and strontium) which also were extracted. Results of the inventory calculations are documented in WHC-SD-WM-RPT-164, *Inventories for Low-Level Waste Tank Waste*.

Computer modeling identified the potential presence of more than 150 radionuclides in tank waste. The total activity for each radionuclide was multiplied by its inhalation dose conversion factor to determine its relative dose inhalation hazard. Dose conversion factors were taken from EPA-520/1-88-020, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*. The following seven radionuclides were found to contribute approximately 99% of the inhalation dose: ^{90}Sr, ^{90}Y, ^{137}Cs, ^{239}Pu, ^{238}Pu, ^{241}Pu, and ^{241}Am. Two additional radionuclides, ^{237}Np and ^{244}Cm, were added based on process knowledge; and two additional radionuclides, ^{60}Co and ^{154}Eu, were added to account for external exposure considerations.

The in-tank concentrations of the 11 radionuclides are given in Table 3.4.1-4. These concentrations were developed by collecting and evaluating historical sample data and tank content estimates derived from flowsheet-based models and intertank transfer records. Data sources include the following:

- WHC-SD-WM-TI-543, *Radionuclide and Chemical Inventories for the Double-Shell Tanks*
- WHC-SD-WM-TI-565, *Radionuclide and Chemical Inventories for the Single-Shell Tanks*
- WHC-SD-WM-SARR-003, *High-Level Waste Tank Subcriticality Safety Assessment*
- WHC-SD-WM-TI-057, *TRAC: A Preliminary Estimation of the Waste Inventories in Hanford Tanks through 1980*
- WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*

- WHC-SD-WM-ER-350, *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 East Area*

- WHC-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area*

- WHC-SD-WM-ER-352, *Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area.*

From the above sources, a database containing more than 11,000 entries was developed. Using this data, scatter plots for each of the 11 radionuclides were generated for both solid and liquid SST, DST, and AWF tank samples. Subject matter experts familiar with the process history of the Hanford Site evaluated the plots and selected the highest value on the plot that (1) was technically possible and (2) did not conflict with known process parameters or contain an obvious error. The result is a composite inventory in which the concentration of each radionuclide is maximized. For example, the composite inventory for DST liquids represents a single tank containing the highest activity concentration for each radionuclide found in the sample data for all DST liquids. The scatter plots and the supporting data, procedures, and assumptions are documented in WHC-SD-WM-ER-400, *Tank Waste Source Term Inventory Validation.* A detailed discussion of the development of the radionuclide inventory is presented in WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations.*

3.4.1.1.2 Exposure Pathways. Two potential radiological exposure pathways (internal and external) are associated with releases of radioactive materials. The total effective dose equivalent calculated for an individual is equal to the sum of the dose contributions from these two exposure pathways.

Internal Exposure Pathway. Internal exposure pathways include inhalation and ingestion. The inhalation pathway is the major internal exposure pathway for TWRS facility accidents. Exposure by way of the inhalation pathway occurs (1) when an accident results in a release of airborne radioactive material that is transported downwind and inhaled by the maximum onsite and offsite individuals or (2) when radioactive materials that have been deposited on the ground become suspended and are subsequently inhaled. The resuspension dose is not included in the consequence calculations for the maximum onsite individual because it is conservatively assumed that 100% of the respirable material released remains airborne. The resuspension dose is included in the consequence calculations for the maximum offsite person as an inherent part of the ingestion dose calculations because deposition must be assumed in order to calculate an ingestion dose.

Exposure by means of the ingestion pathway occurs when radioactive material that has been deposited offsite is ingested by any of the following methods: eating crops on which radioactive materials have deposited; eating crops grown in, or animals raised on, contaminated soil; or drinking contaminated water. Depending on the type of tank waste involved, the dose contribution from the ingestion of contaminated food during a 24-h period can account for up to

20% of the total effective dose equivalent. Therefore, the dose contribution from the ingestion of contaminated foods for 24 h is included in offsite consequence calculations. The 24-h duration is based on the premise that the maximum offsite individual can be notified and appropriate corrective action can be taken within 24 h of the start of the accident (DOE/RL-94-02, *Hanford Emergency Response Plan*).

External Exposure Pathway. External exposure pathways include submersion, ground shine, and direct exposure from a concentrated radioactive source, such as a pool formed from a spill of liquid radioactive material.

Submersion refers to the external dose received by a person located in the plume of airborne radioactive material during plume passage. An analysis was performed to determine the dose resulting from submersion relative to inhalation (see WHC-SD-WM-CN-080, *Comparison of Radiological Dose Pathways for Tank Farm Accidents*). As shown in Table 3.4.1-5, the submersion dose is orders of magnitude less than the inhalation dose. Because the submersion dose contribution is minor, it is not included in consequence calculations.

Ground shine refers to the external dose received by a person standing on ground contaminated by radioactive materials deposited during plume passage. An analysis was performed to determine the dose resulting from ground shine relative to inhalation (WHC-SD-WM-CN-080). Assuming (1) that no deposition occurred before the plume reached the vicinity of the onsite receptor and (2) that maximum external exposure was received from the tank waste with the highest ^{137}Cs concentration (SST solids), the ratio of the ground shine dose to the inhalation dose was found to be 2.7×10^{-5}. Because the ground shine dose contribution is minor, it is not included in consequence calculations for the maximum onsite individual. The ground shine dose is included in the consequence calculations for the maximum offsite person as an inherent part of the ingestion dose calculations because deposition must be assumed in order to calculate an ingestion dose.

The dose contribution to the maximum onsite individual from the direct exposure pathway can be significant for accidents that result in surface pools of tank waste. For these surface pool accidents, the direct exposure to the maximum onsite individual is calculated and combined with the inhalation dose to obtain the total effective dose equivalent (see Sections 3.4.2.7 and 3.4.2.8).

3.4.1.1.3 Dose Calculation Methods. An overview of (1) the method used to calculate the inhalation dose to the maximum onsite individual and (2) the inhalation, ingestion, and resuspension doses to the maximum offsite individual are presented in Figure 3.4.1-1.

For accident analyses without controls, dose calculations for the maximum onsite individual assume that the individual remains at a distance of 100 m (328 ft) for the duration of plume passage up to a maximum of 12 h. The 12-h maximum duration is chosen because it is the normal work shift for TWRS operating personnel. Dose calculations for the maximum offsite individual assume that the individual remains at the worst-case distance for the duration of plume passage up to a maximum of 24 h. The 24-h maximum duration is judged to be an appropriate endpoint for consequence calculations based on the premise that the offsite individual can be

notified and appropriate corrective action taken within 24 h of the start of the accident. For accident analyses with controls, a different exposure duration may be used based on a demonstrated ability to detect the accident and protect the receptor.

The first step in calculating the dose is to derive the airborne source term (i.e., the amount of airborne radioactive material generated by the accident that is available for transport to the maximum onsite and offsite individuals). As presented in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, the airborne source term is typically estimated as is shown in Equation 3.4.1-1:

$$\text{Source term} = \text{MAR} \times \text{ARF (or ARR} \times \text{T)} \times \text{RF} \times \text{LPF} \qquad (3.4.1\text{-}1)$$

where:

MAR = material at risk
ARF = airborne release fraction
ARR = airborne release rate (for continuous releases)
T = time
RF = respirable fraction
LPF = leak path factor.

The MAR is the amount of material available to be acted on by accident-induced physical stresses such as temperature or pressure.

The airborne release fraction is the coefficient used to estimate the amount of material suspended in air as an aerosol and thus available for transport caused by the physical stresses of a specific accident. For mechanisms that continuously act to suspend material (e.g., a spray release), an airborne release rate is required to estimate the potential airborne release from postulated accident conditions.

The respirable fraction is the fraction of airborne particles that can be transported through air and inhaled into the pulmonary region of the human respiratory system, and includes particles having a 10-μm aerodynamic equivalent diameter or less (DOE-HDBK-3010-94). The aerodynamic equivalent diameter is the diameter of a sphere of unit density (1 g/cm^3) that exhibits the same terminal velocity as the particle in question.

The leak path factor is the fraction of the material in the aerosol transported through a confinement deposition or filtration mechanism. Leak path factors are developed as applicable based on (1) established relationships among the size of the particulate material, airborne transport mechanisms, and losses by deposition; or (2) specified filtration efficiencies (DOE-HDBK-3010-94).

Appropriately conservative values for MAR, airborne release fraction/airborne release rate, respirable fraction, and leak path factor are selected based on the best available information. In some cases, TWRS-specific data allows for selection of a relatively precise value. In the absence of TWRS-specific data, values must be selected from the available literature. In such

cases, potentially relevant reports are researched and values selected that closely match the subject accident scenario in terms of (1) design, (2) physical and chemical properties of the MAR, and (3) magnitude and type of energy released.

Given an airborne source term, the doses from the inhalation and ingestion pathways are calculated as is shown in Equations 3.4.1-2 and 3.4.1-3:

Inhalation:

$$D_{inh}(Sv) = Q(L) \times \frac{\chi}{Q'}\left(\frac{s}{m^3}\right) \times R\left(\frac{m^3}{s}\right) \times ULD_{inh}\left(\frac{Sv}{L}\right) \qquad (3.4.1\text{-}2)$$

Ingestion:

$$D_{ing}(Sv) = Q(L) \times \frac{\chi}{Q'}\left(\frac{s}{m^3}\right) \times ULD_{ing}\left(\frac{Sv\text{-}m^3}{L\text{-}s}\right) \qquad (3.4.1\text{-}3)$$

where:

D_{inh} = dose resulting from inhalation
D_{ing} = dose resulting from ingestion
Q = respirable source term
χ/Q' = atmospheric dispersion coefficient
R = breathing rate
ULD_{inh} = inhalation unit liter dose
ULD_{ing} = ingestion unit liter dose.

For the inhalation pathway, the dose calculated is the 50-yr committed effective dose equivalent. The committed effective dose equivalent is defined as the dose received by the individual during 50 yr following the uptake. For the maximum onsite individual, the committed effective dose equivalent must be combined with the deep dose from external exposure (if any) to yield the total effective dose equivalent. For the ingestion pathway, the dose calculated is the committed effective dose equivalent from ingestion plus the dose resulting from external exposure (e.g., ground shine). Combining the ingestion dose with the inhalation dose yields the total effective dose equivalent for the maximum offsite individual.

The atmospheric dispersion coefficient (χ/Q') represents the dilution of an airborne contaminant caused by atmospheric turbulence resulting from wind speed and atmospheric stability conditions. The χ/Q' values applicable to TWRS accident analyses have been calculated and are documented in WHC-SD-WM-SARR-016. The χ/Q' values applicable to ground-level releases are shown in Tables 3.4.1-6 and 3.4.1-7. The values shown are the 99.5% sector-dependent χ/Q's as defined by *Regulatory Guide 1.145*, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants" (NRC 1982). Tables 3.4.1-6 and 3.4.1-7 also present the maximum 50 percentile χ/Q' values. These values are provided to quantify the relative conservatism associated with use of bounding χ/Q' values.

The bounding integrated χ/Q' values shown in Table 3.4.1-6 are used for release durations up to 1 h. For release durations of between 1 and 2 h, the integrated χ/Q' with plume meander values is used. Plume meander accounts for enhanced horizontal spreading of the plume as it meanders over a large area during light wind and relatively stable atmospheric conditions. Plume meander corrections were made according to the empirical model given in Regulatory Guide 1.145. As recommended in Regulatory Guide 1.145, for release durations greater than 2 h, a logarithmic interpolation is made between the acute bounding χ/Q' with plume meander and the chronic annual average χ/Q' values (listed in Table 3.4.1-8).

Breathing rate values used to calculate the radiological consequences of accidents are taken from ICRP (1975), *Report of the Task Group on Reference Man*. For the maximum onsite individual, the light activity breathing rate is used (i.e., 3.3×10^{-4} m^3/s). For the maximum offsite individual, the 24-h average breathing rate is used (i.e., 2.7×10^{-4} m^3/s).

The inhalation ULDs and ingestion ULDs for six waste types are presented in Table 3.4.1-9. The inhalation ULD represents the dose associated with the hypothetical inhalation of 1 L (0.26 gal) of waste. The ingestion ULD represents the dose associated with the hypothetical ingestion of contaminated fruits and vegetables, inadvertent soil ingestion, ground shine, and the inhalation of resuspended material resulting from a 1-L (0.26-gal) release of waste. The ULDs were calculated by summing the dose contribution of each radionuclide present in the waste based on the composite radionuclide concentrations given in Table 3.4.1-4. The inhalation ULDs were calculated using the dose conversion factors in EPA-520/1-88-020. The ingestion ULDs were calculated using the GENII computer program (PNL-6584, *GENII - The Hanford Environmental Radiation Dosimetry Software System*). The ULDs are known to be conservative because (1) compared with isotope production data from reactor operations, individual isotope ULDs have a weighted average about 58 times the production-based values, (2) high points of sample distributions were selected versus the average values when defining individual radionuclide concentrations, and (3) statistical analysis has shown that the probability of finding a higher concentration for a radionuclide in the sample database is less than 4% with a 95% confidence. A detailed description of the derivation of ULDs is presented in WHC-SD-WM-SARR-037.

3.4.1.2 Toxicological Consequence Calculation Methodology.

3.4.1.2.1 Chemical Inventory.

Liquids and Solids. The chemical composition of tank wastes has been determined based on an evaluation of currently available data that characterizes the tank waste. Information sources are identical to those listed in Section 3.4.1.1.1. The term "analyte" is more appropriate than "chemical" when referring to sample data because laboratory analyses of waste samples are typically designed to detect elements and ions versus full-molecule compounds. Appendix I lists analytes and more than 150 associated compounds potentially present in tank waste. The listing is based on an expert review of the data sources. To assess the relative hazard posed by these compounds, a screening process was applied to identify those compounds that (1) can exist in an alkaline environment and (2) pose an acute exposure hazard as a toxic, corrosive, or irritant. Approximately 70 chemical compounds associated with 24 analytes were identified. If a

particular analyte occurred in several toxic compounds, limits for the analyte subsequently derived were based on the most restrictive compound. For example, calcium was identified as being present in three compounds: $CaCO_3$, $CaOH\text{-}SiO_2\text{-}H_2O$ gels, and $Ca(OH)_2$. The hydroxide was determined to pose the limiting inhalation hazard because of its corrosiveness. Therefore, all calcium is assumed to be present as $Ca(OH)_2$ even though some would be present as noncorrosive compounds.

Similar to the approach used for radionuclides, scatter plots for each of the 24 analytes were generated for both solid and liquid SST and DST samples, and the concentrations were reviewed by an expert panel to determine the maximum valid concentration. Composites were developed by taking the maximum valid concentration for all the analytes in all the tanks in that composite grouping. For example, the arsenic concentration used for SST liquids is the maximum valid arsenic concentration measured in all SST liquid samples. The composite concentrations for the 24 analytes of concern are presented in Table 3.4.1-10. The scatter plots, along with the supporting data, procedures, and assumptions are documented in WHC-SD-WM-ER-400. A detailed discussion of the development of the chemical inventory is presented in WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases.*

Tank Headspace Gases. Tank headspaces contain gases released from the waste and caused by continuing chemical reactions and vapor pressure changes. Experts conducting gas sampling concluded that Tank 241-C-103 contains the highest concentration of organic gases. Twelve gases are present in Tank 241-C-103 at sufficiently high concentrations to warrant further consideration on the basis of their relative toxicity.

Higher concentrations of ammonia and nitrous oxide have been detected in the headspaces of tanks other than Tank 241-C-103. Even larger concentrations of these gases exist in tank slurries, and a release to headspace, such as that which occurs during a GRE, can result in extremely high concentrations.

Worst-case and maximum steady-state headspace gas composite concentrations are presented in Table 3.4.1-11. The organic concentrations are identical for the two composites and are based on Tank 241-C-103 data. For the worst-case composite, the ammonia and nitrous oxide concentrations are based on Tank 241-SY-101 slurry release data as discussed in WHC-SD-WM-SARR-011. For the maximum steady-state composite, the ammonia and nitrous oxide concentrations were conservatively selected based on headspace sample data that indicates peak steady-state ammonia concentration of 2,000 ppmv and nitrous oxide concentration of 1,400 ppmv.

3.4.1.2.2 Exposure Pathways. The toxicological source terms resulting from TWRS accidents comprise liquid and solid particulates and gases. Evaluation of the effects of chemical exposure is based on the airborne pathway only because the toxicological risk guidelines are based on the chemical concentration at the location of the maximum onsite and offsite individuals. Inhalation of chemicals and exposure to the skin and eyes were considered in the development of the risk guidelines.

3.4.1.2.3 Exposure Calculation Methods. Figure 3.4.1-2 provides an overview of the method used to calculate toxicological consequences at the location of the maximum onsite and offsite individual. Toxicological consequence calculations are performed to determine the peak 15-min average concentration[1] for the maximum onsite and offsite individual over the duration of the release for all chemicals where the toxic effect is immediate (i.e., concentration-dependent). If it is known that the toxic effects of a chemical are not concentration-dependent and it is known that the effects depend on the total quantity of chemical taken up by the body (i.e., dose-dependent), then the peak 1-h concentration may be used. The calculated toxic chemical concentration is compared with *Emergency Response Planning Guidelines* (ERPGs) (AIHA 1988) or alternative equivalent guidelines (see Table 3.4.1-2). The ERPGs are based on exposures of up to 1 h and are the best existing values for evaluation of acute exposure to toxic chemicals.

The calculation method for chemical exposure is based on the use of ERPGs for risk evaluation. For comparison with the ERPG limits, the peak concentration must be calculated. Equations used to calculate peak concentrations of individual chemicals in WHC-SD-WM-SARR-011 are given in Appendix J. In calculating peak concentrations, a unit release of tank waste with chemical concentrations based on best available tank waste characterization data (Tables 3.4.1-10 and 3.4.1-11) was assumed. These peak concentrations were then used to calculate sum-of-fraction values.

When calculating peak concentration, a distinction must be made between continuous and instantaneous (or "puff") releases caused by differences in atmospheric dispersion modeling. A release is essentially instantaneous when its release duration is much less than the plume travel time to the maximum onsite and offsite receptors. Releases are modeled as a puff for the release durations in Table 3.4.1-12. For release durations greater than those shown in Table 3.4.1-12, the continuous release model is used. Puff release atmospheric dispersion coefficients are provided in Tables 3.4.1-6 and 3.4.1-7.

3.4.1.2.4 Comparison With Guidelines. In developing limits for releases of solids and liquids, chemicals were separated into the following health effect categories: particulates, corrosives and irritants, and toxic chemicals.

Particulates are compared with the risk guidelines using Equations J-5 and J-6 in Appendix J to calculate concentrations resulting from a 1-L/s (0.26-gal/s) continuous release or a 1-L (0.26-gal) puff release. The concentration is divided by the appropriate guideline as function of receptor location and accident frequency bin to determine a constant that is multiplied by the release rate to determine the acceptability of a given scenario.

[1]The accident duration is used for exposures of less than 15 min with a minimum of 1 min.

Limits for comparison of corrosives, irritants, and toxic chemicals with the risk guidelines were derived using the following steps:

1. For each composite (e.g., tank liquids or solids), the chemical concentration of each analyte at the locations of the offsite and onsite receptors were calculated using the equations provided in Appendix J for both a unit continuous release (1 L/s [0.26 gal/s]) and a unit puff release (1 L [0.26 gal]).

2. For each calculation, the resulting concentration of each analyte was divided by the appropriate risk guideline (i.e., ERPGs) for each of the accident frequency bins (10^{-2} to 10^{0}, 10^{-4} to 10^{-2}, and 10^{-6} to 10^{-4}/yr).

3. Quotients were summed for all analytes for each onsite and offsite receptor, frequency bin, composite, and release type. The sum can be shown as follows:

$$S = \sum_{i=1}^{n} \frac{C_i}{G_i} \qquad (3.4.1\text{-}4)$$

where:

S = sum-of-fractions
n = number of analytes
C_i = concentration
G_i = risk guideline.

This is referred to as the summing of fractions of health effects. The sum-of-fractions approach addresses situations in which mixtures of chemicals may include chemicals that have additive health effects. The sum-of-fractions approach has been used in other applications. Examples include EPA/600/8-87/045, *Guidelines for the Health Risk Assessments of Chemical Mixtures*, and ACGIH (1996), "Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)."

The limiting sum-of-fraction values for unit releases of SST and DST solids and liquids are presented in Table 3.4.1-13. The limiting value is the largest of those calculated for particulates, corrosives and irritants, and toxic chemicals.

In developing sum-of-fraction values for releases of gases, chemicals were separated into three health effect categories: central nervous system depressants, systemic poisons, and corrosives and irritants.

Limits for comparison with the risk guidelines were derived in the same manner as those for liquids and solids. The limiting sum-of-fraction values for unit gas releases are presented in Table 3.4.1-13. The limiting value is the largest of those calculated for central nervous system depressants, systemic poisons, and corrosives and irritants.

Comparison of toxicological consequences with the risk guidelines is made as follows:

1. Determine the accident frequency range of the accident.

2. Determine the type of material being released (i.e., SST solids or liquids).

3. Determine whether the release is continuous or instantaneous (i.e., puff).

4. Determine the release quantity or release rate (i.e., the airborne source term). This is performed in the same manner as for radioactive materials.

5. Multiply the release quantity or release rate determined in Step 4 by the appropriate unit release value from Table 3.4.1-13. Products less than or equal to one indicate that the risk guidelines have been met.

A more detailed discussion of the derivation of unit release sum-of-fraction values is presented in WHC-SD-WM-SARR-011, and detailed calculations are presented in Appendix E of WHC-SD-WM-SARR-011.

3.4.1.3 Basis for Estimating Accident Frequency. The original frequency category for the representative accident without controls is qualitatively estimated during the hazard evaluation. The accident frequency category without controls is reconfirmed based on review of the postulated accident scenario. The frequency of the accident scenario with selected controls is determined assuming that the safety SSCs perform their safety function and that the TSRs are followed. For preventive controls, the postulated accident may be prevented, or the frequency of the accident reduced, with the same consequences. For mitigative controls, the accident frequency remains unchanged, but the accident consequences are reduced. Estimated frequencies are the annual frequency of the representative accident at TWRS facilities (i.e., all tank farms).

The assumption that safety SSCs perform their safety function is reasonable because the reliability of SSCs was an important control decision criterion. Additionally, several controls are typically selected to reduce the risk of the postulated accident. The failure of SSCs and TSRs is addressed in beyond evaluation basis accidents (Section 3.4.3).

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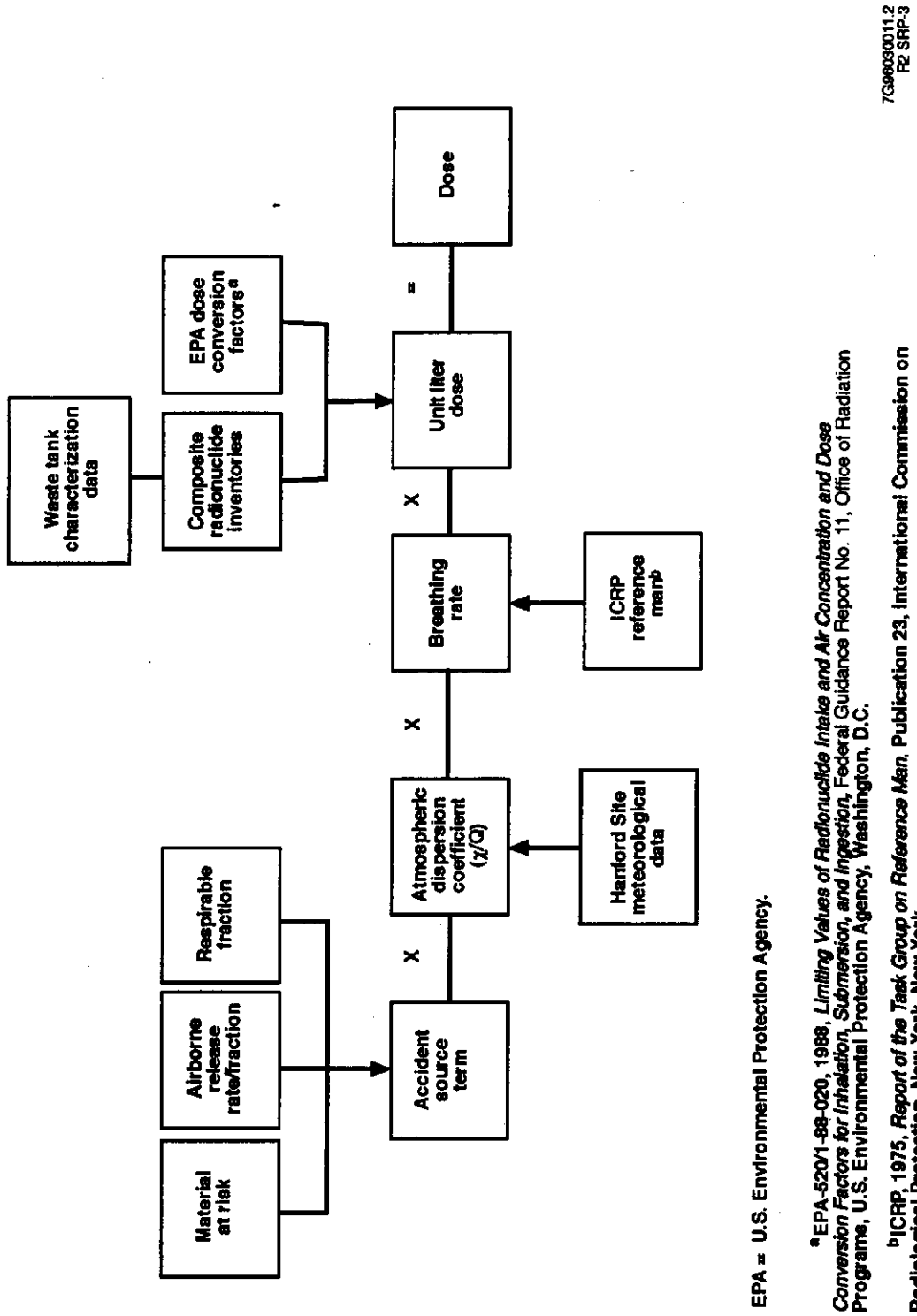
Figure 3.4.1-1. Radiological Consequence Methodology.



EPA = U.S. Environmental Protection Agency.

[a] EPA-520/1-88-020, 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C.

[b] ICRP, 1975, *Report of the Task Group on Reference Man*, Publication 23, International Commission on Radiological Protection, New York, New York.

Figure 3.4.1-2. Toxicological Consequence Methodology.

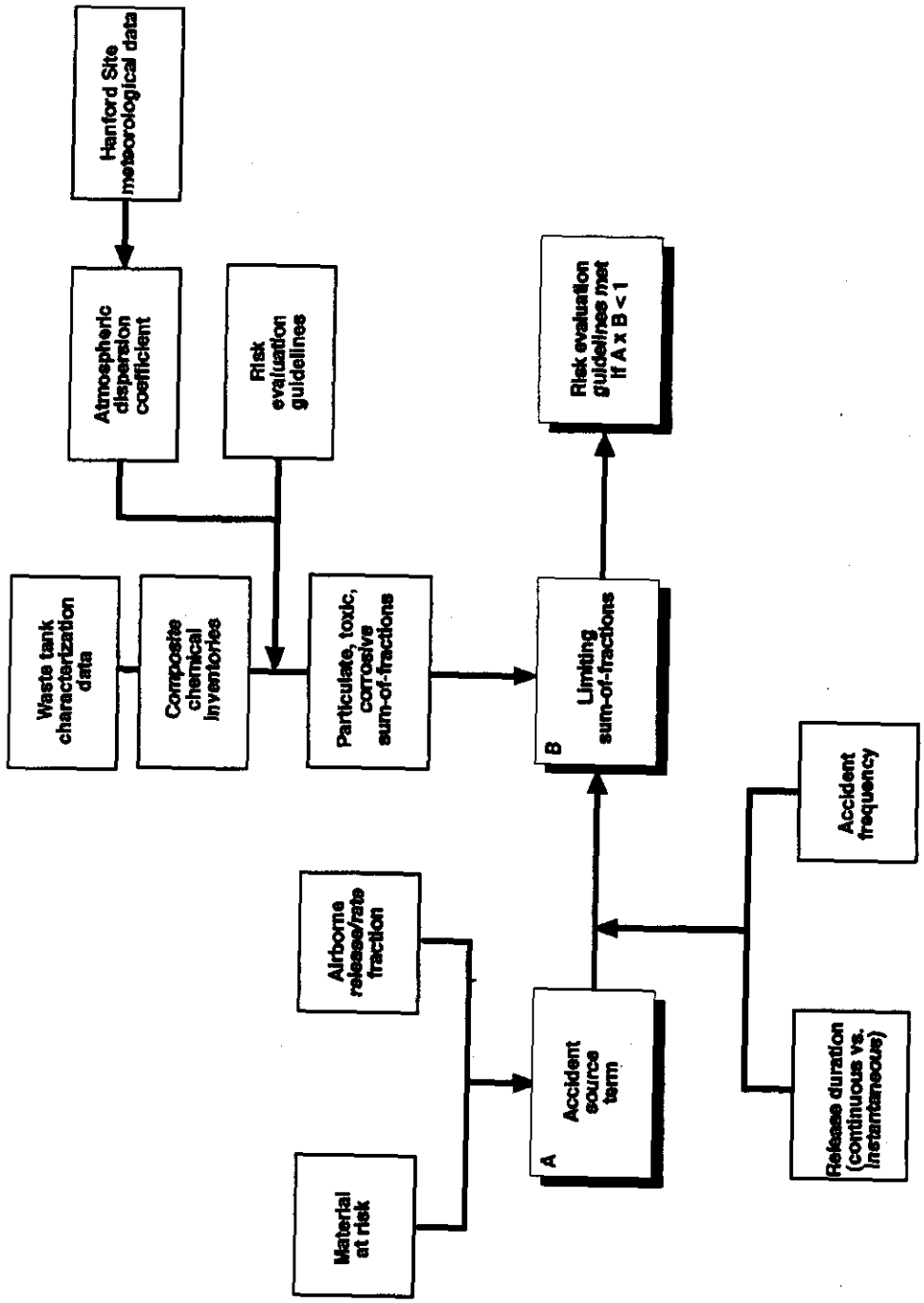


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Table 3.4.1-1. Radiological Risk Guidelines.

Frequency category	Frequency range (yr^{-1})	Effective dose equivalent Sv (rem)	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^{0}$	5.0 E-03 (5.0 E-01)	1.0 E-03 (1.0 E-01)
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	5.0 E-02 (5.0 E+00)	5.0 E-03 (5.0 E-01)
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	1.0 E-01 (1.0 E+01)	4.0 E-02 (4.0 E+00)

Source: Bacon, R. F., 1996, *Tank Waste Remediation System Accident Analysis Risk Evaluation Guidelines* (letter 9651709 to J. E. Kinzer, U.S. Department of Energy, Richland Operations Office, April 22), Westinghouse Hanford Company, Richland, Washington.

Table 3.4.1-2. Toxicological Risk Guidelines.

Frequency category	Frequency range (yr^{-1})	Primary concentration guidelines	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^{0}$	≤ERPG-1	≤PEL-TWA
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	≤ERPG-2	≤ERPG-1
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	≤ERPG-3	≤ERPG-2

Source: Bacon, R. F., 1996, *Tank Waste Remediation System Accident Analysis Risk Evaluation Guidelines* (letter 9651709 to J. E. Kinzer, U.S. Department of Energy, Richland Operations Office, April 22), Westinghouse Hanford Company, Richland, Washington.

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
TWA = time-weighted average.

Table 3.4.1-3. Site Boundary Distances for Tank Waste Remediation System Facilities.

Transport direction	Distance, m (ft)
S	15,360 (50,390)
SSW	15,640 (51,310)
SW	13,875 (45,520)
WSW	11,100 (36,420)
W	11,100 (36,420)
WNW	11,100 (36,420)
NW	11,440 (37,530)
NNW	8,690 (28,510)
N	8,760 (28,740)
NNE	10,610 (34,810)
NE	10,680 (35,040)
ENE	10,530 (34,550)
E	12,630 (41,440)
ESE	18,730 (61,450)
SE	22,440 (73,620)
SSE	19,960 (65,490)

Note: Site boundary distances are based on the minimum distance from the nearest tank farm (or associated waste transfer lines) to the Hanford Site boundary. The Site boundary used for calculations in this document is the near bank of the Columbia River to the north and the east.

Table 3.4.1-4. Derived In-Tank Concentrations of the 11 Radionuclides Chosen for Inclusion in Accident Analysis.

Isotope	Concentration (Bq/L)					
	SST liquids	SST solids	DST liquids	DST solids	AWF liquids	AWF solids
^{60}Co	9.53 E+06	4.2 E+08	6.97 E+06	1.5 E+07	7.71 E+05	4.9 E+08
^{90}Sr	1.05 E+10	1.6 E+12	4.59 E+09	5.2 E+10	5.60 E+09	2.9 E+12
^{90}Y	1.05 E+10	1.6 E+12	4.59 E+09	5.2 E+10	5.60 E+09	2.9 E+12
^{137}Cs	2.21 E+10	1.0 E+11	5.86 E+10	5.9 E+10	8.84 E+10	9.8 E+10
^{154}Eu	2.35 E+09	5.8 E+09	4.18 E+07	3.0 E+08	0.00*	1.1 E+10
^{237}Np	0.00*	3.0 E+07	2.3 E+05	8.1 E+05	9.20 E+04	9.9 E+08
^{238}Pu	9.21 E+04	1.9 E+08	1.78 E+06	7.2 E+07	2.75 E+03	6.7 E+07
^{239}Pu	3.62 E+07	4.4 E+08	7.65 E+06	1.6 E+09	1.20 E+06	4.4 E+08
^{241}Pu	2.57 E+08	3.2 E+09	1.84 E+07	3.8 E+09	3.39 E+05	1.7 E+09
^{241}Am	4.23 E+07	2.3 E+08	3.40 E+07	2.7 E+09	1.10 E+06	1.1 E+10
^{244}Cm	4.23 E+05	2.3 E+06	1.22 E+05	1.6 E+07	1.10 E+04	6.1 E+07

Source: WHC-SD-WM-SARR-037, 1996, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

*No valid sample result exists for these isotopes. Analysis indicates these isotopes, in the liquids, are negligible contributors to dose.

AWF = Aging Waste Facility.

DST = double-shell tank.

SST = single-shell tank.

Table 3.4.1-5. Comparison of Inhalation and Submersion Doses for the Maximum Onsite Receptor.

Tank waste type	Inhalation dose, Sv	Submersion dose, Sv
Single-shell tank solids	2.3 E+00	1.5 E-04
Single-shell tank liquids	1.2 E-01	2.9 E-05
Double-shell tank solids	5.9 E+00	6.5 E-05
Double-shell tank liquids	6.7 E-02	6.3 E-05
Aging waste facility tank solids	1.9 E+01	1.8 E-04
Aging waste facility tank liquids	1.5 E-02	9.4 E-05

Table 3.4.1-6. Centerline Atmospheric Dispersion Coefficients for 200 Area Tank Waste Remediation System Facilities Acute Release to 100 m (328 ft) Onsite Receptor Located in Worst Sector.

Meteorological condition	Integrated χ/Q' (s/m^3)	Integrated χ/Q' (s/m^3) with plume meander[a]	Maximum puff χ/Q ($1/m^3$)[b]
99.5 percentile (bounding) Sector and distance	3.41 E-02 E 100 m	1.13 E-02 ESE 100 m	9.85 E-03 E 100 m
50 percentile Sector and distance	5.33 E-03 N 100 m	2.27 E-03 N 100 m	9.48 E-04 E 100 m

[a]NRC, 1982, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Regulatory Guide 1.145, U.S. Nuclear Regulatory Commission, Washington, D.C., plume meander correction applied.

[b]Puff χ/Q' are used only in toxicological consequence calculations.

Table 3.4.1-7. Centerline Atmospheric Dispersion Coefficients for 200 Area Tank Waste Remediation System Facilities Acute Release to Site Boundary Receptor Located in Worst Sector.

Meteorological condition	Integrated χ/Q' (s/m^3)	Integrated χ/Q' (s/m^3) with plume meander*	Maximum puff χ/Q ($1/m^3$)
99.5 percentile (bounding) Sector and distance	2.83 E-05 N 8,760 m	2.12 E-05 N 8,760 m	1.14 E-07 NNW 8,690 m
50 percentile Sector and distance	4.43 E-06 N 8,760 m	3.79 E-06 N 8,760 m	1.02 E-08 N 8,760 m

*NRC, 1982, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Regulatory Guide 1.145, U.S. Nuclear Regulatory Commission, Washington, D.C., plume meander correction applied.

Table 3.4.1-8. Chronic Annual Average Atmospheric Dispersion Coefficients for 200 East and 200 West Area Tank Waste Remediation System Facilities.

Maximum individual	Integrated χ/Q' (s/m^3)
Onsite Sector and distance	4.03 E-04 ESE 100 m
Offsite Sector and distance	1.24 E-07 E 12,630 m

Note: The information in this table is from WHC-SD-WM-SARR-016, 1996, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Table 3.4.1-9. Unit Liter Doses for Tank Waste Composites.

Composite	Inhalation ULD (Sv/L)	Ingestion ULD* (Sv-m^3/s-L)
Single-shell tank liquids	1.1 E+04	0.052
Single-shell tank solids	2.2 E+05	4.1
Double-shell tank liquids	6.1 E+03	0.068
Double-shell tank solids	5.3 E+05	0.48
Aging waste facility tank liquids	1.4 E+03	0.092
Aging waste facility tank solids	1.7 E+06	8.1

*Includes 24-h ingestion of fruits and vegetables, ground shine, inadvertent soil ingestion, and inhalation of material resuspended from the ground.

ULD = unit liter doses.

Table 3.4.1-10. Composite Concentrations for the 24 Analytes at the Tank Waste Remediation System Tank Farms.

Analyte	Composite concentrations (g/L)			
	SST solids	SST liquids	DST solids	DST liquids
Ammonia (NH_3)	3.3 E-01	5.1 E-01	6.6 E+00	7.1 E+00
Antimony (Sb)	1.5 E+00	3.6 E-03	9.2 E-01	6.4 E-03
Arsenic (As)	1.2 E+00	3.0 E-03	5.7 E+00	1.1 E-02
Barium (Ba)	4.0 E+01	5.3 E-02	5.9 E+00	3.3 E-02
Beryllium (Be)	2.6 E-02	3.0 E-04	2.4 E-01	3.8 E-03
Cadmium (Cd)	1.7 E+00	5.0 E-02	2.6 E+01	7.0 E-02
Calcium (Ca)	5.1 E+01	1.1 E+00	2.6 E+01	1.3 E+00
Cerium (Ce)	9.0 E-01	1.8 E+00	2.6 E+00	5.8 E-02
Chromium (Cr^{+3})	6.9 E+01	[a]	1.5 E+02	[a]
Cobalt (Co)	5.4 E-01	1.3 E-03	4.4 E+00	8.8 E-03
Cyanide (CN)	8.2 E+00	5.3 E+00	4.7 E-01	9.1 E-02
Dysprosium (Dy)	[a]	[a]	[a]	[a]
Lanthanum (La)	5.0 E+01	1.9 E-01	3.0 E+01	1.0 E+00
Mercury (Hg)	5.4 E+01	3.1 E-01	1.2 E-01	2.4 E-04
Neodymium (Nd)	2.4 E-01	1.4 E-01	7.0 E+00	5.6 E-03
Oxalate (C_2O_4)	2.8 E+02	3.7 E+00	2.8 E+02	[a]
Selenium (Se)	3.5 E+00	8.2 E-02	1.9 E+00	2.8 E-01
Sodium hydroxide (NaOH)	2.1 E+02	2.1 E+02	2.3 E+02	2.1 E+02
Sodium (Na)[b]	4.8 E+02	2.1 E+02	3.5 E+02	2.1 E+02
Tellurium (Te)	2.0 E-01	[a]	9.3 E-01	2.7 E-03
Thallium (Tl)	1.2 E+00	3.2 E-03	1.5 E+01	3.7 E-02
Total organic carbon (TOC)-oxalate[b]	1.0 E+02	4.0 E+01	7.5 E+01	4.0 E+01
Uranium (U)	2.8 E+02	1.8 E+00	4.4 E+01	1.1 E+01
Vanadium (V)	3.3 E-02	4.1 E-03	1.2 E-01	2.1 E-03

Source: WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Note: The Aging Waste Facility tanks are grouped with the other double-shell tanks for toxicological analysis.

[a]The best available data indicates that there are no significant concentrations of this analyte in this composite.

[b]To avoid counting the same analyte twice, the oxalate concentration was subtracted from the total organic carbon concentration and NaOH was subtracted from the Na concentration.

DST = double-shell tank.

SST = single-shell tank.

Table 3.4.1-11. Worst-Case and Maximum Steady-State Headspace Gas Composite Concentrations.

Gas	Worst-case composite concentration[a]		Maximum steady-state concentration[b]	
	ppmv	mg/m^3[c]	ppmv	mg/m^3[c]
Acetonitrile	13	21.8	13	21.8
Ammonia	61,300	40,000	2,000	1,300
Benzene	0.4	1.3	0.4	1.3
1,3 Butadiene	0.1	0.19	0.1	0.19
Butanol	58	164	58	164
Dodecane	45	296	45	296
2-Hexanone	0.8	2.7	0.8	2.7
Methylene chloride	2	22	2	22
Nitrous oxide	67,000	110,000	1,400	2,340
Propanenitrile	5	11	5	11
Tributyl phosphate	1	12	1	12
Tridecane	50	390	50	390

[a]Based on worst-case composites including slurry gas released.
[b]Based on worst-case steady-state samples, does not include slurry gas releases.
[c]The conversion from ppmv to mg/m^3 assumes a temperature of 38 °C (100 °F) and a pressure of 740 torr (0.1 MPA).

Table 3.4.1-12. Release Durations for which the Maximum Puff χ/Q is Applied.

Release	Duration(s)
Onsite receptor, ground level release	3.5
Offsite receptor, ground level release	420

Note: The information in this table is from WHC-SD-WM-SARR-016, 1996, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Table 3.4.1-13. Sum-of-Fractions[a] of Risk Guidelines for a Unit Release of Chemicals and Gases. (2 sheets)

Tank waste type (units of sum-of-fractions follow tank waste type)	Maximum individual	Accident frequency, 1/yr		
		10^{-2} - 10^{0}	10^{-4} - 10^{-2}	10^{-6} - 10^{-4}
DST or SST Solid or Liquid Continuous Release				
Single-shell liquids (s/L)	Onsite	9.6 E+03	7.5 E+02	2.0 E+02
Single-shell liquids (s/L)	Offsite	8.0 E+00	8.0 E+00	6.2 E-01
Single-shell solids (s/L)	Onsite	4.0 E+04	2.1 E+04	1.0 E+03
Single-shell solids (s/L)	Offsite	9.4 E+01	3.3 E+01	1.7 E+01
Double-shell liquids (s/L)	Onsite	1.0 E+04	7.5 E+02	2.1 E+02
Double-shell liquids (s/L)	Offsite	8.4 E+00	8.4 E+00	6.2 E-01
Double-shell solids (s/L)	Onsite	1.8 E+04	3.3 E+03	6.3 E+02
Double-shell solids (s/L)	Offsite	1.9 E+02	1.5 E+01	2.8 E+00
DST or SST Liquid or Solid Puff Release				
Single-shell liquids (L^{-1})	Onsite	2.8 E+03	2.2 E+02	5.7 E+01
Single-shell liquids (L^{-1})	Offsite	3.2 E-02	3.2 E-02	2.5 E-03
Single-shell solids (L^{-1})	Onsite	1.2 E+04	6.0 E+03	2.9 E+02
Single-shell solids (L^{-1})	Offsite	3.8 E-01	1.3 E-01	6.9 E-02
Double-shell liquids (L^{-1})	Onsite	2.9 E+03	2.2 E+02	6.0 E+01
Double-shell liquids (L^{-1})	Offsite	3.4 E-02	3.4 E-02	2.5 E-03
Double-shell solids (L^{-1})	Onsite	5.2 E+03	9.7 E+02	1.8 E+02
Double-shell solids (L^{-1})	Offsite	7.7 E-01	5.9 E-02	1.1 E-02
Gas Release - Worst Case Composite				
Continuous (s/m^3)	Onsite	7.7 E+01	9.4 E+00	1.9 E+00
Continuous (s/m^3)	Offsite	6.6 E-02	6.6 E-02	8.1 E-03
Puff (m^{-3})	Onsite	2.3 E+01	2.8 E+00	5.8 E-01
Puff (m^{-3})	Offsite	2.7 E-04	2.7 E-04	3.2 E-05

Table 3.4.1-13. Sum-of-Fractions[a] of Risk Guidelines for a Unit Release of Chemicals and Gases. (2 sheets)

Tank waste type (units of sum-of-fractions follow tank waste type)	Maximum individual	Accident frequency, 1/yr		
		10^{-2} - 10^{0}	10^{-4} - 10^{-2}	10^{-6} - 10^{-4}
Gas Release - Maximum Sample Composite[b]				
Continuous (s/m^3)	Offsite	2.3 E-03	2.3 E-03	2.8 E-04
Continuous (s/m^3)	Onsite	2.6 E+00	3.3 E-01	7.1 E-02
Puff (m^{-3})	Onsite	7.9 E-01	9.9 E-02	2.1 E-02
Puff (m^{-3})	Offsite	9.3 E-06	9.2 E-06	1.1 E-06
50% NaOH Releases				
Continuous (s/L)	Onsite	1.3 E+04	1.0 E+03	2.6 E+02
Continuous (s/L)	Offsite	1.1 E+01	1.1 E+01	8.6 E-01
Puff (L^{-1})	Onsite	3.8 E+03	3.0 E+02	7.5 E+01
Puff (L^{-1})	Offsite	4.3 E-02	4.3 E-02	3.5 E-03
All-Liquids or All-Solids Continuous Release				
All liquids (s/L)	Onsite	1.0 E+04	7.5 E+02	2.1 E+02
All Liquids (s/L)	Offsite	8.4 E+00	8.4 E+00	6.2 E-01
All solids (s/L)	Onsite	5.1 E+04	2.3 E+04	1.2 E+03
All solids (s/L)	Offsite	2.5 E+02	4.2 E+01	1.9 E+01
All-Liquids or All-Solids Puff Release				
All liquids (L^{-1})	Onsite	2.9 E+03	2.2 E+02	6.0 E+01
All liquids (L^{-1})	Offsite	3.4 E-02	3.4 E-02	2.5 E-03
All solids (L^{-1})	Onsite	1.5 E+04	6.6 E+03	3.6 E+02
All solids (L^{-1})	Offsite	1.0 E+00	1.7 E-01	7.6 E-02

Notes:

(1) The Aging Waste Facility tanks are grouped with the other double-shell tanks for the toxicological analysis.

(2) Information in this table relative to WRSS is used in Addendum 1.

[a]The sum-of-fractions is multiplied by the release rate for continuous release and release amount for a puff releases. Release rates for continuous releases are in units of L/s for liquids and solids, and m^3/s for gases. Puff release quantities are in units of liters for solids and liquids and m^3 for gases.

[b]Note this data should be used only when the accident scenario does not involve a slurry gas release. Otherwise use the Gas Release - Worst Case Composite.

DST = double-shell tank.

SST = single-shell tank.

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3.4.2 Evaluation Basis Accidents

This section presents analyses of evaluation basis accidents identified in Section 3.3.2.3.1 with the potential for significant offsite consequences (i.e., S3). The evaluation basis accidents are analyzed to identify the necessary and sufficient set of Safety-Class and Safety-Significant SSCs and TSR controls to prevent their occurrence or mitigate their consequences. In contrast to evaluation basis accidents, design basis accidents are analyzed during the planning stages of new facilities. Design basis accident analysis allows the identification of the necessary and sufficient set of Safety-Class and Safety-Significant SSCs and TSR controls before the initial operation of the facility. Design basis accident analysis is not performed in this document. Section 3.3.2.4 presents analyses of evaluation basis accidents with the potential for significant onsite consequences.

The first step in the analytical process is to quantify the consequences and frequency of a postulated accident assuming the absence of existing preventive or mitigative features. As stated in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, assuming the absence of preventive or mitigative features "does not require denying the physical design of facility structures, systems, and components." Accordingly, credit is taken for certain design features, primarily those that are passive (e.g., in a waste transfer analysis, it is assumed that a waste transfer line exists).

It is important to understand that an "analysis without controls" is an evaluation of a hypothetical condition as opposed to an evaluation of the current operational configuration of a subject facility. The purpose of performing the analysis without controls is to establish a baseline risk (i.e., a consequence and frequency) that can be compared with the risk guidelines. This comparison puts the relative importance of the need for controls into perspective and defines the need for further analysis.

Consequences for analyses without controls are calculated by not taking credit for mitigative features (e.g., filtered ventilation pathways) during source term development. Frequencies are based on the absence of controls as opposed to the failure of controls at a defined rate and are therefore equal to the initiating event frequencies. Based on this approach, the frequency of accidents without controls typically falls in the anticipated category (i.e., $>10^{-2}$ to $\leq 10^{0}$/yr). This should not be misinterpreted as meaning the consequences of an accident without controls can actually occur at a TWRS facility at an anticipated frequency. As stated above, these are evaluations of hypothetical conditions performed to establish a baseline risk.

Once determined, the consequences and frequency of the accident without controls are compared with the risk guidelines. If the consequences are within both the onsite and offsite guidelines at the applicable frequency, no further quantitative analysis is performed for the purpose of defining controls. In such cases, existing controls are typically defined as providing Defense-in-Depth.

If the risk guidelines are exceeded, additional analysis is required to identify Safety-Class or Safety-Significant SSCs and TSR controls that bring the consequences and frequency within

the guidelines. In accordance with the requirements identified in Chapter 4.0, Safety-Class SSCs are required if the offsite radiological guidelines are exceeded. Safety-Significant SSCs are required if the offsite toxicological guidelines or onsite radiological or toxicological guidelines are exceeded.

Consistent with DOE-STD-3009-94, safety SSCs and TSR controls are selected using an iterative process in which credit for preferentially selected controls is incrementally taken, and the results are compared with the risk guidelines. The end result is an "analysis with controls." In these analyses, consequences and frequencies are determined assuming that the identified controls function as intended. If the controls are mitigative, the accident frequency remains unchanged relative to the analysis without controls but consequences are reduced. If the controls are preventive, the means by which the controls prevent the accident (or serve to reduce its frequency) are described but no consequences are calculated. Although these analyses make the assumption that the controls function as intended, it is recognized that each identified SSC and TSR control has an associated failure rate. The failure of controls, and the associated impact relative to the risk guidelines, are addressed in Section 3.4.3.

Controls were selected using the process and control decision criteria discussed in Section 3.3.1.5. When comparing the results of analyses without controls and with controls with the guidelines, consideration was given to (1) the margin by which the guidelines were met and (2) the reliability of the selected controls. In cases where the margin was small, the need for additional controls was evaluated. In these evaluations, consideration was given to the degree of conservatism in the consequence calculation. Controls known to be of low reliability were not selected. In cases where the degree of reliability was uncertain, the need for additional controls was evaluated.

In addition to the safety SSCs and TSR controls, one control is implicit to multiple accidents. This is a prohibition of transfers, exclusive of flushing, into SSTs. This is another key element of the transfer controls.

The following subsections summarize the findings of the evaluation basis accident analyses. Scenarios, source terms, consequence analyses, and comparisons with guidelines are presented for each evaluation basis accident both without and with controls. Selected safety SSCs, TSR controls, and Defense-in-Depth controls are identified and defined. Each scenario describes the accident progression that links initiating events with other contributing phenomena and, for the analyses with controls, selected preventive or mitigative controls. For operational accidents, the scenario frequencies were developed from TWRS operating history, applicable equipment failure rates, and human error probabilities. The frequencies were developed to a level of detail sufficient to place the event in a two-order magnitude bin as defined by the risk guidelines (e.g., 10^{-4} to 10^{-2}/yr).

Source terms and consequences of the postulated accidents were calculated using the methodologies described in Section 3.4.1. The calculations are deterministic in nature. Realistic, yet conservative, values were selected for each parameter used in the source term calculations. The ULDs, sums-of-fractions, and adverse meteorological conditions used in the consequence

calculations add additional conservatism. It is recognized that such a compounding of conservatisms results in consequence values that, when combined with the event frequency, can overstate the actual risk. This conservatism, however, is relied on to ensure that associated uncertainties are bounded. Within each section, sensitivity of key assumptions used in the consequence calculations is presented.

Reference

DOE-STD-3009-94, 1994, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

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3.4.2.1 Tank Failure Due to Excessive Loads. In this scenario, tank failure refers to loads or conditions that could result in (1) dome or roof collapse; (2) dome or roof settling (wall failure); or (3) dome, roof, wall, or bottom perforation. Structural failure can result in the release of radioactive waste to the environment through openings in the dome, the walls, or the bottom of a tank. These releases may also affect onsite and offsite individuals. This section summarizes the accident analysis of potential tank failures resulting from excessive loads at the TWRS DSTs (including AWF tanks, SSTs, DCRTs, catch tanks, 20-ft-dia SSTs, and MISFs). The following accident scenarios were identified in the hazard analysis as those that could lead to tank failure (Section 3.3):

- Excessive pressurization of tank dome and walls as the result of flammable gas explosion, organic fire, or exothermic reactions
- Seismic forces
- Load drop or structure toppling onto soil above the tank, onto a riser, or into a pump pit
- Excessive external uniform load (e.g., excess soil cover) or concentrated load (e.g., large vehicle on the tank) over the dome
- Aging of the tank structure as the result of thermal cycling, corrosion, and level cycling
- Excessive vacuum caused by (1) failures in the ventilation system with continued exhaust operation, (2) cool down after certain accidents (e.g., fire), or (3) cooling of the atmosphere or waste as the result of the addition of water
- Excessive internal forces resulting from waste storage (e.g., waste level, waste density, or waste temperature)-
- Water or waste addition to the annulus of a DST that results in uplift of the primary tank
- High concrete temperatures as a result of ventilation failure, heat load in excess of design conditions, or thermal characteristics that result in "hot spots"
- Accelerated wall or rebar corrosion or degradation as the result of corrosive chemicals added to the tank.

These accident scenarios are listed in order of severity. Severity was determined by using simple, conservative calculations as documented in WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks.*

The two worst-case scenarios, excessive pressurization and seismic forces, are addressed in other Section 3.4.2 subsections. The third-ranked and fourth-ranked accidents in potential severity, a load drop event and excessive uniform or concentrated loads, were considered in the detailed accident analysis.

The remaining six TWRS tank failure hazards are briefly summarized in the following paragraphs but were not considered in the detailed accident analysis because those hazards do not pose a threat of airborne release. The MISFs were not analyzed. Although no analysis was done because of the lack of structural information, controls were placed on these tanks partly based on the analysis of the other tanks and partly based on safety considerations. WHC-SD-TWR-RPT-002 and WHC-SD-WM-TI-775, *Structural Assessment of Accident Loads*, contain details of the structural analyses performed to determine the severity of these tank failure hazards. The following discussion is based on these two references and others, as noted:

- **Tank Structural Aging**—The effects of structural aging on the failure rates of DSTs, SSTs, DCRTs, catch tanks, and 20-ft-dia SSTs were evaluated. The effect on MISFs was not analyzed. Aging of the tank structure is a slow process of degradation that includes corrosion, thermal cycling, and stress cycling caused by waste level changes. Tank failures that are the result of structural aging do not result in releases from the tank domes because the aging processes have a much more pronounced effect on the walls of a tank than on the dome. In the worst-case DST or SST accident for this scenario, a tank could experience wall failure and subsequent dome movement, but the dome would remain intact (WHC-SD-WM-ER-414, *Hanford Waste Tank System Degradation Mechanisms Report*).

  Corrosion or degradation may result in local failures of DCRTs, catch tanks, or 20-ft-dia SSTs but will not cause collapse of the entire tank. Thermal cycling and thermal loading will not result in collapse of the steel DCRTs or catch tanks constructed in vaults. This statement is based on information contained in WHC-SD-WM-TI-775 that states that thermal cycling will have no effect on the steel tank because the waste temperatures are low. Even at 315 °C (600 °F) (the hottest Hanford waste), the yield strength is only decreased 26%, and the tanks of the DCRTs are not near the concrete except at the floor. If a DCRT, catch tank, or 20-ft-dia SST fails as the result of corrosion, the release will be to the soil column (direct-buried catch tanks) or to the concrete encasement structure (DCRTs, vault-contained catch tanks, and 20-ft-dia SSTs) but not to the atmosphere.

- **Excessive Vacuum**—The failure rates of DSTs, SSTs, DCRTs, catch tanks, and 20-ft-dia SSTs were evaluated assuming a vacuum loading of up to -55 kPa (-8 lb/in.^{2} gauge). The effect on MISFs was not analyzed. Excessive vacuum does not result in releases from the domes of DSTs or SSTs because the concrete tank walls and domes can withstand relative vacuums of up to -55 kPa (-8 lb/in.^{2}

gauge). This threshold bounds a vacuum from fire, ventilation system failure (i.e., exhaust fan with all flow paths blocked), and cooling of the dome space from water spray.

Calculations show that most of the DCRTs, catch tanks, and 20-ft-dia SSTs can withstand a -55 kPa (-8 lb/in.^{2} gauge) vacuum load. However, some of the DCRTs (244-BX, 244-TX, 244-U, and 244-S) and catch tanks (241-ER-311, 241- EW-151, 241-UX-302-A) would fail under the vacuum evaluated. The waste would remain in the failed DCRTs, and the waste from the failed vault-enclosed catch tanks would be contained in the vault structure. Airborne releases would be prevented because the vaults can withstand the resulting loads should the tanks fail. The direct-buried catch tanks that fail would be filled with soil from the 5.5-m (18-ft) cover.

- **Internal Loads**—Variations in internal loads (i.e., waste level, density) do not result in tank failure of DSTs, SSTs, DCRTs, catch tanks, or 20-ft-dia SSTs (WHC-SD-WM-DA-150, *Structural Sensitivity Evaluations Single Shell and Double Shell Waste Storage Tanks for the Accelerated Safety Analysis*). Therefore, no effects would be realized.

- **Water or Waste Addition to a DST Annulus**—DSTs were analyzed for effects of additional water or waste into the annulus. Uplift occurring from addition of water to a DST annulus will not result in dome collapse even if the annulus is full of liquid. If an 11.9-m- (39-ft-) tall annulus is full of waste with a density of 1.7 g/cm^3 (106 lb/ft^3), the worst-case force on the bottom of the tank is a little less than 202 kPa (30 lb/in.^{2}). DSTs can withstand up to 404 kPa (60 lb/in.^{2}) without failure.

- **High Concrete Temperatures**—Postulated failures of DSTs, SSTs, DCRTs, catch tanks, and 20-ft-dia SSTs were evaluated based on studies of Hanford Site high tank temperatures. The effect on MISFs was not analyzed. Heat transfer studies of the effects of loss of cooling show that wall temperatures next to waste with the greatest heat loads (e.g., Tank 241-A-106 in 1963) may have reached 243 °C to 284 °C (471 °F to 544 °F), but tank dome temperatures did not exceed 121 °C (250 °F) (RHO-SD-RE-TI-037, *Tank 241-A-106 Steady State Heat Transfer Analysis*; RHO-LD-171, *Heat Transfer Analysis for In-Situ Disposal of Nuclear Wastes in Single- and Double-Shell Underground Storage Tanks*). BNL-52384, *Thermal Degradation of Concrete in the Temperature Range from Ambient to 315 °C (600 °F)* shows that under such temperature conditions DST and SST walls may lose strength, but the structural properties of the dome are unchanged. WHC-SD-WM-SARR-010, *Heat Removal Characteristics of Waste Storage Tanks*, shows that ventilation outages of at least three years in duration are required before tank walls lose strength. Even if the tank walls were to slump the dome would remain intact, because the very hot portion of the liner is the

bottom of the wall or floor. The top of the wall and dome are cooler. Any failure would be a tear in the wall that would result in a release to the soil, but the dome would remain intact.

Effects of high temperature waste to DCRTs, catch tanks, and 20-ft-dia SSTs are assessed in WHC-SD-WM-TI-775. The DCRTs can withstand the effects of high temperature without failure; the vault-contained catch tanks and 20-ft-dia SSTs will be affected but will not collapse; and the direct-buried catch tanks will fail but with no release to the atmosphere.

- **Accelerated Wall Corrosion and Degradation**—The presence of improper chemicals in tank waste could result in accelerated tank corrosion or degradation. Effects of the presence of such chemicals are addressed in the "Tank Structural Aging" segment of this scenario.

The specific load drop and excessive load accidents found to pose a threat of airborne releases are as follows:

- Load drops onto SSTs, DSTs, DCRTs, and 20-ft-dia SSTs

- Excess uniform loads or concentrated loads on SSTs, DSTs, 20-ft-dia SSTs, and concentrated loads on DCRTs.

Airborne release scenarios were selected for DSTs, SSTs, DCRTs, catch tanks, and 20-ft-dia SSTs as follows.

- **Load Drop**—WHC-SD-TWR-RPT-002 states that an impact energy of 2.7×10^5 J (2×10^5 ft-lb) is a conservative minimum value for DST and SST dome failure. This value was based on LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington,* assuming the mixer pump weighed 9,100 kg (20,000 lb). WHC-SD-WM-TI-782, *Load Drop Evaluation*, refines the LA-UR-92-3196 calculations and shows that the Tank 241-101-SY mixer pump must be dropped 7.6 m (25 ft) to fully penetrate the pump pit floor and dome concrete. (No credit is taken for the steel liners in DST domes.) The mixer pump drop analysis is based on a weight of 11,400 kg (25,000 lb), and the area of impact is based on a 17-cm (6.8-in.) dia. The impact energy for this situation is 6.8×10^5 J (5×10^5 ft-lb). This is the value that will be used in the accident analyses because it is a more accurate value. Large loads are typically lifted the minimum height needed to clear obstacles.

  The direct-buried catch tanks are greater than 5 m (16 ft) belowgrade and would therefore be undamaged by a load drop. The pit cover blocks over the catch tanks

could easily fail as a result of a load drop, but the dropped load or cover block would not reach the waste because the pit floor is separated from the catch tank by about 3 m (10 ft) of soil.

DCRT, catch tank, and 20-ft-SST vault cover blocks would also easily fail as a result of a load drop. With these tanks, the load or the cover block could reach the waste if a drop is energetic enough to fail the cover blocks over the tank vault or over the tank.

- **Concentrated and Uniform Load**—WHC-SD-TWR-RPT-002 shows that DST and SST dome failure would occur only if a concentrated load exceeded 2.7×10^5 kg to 5.4×10^5 kg (300 to 600 tons) or if the uniform load exceeded that equal to a total of 8.2 m (27 ft) of soil above the tank apex. At present, the largest concentrated DST or SST load weighs less than 2.3×10^5 kg (250 tons) (i.e., the crane used to lower the mixer pump into Tank 241-101-SY). The largest uniform load to date is equivalent to about 3.05 m (10 ft) of soil above an SST apex.

  Snow loads and snow-plus-ash loads are insignificant (73-98 kg/m^2 [15-20 lb/ft^2]). A 5-cm (2-in.) rainfall would add 49 kg/m^2 (10 lb/ft^2) if the water all pooled on the surface. A failure that results in a 378-m^3 (100,000-gal) water spill (the capacity of the voids in the soil assuming a 30% void fraction) that remains directly over the tank would create a 930-kg/m^2 (190-lb/ft^2) load. The water spill load is insignificant compared with the existing soil loads.

  Four catch tanks (241-TX-302C, 241-UX-302A, 241-ER-311, 241-A-302A) have stresses that exceed code allowables (WHC-SD-WM-TI-775). These excessive loads are the result of soil pressure from the present soil overburden. The tanks have not failed; however, if the catch tanks should fail there would be no airborne releases because the tanks are covered by 5.5 m (18 ft) of soil.

  The top of the DCRT structure is at or slightly abovegrade; therefore, the only uniform loads are snow and ashfall. The vault cover blocks can withstand at least 2,000 kg/m^2 (400 lb/ft^2) (WHC-SD-WM-TI-775). Because the DCRT design basis snow or ash fall loads are much less than 2,000 kg/m^2 (400 lb/ft^2), the cover blocks can handle the snow or ashfall loads. The WHC-SD-WM-TI-775 analysis also shows that the cover blocks can withstand a load of at least 14,000 kg (31,000 lb or 15.5 tons) before failure occurs.

  The 20-ft-dia SSTs have cover blocks over the riser at grade. These tanks can withstand 1.49×10^5 kg (163.5 tons) or 4,900 kg/m^2 (1,000 lb/ft^2) loads without dome failure (WHC-SD-WM-TI-775).

No credible scenario that would result in dome collapse resulting from excessive uniform load was identified. Dome failure for DSTs and SSTs occurs only if the uniform load exceeds the

equivalent of 8.2 m (27 ft) of soil above the apex. At present, the largest uniform load is approximately 3.05 m (10 ft) of soil. Dome collapse from excessive uniform load was therefore judged to be "beyond extremely unlikely."

Dome failure resulting from a concentrated load is also judged to be "beyond extremely unlikely." The largest available concentrated load is the crane used to lower the mixer pump into Tank 241-SY-101. The crane weighs less than 2.3×10^5 kg (250 tons). The failure load is 2.7×10^5 to 5.4×10^5 kg (300 to 600 tons) for SSTs and 3.6×10^5 to 7.3×10^5 kg (400 to 800 tons) for DSTs. Had the crane been inadvertently moved over the dome, the dome still would not have failed.

Tank failure resulting from a load drop event is the only identified event found to be credible. A load drop scenario bounds accidents involving excessive vacuum, aging and corrosion, internal loads, waste or waste addition, high waste temperature, high concrete temperature, and accelerated wall corrosion and degradation. Calculations show that tank failures resulting from the latter causes would not include dome failures and would not result in airborne release. Load drops, however, can cause an opening in the dome that would allow for an airborne release.

The largest load drop consequence would occur as a result of a drop onto dry salt cake (see Section 3.4.2.1.3) in a DST or SST. The DCRTs contain liquid or sludges that would minimize the airborne release, and the 20-ft-dia SSTs that contain dry salt cake have a waste level closer to grade, reducing the release impact energy. Therefore, the tank failure resulting from excessive loads scenario summarized in the following subsections assumes a load drop.

3.4.2.1.1 Scenario Development. Load drops will cause localized structural damage to a riser pit floor and the tank dome if drop heights are great enough and if the items dropped have sufficient rigidity. The failure mode for drops from up to 6.1 m (20 ft) is the result of excess local shear stresses in the dome itself. A load drop event can occur as a result of the following:

- Drop of the load as the result of crane cable failure, brake failure, or operator error
- Drop of the crane boom (with or without the load) as the result of boom failure or boom cable failure.

The load can drop onto the soil cover over a tank, onto the pits over a tank (primarily onto the pump pit), or onto a riser. The worst-case scenario is a load drop into a pump pit because the pit is the weakest structural point of all the possible drop locations that could result in the load reaching the tank waste.

For this scenario it is assumed that a 9,100-kg (20,000-lb) mixer pump (weight of the lifting hardware not included) is dropped into a DST pump pit. Although some cover blocks are heavier than mixer pumps, the impact area means that the cover block drop height necessary to damage the dome is at least 10 times greater than the drop height of a mixer pump (WHC-SD-WM-TI-775). A cover block impact area is 0.13 m^2 (200 $in.^2$), and a mixer pump

impact area is 0.023 m^2 (36 $in.^2$). A mixer pump drop is considered to be the worst-case scenario because of the orientation of the equipment during a lift; the pump is lifted so that the axis is vertical. A cover block is lifted flat and it would have to impact exactly on its corner for the impact energy to be greater than that of a pump. The TSR controls discussed in Section 3.4.2.1.5 limit the lift height of all equipment.

Accident Scenario Without Controls. For the credible load drop scenario without controls that follows, a 9,100 kg (20,000 lb) mixer pump (LA-UR-92-3196) is assumed to be scheduled for insertion. The pump is attached to the crane, righted, and lifted. An operator error (or possible equipment failure) is postulated, and the lift results in the pump being lifted high over the tank. When the pump is over the pump pit (1) the sling breaks, (2) the pump is lifted even higher and the hook becomes dislodged when the pump hits the boom, or (3) some other failure occurs that results in a pump drop. The pump is assumed to drop 25 m (82 ft) to the waste (20 m [66 ft] in the pump pit). This drop height, coupled with the pump weight, results in an impact energy of 1.8×10^6 J (1.3×10^6 ft-lb) to the pump pit floor. The impact energy on the pump pit floor and dome exceeds the 6.8×10^5 J (5.0×10^5 ft-lb) dome capacity (WHC-SD-WM-TI-782).

The maximum drop height of 25 m (82 ft) is determined by assuming that the crane is positioned 27.4 m (90 ft) from the center of the tank or 16 m (52.5 ft) from the edge of the tank. The boom length for the crane is assumed to be 42.7 m (140 ft), making the boom 32.6 m (107 ft) abovegrade. The pump itself is 17.1 m (56 ft) long, placing the bottom of the pump 15.5 m (51 ft) abovegrade. The distance from grade to dome ranges from 2.1 to 3.0 m (7 to 10 ft), so an average distance of 2.5 m (8.2 ft) is chosen. The distance from the dome to the waste ranges from 4.1 to 9.2 m (15 to 30 ft), so an average distance of 7 m (23 ft) is chosen. A drop from 15.5 m (51 ft) abovegrade equates to a drop of 25 m (82 ft) onto the waste.

Accident Frequency Without Controls. The postulated load drop accident without controls arises as a result of a number of failures. Table 3.4.2.1-1 presents historical data compiled from Occupational Safety and Health Administration, U.S. Navy, and commercial reactor records presented in NUREG-0612, *Control of Heavy Loads at Nuclear Power Plants*, that can be used to show the causes of load drops. In all three sets of data presented in NUREG-0612, operator error predominates.

Another cause for the Hanford Site accident scenario identified in the hazards analysis is load drop resulting from high winds or dust devils. These possible scenarios are addressed in Section 3.4.2.12.1.

Crane operators perform activities in accordance with DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*. The accident frequency is based on the use of DOE/RL-92-36. This assumption is made because a manual of this type is used in all industries, at all times, and for all kinds of lifts. To assume absolutely no controls would be too conservative. Lifts are considered critical if the load (1) requires exceptional care because of size or weight of the lifted load, or (2) could result in serious economic or programmatic consequences, or (3) could cause a significant release if the load were dropped. Hanford Site critical lift procedures require

designated check and hold points, preplanning of the rigging and load path, verification of the equipment capacity with regard to the load being lifted, and signoffs that verify inspections are current.

U.S. Navy and commercial reactor lifts include similar provisions for critical lifts; because there is no Hanford-specific failure rate data, U.S. Navy data documented in NUREG-0612 has been used to determine frequency for this analysis. Based on the NUREG-0612 U.S. Navy experience, the frequency of a load drop ranges from 2.5×10^{-5} to 3×10^{-4} per lift. The NUREG-0612 U.S. Navy data covers between 250,000 to 1,500,000 lifts per year. Those lifts range from large shipyard cranes to hoists to chain falls. The range in load-drop frequency is based on uncertainties in the data, not on whether a lift is a critical lift.

Inserting a large pump into a DST requires five or six lifts (i.e., two to remove the cover blocks, one to remove the old pump, one to insert the new pump, two to replace the cover blocks). Typically only one installation of a large load is performed per Hanford Site tank per year. Because only pump drops can fail the dome, the "per tank" frequency for a load drop during installation of a large load is 5×10^{-5} to 6×10^{-4}/yr; twice the individual large-load drop value. It is assumed that only one mixer pump is inserted on the Hanford Site per year; therefore, the "per tank" frequency equals the "per year" frequency.

Drop of a large critical load is still considered "unlikely" as (1) individuals will naturally take more care with these large loads, and (2) because use of the high-end frequency of the NUREG-0612 U.S. Navy data (6×10^{-4}/yr) also shows the event to be "unlikely."

Accident Scenario With Controls. There is no load drop with controls scenario because with controls a load drop would be prevented. The postulated TWRS load drop accident with controls were prevented because (1) DOE/RL-92-36 is used to determine general lifting prerequisites and requirements and (2) controls are placed on lifting heights.

Accident Frequency With Controls. The frequency of a load drop for a sequence of operations is not much different than the 5×10^{-5} to 6×10^{-4}/yr frequency for the load drop accident scenario without controls because it was assumed that a manual such as DOE/RL-92-36 is necessary and is followed. Even if a large load were dropped, it will not penetrate the dome unless it were dropped more than 7.6 m (25 ft) (WHC-SD-WM-TI-782). Therefore, the addition of a TSR control on load height is necessary as well. The combination of these two controls prevents the accident.

3.4.2.1.2 Source Term Analysis. This section provides quantification of the material released should a load drop occur. The quantity of postulated material releases for scenarios with controls and without controls are shown. Details are in WHC-SD-WM-CN-051, *The Effects of Load Drop, Uniform Load, and Concentrated Loads on Waste Tanks*.

Source Term Without Controls. WHC-SD-TWR-RPT-002 states that the concrete would be spalled out to 3.05 m (10 ft) in diameter. The punched out area is assumed to be 0.6 m (2 ft) in diameter based on pump dimensions and a conservative estimate of the additional area

punched out (i.e., the punched area is larger than the impact area). The volume punched out with the mixer pump and the volume spalled falls to the waste surface and strikes the waste as a single unit. Fines of particulates or small droplets are created by the impact, some of which are transported out of the tank by airflow from the volume change, air turbulence, and wind blowing over the opening.

A drop to dry salt cake is considered as the bounding case because there is floating salt cake up to 1.2 m (4 ft) thick in a number of DSTs. A load drop impact onto dry salt cake results in the largest releases per DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, and Owczarski and Mishima (1996), *Airborne Release/Respirable Fractions for Dome Collapse in HLW Tanks*.

DOE-HDBK-3010-94 presents the respirable fraction for conditions under which a brittle material is crushed as the result of an impact. The respirable fraction is based on experiments in which small samples of glass, ceramics, and concrete were crushed by an impact hammer and measured with particle size counters. The respirable fraction is determined to be:

$$RF = 2.0 \times 10^{-4}(E/V)$$

where: RF = respirable fraction
E = impact energy, J
V = volume affected, cm^3.

Other experiments described in WHC-SD-WM-CN-051, show that the respirable fraction, as a function of energy, is two to three times greater than that given in DOE-HDBK-3010-94. However, that data is based on small, hard, and brittle specimens supported on a steel plate and fractured by impact of a steel hammer. In the waste tank, the support plate is many meters from the impact, and the waste is not hard and brittle throughout. Even tanks containing "dry" salt cake contain moist, flexible waste near the bottom of the tank (i.e., less moist and less flexible waste near the surface and dry and hard waste at the top). Because of the moisture distribution in the waste and the anticipated energy dissipation characteristics, the value in DOE-HDBK-3010-94 is appropriate for use in tanks containing dry salt cake.

The affected volume assumed in the equation is the area impacted times the depth in which the impact energy is absorbed. The dry salt cake depth has been determined using studies of earth penetration by projectiles. Young (1969) considers blunt-ended projectiles falling from a variety of heights onto soils. The depth was calculated assuming a free-fall velocity of a drop of 25 m (82 ft). No credit was taken for the reduction in velocity that results from breach of the pump pit floor and dome. The energy loss is 30% because a 7.6 m (25 ft) drop will not fail the dome.

Table 3.4.2.1-2 presents the range of values for the penetrability of soil; the greater the value, the greater the depth penetrated. The depth penetrated times the area of impact equals the volume from which the respirable quantity was derived. From Table 3.4.2.1-2, the penetrability value of 10 is judged to represent balance between a conservatively large penetration depth

without representing an overly conservative respirable quantity. The depth of waste affected is based on a damage diameter of 0.6 m (2 ft) (WHC-SD-TWR-RPT-002), making the area of damage 0.3 m^2 (3.1 ft^2). If the large diameter portion of the pump impacts the pit floor, the damaged area could be larger. However, to maximize consequences, the waste surface was assumed quite hard; therefore, the mixer pump will not penetrate to the point that the large diameter portion impacts the pit floor and the damaged area is as stated. The weight of the material impacting the waste is assumed to be a 0.76-m- (2.5-ft-) high piece of dome measuring 0.3 m^2 (3.1 ft^2) that is impacted by a 9,100-kg (20,000-lb) pump. The penetration depth was found to be 0.8 m (2.6 ft).

Spalling was assumed to cause the release of a small amount of waste to the respirable quantity. The spalled pieces were assumed to be about 3 cm (1.2 in.) (the distance from the surface to the first row of rebar) x 0.09 m^2 (1 ft^2) and to weigh 6.4 kg (14 lb). The velocity of a falling fragment at impact, based on a drop height of 7 m (23 ft), was assumed to be 12 m/s (39 ft/s). The dome velocity at the time of spalling is unknown. This velocity, if known, would be added to the velocity due to falling from a height of 7 m (23 ft) and would result in a larger release. The release caused by spalling is so low, however, that neglect of the dome velocity has little effect. The total amount of respirable waste resulting from pump impact (0.5 L) and the quantity resulting from spalled material (0.01 L) was calculated to be 0.51 L.

The fraction of the respirable particles removed from the surface was determined by assuming that waste is compressed by the impact and rebounds when the pump rebounds. If the pump does not rebound, the respirable material will be covered by the pump and not suspended. Air is also assumed to flow out from under the rebounded concrete and pump. The compression, rebound, and airflow results in some of the newly made respirable material being removed from the surface. From DOE-HDBK-3010-94, the fraction made airborne from rapidly depressurizing powders ranged from 0.05 to 0.1.

Another potential mechanism for removal from the surface is to assume that compression followed by rebound results in accelerated air flow along the surface between the debris and the waste before the pump comes to rest on top of the waste and debris. That is, the pump impacts the waste and creates respirable particles, the pump rebounds off the waste, and air rushes in and suspends some of the newly created particulate. The pump falls again onto the waste and comes to rest. The process of falling the second time creates additional airflow from under the pump. Owczarski and Mishima (1996) provide an airborne release fraction (ARF) of 5×10^{-3} for the suspension of powders resulting from accelerated flow parallel to the surface from an explosion. Owczarski and Mishima (1996) also provide a fracture release of 0.1 for the suspension of powder resulting from a deflagration above the powder. Use of these models suggests that it is reasonable to assume that the fracture release of the respirable particles suspended during the rebound is 0.1.

Suspended particles will likely be removed from the air after the debris settles following the rebound. For conservatism, it will be assumed that all suspended material is transported out from under the debris into the dome space. That is, there is no removal of material under the falling, rebounded debris. The suspended material is transported into the dome headspace.

The material is being transported horizontally around the edges of the debris and vertically through the space between adjacent pieces of the debris resulting from circulation caused by the air moving in under the rebounded pump and moving out when the pump settles. This circulation will spread the lifted material throughout the dome headspace. An initial concentration gradient with the high concentration will be directly above and to the side of the debris and the concentration at the walls will be at nearly zero. In time, the concentration will become more uniform.

The release of the suspended material out of the tank will take place by means of an initial puff release. The puff release comes about as a result of the sudden volume change from material entering the tank. The volume of the debris is 0.7 m^3 (25.9 ft^3) and is made up of the volume that the pump and concrete occupies. The pump volume is 0.5 m^3 (18.1 ft^3) based on an average, diameter of 0.3 m (1 ft), and a length of 7 m (23 ft). The pump diameter is an average taking into account the nozzles and instrument piping. The volume of the concrete is 0.2 m^3 (7.8 ft^3), assuming that the concrete is 0.8 m (2.6 ft) thick and has an area of 0.3 m^2 (3.2 ft^2). The volume is presented to one significant figure. It is assumed that the release is so rapid that none of the suspended material goes out the vent system.

Assume that the suspended material is initially contained in a volume inscribed by a cylinder two times the diameter of the opening in the dome and as tall as the dome; or a 1.2-m- (4-ft-) dia and 7-m- (23-ft-) tall cylinder. The volume of this cylinder is 8.2 m^3 (289 ft^3). The volume of the debris is 0.7 m^3 (25 ft^3). The puff release is conservatively based on the volume change as a result of 0.7 m^3 (25 ft^3) of debris entering a volume of 8.2 m^3 (289 ft^3). The fraction of material in the puff release is 0.7/8.2 (25/289) or 0.09. This value appears to be quite large given the small opening in the dome. The value is left conservatively large to account for uncertainties and to account for additional longer-term releases resulting from air flow over the tank that would draw the material out after the puff release has ended. The total respirable quantity transported to the atmosphere is 0.005 L.

Source Term With Controls. Because the accident would be prevented with controls in place, there is no source term with controls. See Section 3.4.3 for an assessment of the residual risk associated with the potential failure of controls.

3.4.2.1.3 Consequence Analysis.

Consequences Without Controls. The consequences of the load drop scenario presented in Table 3.4.2.1-3 were calculated in accordance with the methodology presented in Section 3.4.1 and assuming an impact onto dry salt cake in a DST (WHC-SD-WM-CN-051). The radiological consequences are based on the ULD for DST solids because this dose is bounding for waste that can be impacted. The toxicological consequences were calculated using the sum-of-fractions technique for an "unlikely" event and a puff release.

Consequences With Controls. Because the accident would be prevented with controls in place, there are no consequences with controls.

3.4.2.1.4 Comparison with Guidelines. The onsite radiological consequence of the load drop accident scenario without controls, 3.0×10^{-2} Sv (3 rem), is below the onsite evaluation guidelines of 5.0×10^{-2} Sv (5 rem) for an "unlikely" event (Table 3.4.2.1-3). At 3.0×10^{-5} Sv (3.0×10^{-3} rem), the offsite guidelines of 5.0×10^{-3} Sv (5.0×10^{-1} rem) are easily met. The onsite toxicological consequences (i.e., sum-of-fractions value) without controls are 5, which exceeds the onsite guideline of 1. The offsite toxicological consequence, 3.0×10^{-4}, meets the offsite toxicological guideline of 1. The event with controls is prevented, and therefore, no consequences are calculated.

3.4.2.1.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirements Controls. Safety SSCs and TSR controls defined as a result of the load drop accident analysis are presented below. Information is also provided regarding safety SSCs and TSR controls for uniform and concentrated load scenarios.

Safety Structures, Systems, and Components. The consequences of a load drop scenario without controls are below the onsite and offsite risk guidelines. Therefore, no Safety-Class or Safety-Significant equipment is required. However, the waste tanks are designated as Safety-Significant to ensure that the tanks can withstand the loads allowed by the TSR controls (Table 3.4.2.1-4). This Safety-Significant SSC also protects against tank failure due to vacuum or degradation. Per agreement with DOE-ORP, this Safety-Significant designation is not effective until March 30, 2000.

Technical Safety Requirements Controls. The TSR controls for uniform and concentrated load scenarios are summarized in Table 3.4.2.1-5. The TSR control chosen for the load drop event for DSTs is an Administrative Control that states the height a load is raised shall not exceed the critical height of 6.1 m (20 ft) above the soil at grade or the floor of the pits. Justification of a drop of 6.1 m (20 ft) is provided in WHC-SD-WM-TI-782 based on an 11,400-kg (20,000-lb) mixer pump and having an impact area of 0.023 m^2 (36.2 $in.^2$). The pit floors are chosen because the cover blocks over the pits do not provide much resistance to a load drop. The numerical value of the critical height is based on the lack of penetration of the largest load (the 101-SY mixer pump) dropped onto the weakest point that could result in dome penetration (the pump pit). Details are in the load drop calculations presented in WHC-SD-WM-TI-782. Load drops from the critical height will not result in penetration of the dome. Load drops from greater than the critical height, or drops of loads that are heavier than 11,400 kg (20,000 lb), or having an impact area different than 0.023 m^2 (36.2 $in.^2$), require separate analyses to determine if the dome fails.

The load drop event for DCRTs, catch tanks, or 20-ft-dia (i.e., 200 Series) SSTs does not have a TSR control on load height. The consequences of such a drop are well below the risk guidelines. The consequences are so low because these tanks contain primarily liquid or wet sludge, both of which result in a much lower consequence according to the calculations presented in WHC-SD-WM-CN-051. The TSR control for load height for MISFs is that no loads are allowed to be lifted over MISFs without appropriate safety evaluations.

An associated TSR requires use of DOE/RL-92-36, which provides guidelines for inspection, personnel qualification, training, equipment to be used, and critical lift procedures for lifts over all TWRS facilities.

Section 3.4.2.1 shows that dome or roof collapse resulting from excessive concentrated loads is not credible. However, because different cranes can be brought to the Site, a control is required to protect the assumption. Section 3.4.2.1 provides the maximum loads above which the dome or roof could fail. These loads are presented in WHC-SD-WM-TI-775 and WHC-SD-WM-RPT-002. The load limits defined in the TSR are set well below the failure loads.

The concentrated load shall not exceed 90,800 kg (100 tons) on a permanent or temporary basis over DSTs or SSTs, and 45,400 kg (50 tons) over 20-ft-dia SSTs (based on WHC-SD-WM-TI-775).

Concentrated loads over the DCRT vault cover blocks must remain well below 14,000 kg (15.5 tons). The value of 14,000 kg (15.5 tons) is the failure point, not the "code allowable" load. This requirement is implemented by prohibiting additional concentrated loads on DCRTs. Concentrated loads are not allowed over MISFs or catch tanks (WHC-SD-WM-TI-775).

Defense-in-Depth. Defense-in-Depth features are those operational practices that also serve to prevent an accident or mitigate the consequences of an accident (Table 3.4.2.1-6). Included in Table 3.4.2.1-6 are Defense-in-Depth features for both tank failure resulting from excessive loads and tank failure resulting from vacuum or degradation.

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Table 3.4.2.1-1. Causes of Load Drops.

Causes	Percent
Occupational Safety and Health Administration	
Improper rigging or rigging failure	34
Performing minor maintenance or unrelated work while the load is in motion	22
Operating the crane without authorization or signals	18
Failure of boom, cable, or sheaves	14
Overloading	4
Striking stationary equipment	2
Other (failure of control systems, poor maintenance, etc.)	6
U.S. Navy Data	
Crane failure Design error, poor maintenance, crane failures	23
Operator error Distraction or inattention, Inadequate training, failure to follow procedures	73
Rigging failures Improper rigging, rigging failure	3
Commercial Reactor Experience	
Design or fabrication errors	26
Operator error or lack of training Failure to follow procedures	36
Mechanical component failure, control failures	24
Faulty inspection	12
Crane overload or load hangup	3

Source: NUREG-0612, 1980, *Control of Heavy Loads at Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Table 3.4.2.1-2. Penetrability of Soil.

Penetrability (a unitless empirical value)	Target description
2 - 4	Dense, dry, cemented sand (e.g., the hard layers in the dry lake playas in Nevada; dry caliche; massive gypsite and selenite deposits (White Sands Missile Range)
4 - 6	Sandy gravel, silty-clay, no cementation
6 - 9	Moderately dense to loose sand (>80% sand), no cementation, water content not important
5 - 10	Silt and clay, low-to-medium moisture, stiff (e.g., the silt and clay layers of the dry lake playas); water content dominates penetrability
10 - 20	Topsoil, loose to very loose; silt and clay, moist to wet; clays will usually have low shear strength and high plasticity
20 - 30	Very soft, saturated clay; very low shear strength
30 - 60	Clay marine sediments; extremely soft, saturated clay with very low shear strength; examples include (1) mud deposits east of Wendover, Utah, and (2) sediments found in the Gulf of Mexico in the Mississippi delta region

Table 3.4.2.1-3. Summary of Consequences of Tank Failure Due to Excessive Loads Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Tank Failure Due to Excessive Loads (load drop scenario analyzed)	3.0 E-02 (3.0 E+00)	5.0 E-02 (5.0 E+00)	3.0 E-05 (3.0 E-03)	5.0 E-03 (5.0 E-01)	5.0 E+00	1 ERPG-2	3.0 E-04	1 ERPG-1	Unlikely

ERPG = Emergency Response Planning Guideline.
SOF = sum-of-fractions.

Table 3.4.2.1-4. Summary of Safety Structures, Systems, and Components for Tank Failure Due to Excessive Loads.

Structures, systems, and components	Safety classification	Safety function	Comments
Waste Tanks	Safety-Significant	The safety functions of the waste tanks are to withstand penetration from load drops, and to maintain structural integrity for uniform and concentrated loads, vacuum, and degradation, averting tank collapse and preventing the release of waste, thus decreasing the frequency of the Tank Failure Due to Excessive Loads (and tank failure due to vacuum or degradation) accident.	Protects the assumptions that the dome can withstand a 6.1-m (20-ft) drop and that the dome can withstand a uniform load of 2.3 m (7.5 ft) of soil and concentrated load of 90,800 kg (100 tons) Applies to DSTs, AWF tanks, and SSTs. For SSTs, the load drop portion of the safety function only applies to the 100 Series tanks. Per agreement with DOE-ORP, this Safety-Significant designation is not effective until March 30, 2000.

AWF = Aging Waste Facility.
DST = double-shell tank.
SST = single-shell tank.

Table 3.4.2.1-5. Summary of Technical Safety Requirement Controls for Tank Failure Due to Excessive Loads. (3 sheets)

Control	Safety function	Comments
1.0 SSTs (except 200 Series tanks), DSTs, and AWF tanks		
1.1 Dome loading controls		
• For mechanical lifts within 6.1 m (20 ft) of underground storage tank, the lower equipment boundary of the lifted item (e.g., bottom of the cover block, thermocouple tree) shall be less than 6.1 m (20 ft) above surface grade, or pit floor above a waste storage tank (covered or uncovered).	Limits load handling over a tank so that in the event the load is dropped the tank dome would not collapse	The cover blocks offer little resistance to load drops as the result of failure at low bending moments and are not considered in determining compliance with the 6.1-m (20-ft) limit. The 6.1-m (20-ft) limit considers the largest mixer pump (9,100 kg [20,000 lb]) and cover blocks as the limiting loads
• Use the *Hanford Site Hoisting and Rigging Manual* (DOE/RL-92-36) for lifts.	Prevents load drop accidents (i.e., decreases the frequency of load drops)	
• A dome loading program shall be established that manages soil and concentrated load baselines above waste storage tank per the following requirements: - SST uniform load shall not be modified - DST uniform loads shall be below 2.5 m (8.3 ft) of soil (241-AY and 241-AZ tank farms), and 2.3 m (7.5 ft) of soil (241-SY, 241-AW, 241-AN, 241-AP tank farms) - DST and 100 Series SST concentrated load shall not exceed 90,800 kg (100 tons) on a temporary or permanent basis.	Prevents exceeding external loads that may cause tank dome failure	

Table 3.4.2.1-5. Summary of Technical Safety Requirement Controls for Tank Failure Due to Excessive Loads. (3 sheets)

Control	Safety function	Comments
2.0 200 Series SSTs		
2.1 Dome loading controls		
• Use the *Hanford Site Hoisting and Rigging Manual* (DOE/RL-92-36) for lifts.	Prevents load drop accidents (i.e., decreases the frequency of load drops)	Compliance with DOE/RL-92-36 is sufficient based on the accident risk (i.e., frequency and consequence)
• A dome loading program shall be established that manages soil and concentrated load baselines above waste storage tank per the following requirements: - 200 Series uniform loads shall not be modified - 200 Series concentrated load shall not exceed 45,400 kg (50 tons) on a temporary or permanent basis.	Prevents exceeding external loads that may cause tank dome failure	
3.0 DCRTs		
3.1 Dome loading controls		
• Use the *Hanford Site Hoisting and Rigging Manual* (DOE/RL-92-36) for lifts.	Prevents load drop accidents (i.e., decreases the frequency of load drops).	Compliance with DOE/RL-92-36 is sufficient based on the accident risk (i.e., frequency and consequence).
• A dome loading program shall be established that manages soil and concentrated load baselines above waste storage tank per the following requirement: - DCRT uniform load shall not be modified - Additional DCRT concentrated load shall be prohibited.	Prevents exceeding DCRT external loads that may cause tank failure.	Although DCRTs are located in vaults whose cover blocks are aboveground, DCRT uniform load restrictions are required because the DCRT vaults for 244-TX, 244-U, and 244-BX extend underground beyond the cover blocks.

Table 3.4.2.1-5. Summary of Technical Safety Requirement Controls for Tank Failure Due to Excessive Loads. (3 sheets)

Control	Safety function	Comments
4.0 Catch Tanks		
4.1 Dome loading controls • Use the *Hanford Site Hoisting and Rigging Manual* (DOE/RL-92-36) for lifts • A dome loading program shall be established that manages soil and concentrated load baselines above waste storage tank per the following requirements: - Catch tank uniform load shall not be modified - Additional catch tank concentrated load shall be prohibited.	Prevent load drop accidents over catch tanks and prevent exceeding catch tank external loads that may cause tank dome failure.	The requirements of this control are based on existing analysis that shows several catch tanks have soil loads that exceed code allowables.
5.0 MISFs		
5.1 Dome loading controls • Mechanical lifts traveling over a MISF are not allowed. • A dome loading program shall be established that manages soil and concentrated load baselines above waste storage tank per the following requirement: - MISF uniform load shall not be modified - Additional MISF concentrated load shall be prohibited.	Prevent load drop accidents over MISFs and prevent exceeding MISF external tank loads that may cause tank dome failure.	The requirements in this control are based on the absence of structural analysis on the MISFs.

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford Inc., Richland, Washington.

DOE/RL-92-36, 1996, *Hanford Site Hoisting and Rigging Manual*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

AWF = Aging Waste Facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
MISF = miscellaneous inactive storage facility.
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 3.4.2.1-6. Summary of Defense-in-Depth Controls for Tank Failure Due to Excessive Loads and Tank Failure Due to Vacuum or Degradation.

Control	Safety function	Comments
Specific to Tank Failure Due to Excessive Loads		
Restrictions on operations during high winds	Provide a decrease in the frequency of a load being dropped as a result of high winds.	--
SST Dome deflection monitoring	Provide information that can be compared with baseline data to see if tank degradation is occurring.	--
Hydrostatic load monitoring	Protects against tank failure due to excessive hydrostatic loads.	--
Emergency preparedness	Mitigate the consequences of a tank failure due to excessive loads.	--
Establish criteria for tank loads.	Provides controls to maintain dome loads within structural capacity of the tanks.	Establish criteria and document tank loadings for concentrated and distributed load limits and incremental load changes.
Specific to Tank Failure Due to Vacuum or Degradation		
Tank pressure monitors/alarms	Provide indication of potential tank failure due to excessive vacuum/pressure conditions.	--
Tank waste compatibility program	Evaluation of waste prior to transfer allows for chemical adjustment to prevent excessive tank degradation due to waste incompatibility.	--
Waste temperature (absolute and delta) monitoring	Provide indication of potential tank degradation due to excessive heat.	--
Tank integrity assessments	Provide information that can be compared with baseline data to see if tank dome degradation is occurring.	Not a routine activity, but integrity assessments of the primary tank in selected DSTs have been performed.
Dome deflection monitoring	Provide information that can be compared with baseline data to see if tank dome degradation is occurring.	--
Hydrostatic load monitoring for waste transfers	Protects against tank failure due to excessive hydrostatic loads.	--
Establish criteria for tank loads.	Provides controls to maintain dome loads within structural capacity of the tanks.	Establish criteria and document tank loadings for concentrated and distributed load limits and incremental load changes.

3.4.2.2 Flammable Gas Deflagrations. This analysis addresses the presence of flammable gases in TWRS facilities. If flammable gases are ignited, a deflagration can liberate sufficient energy to release hazardous material from the tank.

This hazard is the subject of a Safety Issue for SSTs and DSTs and a USQ that has been closed for SSTs and DSTs (Wagoner 1998a, 1998b) but remains open for other TWRS ancillary facilities. As discussed below, technical uncertainties remain regarding flammable gas accident risk. Therefore a project is ongoing to resolve the Flammable Gas Safety Issue and the open USQ for TWRS ancillary facilities. The major objectives of this project are as follows:

- Develop a flammable gas accident analysis model for the refined safety analysis of SSTs and DSTs using waste-type groupings and data sets instead of the current facility groupings approach. The flammable gas accident analysis model allows quantification of the technical uncertainty and risk associated with the flammable gas hazard and an effective means for comparing and optimizing tank controls.

- Perform refined safety analyses for SSTs and DSTs using the accident analysis model including evaluation of tank controls consistent with the flammable gas hazard.

- Obtain flammable gas sampling data and perform additional engineering and safety analysis for TWRS ancillary facilities to provide a basis for assessing, and potentially revising, the existing control strategy.

- Amend the TWRS Authorization Basis.

- Prepare a flammable gas topical report to provide the technical basis for resolution of the Flammable Gas Safety Issue for SSTs and DSTs and removal of flammable gas tanks from the watch list.

Sufficient technical uncertainty remains regarding flammable gas behavior and possible accident phenomena in the TWRS facilities to make bounding analysis and <u>final</u> decisions regarding the selection of controls and the acceptability of actual risk inappropriate at this time. Rather, the acceptability of continued operations and control of flammable gas hazards is based on qualitative evaluation and practical interim controls described in Appendix K.

This section is provided for information, rather than as the technical basis for selection of final safety controls. The information and analysis provided in this section describe the current state of knowledge regarding flammable gas accident phenomena and provide estimates of possible accident consequences. The section deviates from DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, format because this analysis is not considered to be the final evaluation basis analysis. This section is organized as follows:

- The background regarding the flammable gas USQ is summarized.

- Current knowledge regarding flammable gas behavior and accident phenomena is summarized to provide perspective on accident consequences.

- Current controls, which are based on qualitative evaluation and approved for interim use (TWRS-RT-SER-02, *Safety Evaluation Report for the Basis for Interim Operation and Flammable Gas/Slurry Growth Unreviewed Safety Question: Justification for Continued Operation and Technical Safety Requirements*), are summarized.

- Accident scenarios are then developed to address a range of flammable gas accidents.

- Scenarios are described with and without controls to explain how the controls, which are preventive in nature, apply.

- Consequences are developed in a parametric manner to provide a perspective on the range of possible consequences and to relate consequences to various accident phenomena.

- Accident frequency estimates are developed for information so that consequences can be put into perspective relative to Hanford Site guidelines.

- Important remaining technical uncertainties are summarized.

3.4.2.2.1 Background. This section discusses the hazards and controls associated with the generation, storage, release, and postulated combustion of flammable gases in TWRS facilities and structures. This hazard was the subject of a USQ originally identified in 1990 that was applicable to a subset of the 177 TWRS underground waste storage tanks. The original USQ has been closed for Tank 241-SY-101, which was the facility originally identified to be of greatest concern, based on (1) analyses documented in LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, and (2) installation and operation of a mixer pump that prevents the retention and spontaneous release of large amounts of waste-generated gases.

The original flammable gas USQ was replaced by another USQ determination (TF-96-0433, *Consolidation of Flammable Gas/Slurry Growth Unreviewed Safety Question Issues*) that reflected an increased understanding of the flammable gas hazard and an accumulation of related field observations and experience. This USQ clarified the applicability to additional facilities (Wagoner 1996) within TWRS and identified a broader range of accidents and hazards. The USQ consolidated all issues related to flammable gas hazards that have a common root cause. Specifically, the USQ applied to any engineered structure, container, or receiver managed and operated by TWRS at which Hanford Site high-level waste may be stored in a condition and for a period of time that may result in the generation, accumulation, or release of flammable gas. According to TF-96-0433, the safety assessment for Tank 241-SY-101 (LA-UR-92-3196), and

derived controls adequately address the flammable gas hazard; therefore, the USQ did not apply to Tank 241-SY-101.

The USQ applied to the following:

- SSTs
- DSTs (except Tank 241-SY-101)
- AWF tanks
- DCRTs
- IMUSTs
- Catch tanks
- 242-S Evaporator
- 242-T Evaporator
- 244-AR Vault
- 244-CR Vault
- Waste transfer systems (e.g., transfer lines, valve pits, diversion boxes, process pits, and COBs).

The flammable gas USQ was closed for all SSTs and DSTs (Wagoner 1998a, 1998b), but remains open for the other tanks and facilities identified above.

Beginning in September 1996, the waste surface level in Tank 241-SY-101 began rising in a manner inconsistent with previous behavior. On February 26, 1998, RL declared a USQ related to the unexplained level growth in the tank (Kinzer 1998). This USQ subsequently was revised to reflect the results of waste characterization and analysis performed to understand level growth mechanisms and potential hazards in Tank 241-SY-101 (French 1999). Safety analysis and associated controls to manage the risk associated with Tank 241-SY-101 flammable gas hazards are presented in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Actions and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

Appendix K, "Flammable Gas Hazards and Controls in Hanford Waste Storage Tanks and Waste Transfer Facilities," discusses the flammable gas hazard in all TWRS facilities except Tank 241-SY-101. In part, the discussion is based on observations and available data. A three-pronged approach to risk management that addresses ventilation, monitoring, and ignition control is also presented. Controls for managing the risk of the flammable gas hazard and qualitative

conclusions regarding the effectiveness of those controls are provided. Appendix K is based on qualitative evaluations and does not provide quantitative estimates for accident frequencies or consequences.

3.4.2.2.2 Accident Phenomena. Nuclear waste stored within TWRS facilities is capable of generating flammable gas (i.e., principally hydrogen gas) to varying degrees depending on the type, amount, geometry, and condition of the waste in the array of TWRS waste receptacles. Radioactive waste generates hydrogen through the radiolysis of water, thermolytic decomposition of organic components, and corrosion of a tank's carbon steel walls. Radiolysis and thermolytic decomposition also generate ammonia. Nonflammable gases, which act as diluents (e.g., nitrogen), are also produced. Additional flammable gases (e.g., methane and an oxidizer, nitrous oxide) are generated by chemical reactions between various degradation products of organic chemicals present in the tanks. Volatile or semivolatile organic chemicals in tanks also produce organic vapors. The gas produced in this generation is (1) released continually to the tank vapor spaces (historically referred to as a steady-state release; more correctly referred to as chronic release) or (2) retained by the waste matrix. Retained gas may be released in a spontaneous or induced GRE that can significantly increase the flammable gas concentration in the tank vapor space. Appendix K elaborates on the range of hazardous scenarios, which include the following:

- Steady-state gas release
- Accumulation of released gases in (1) tank dome spaces; (2) pits, risers, and connected air spaces; or (3) waste-intrusive equipment
- Retention of gas within the waste matrix followed by (1) spontaneous or natural release from, for example, buoyancy instability or (2) release from waste-disturbing action or motion
- Flammable gas burns (1) beneath the waste surface or (2) in vapor spaces following release from stored waste.

Accident frequency and consequence estimates are strongly influenced by flammable gas behavior in the Hanford Site waste tanks as well as by combustion phenomena and tank failure modes, given ignition occurs. The current state of knowledge regarding flammable gas behavior, combustion phenomena and tank failure modes is summarized below. Additionally, the current understanding of material aerosolization and release phenomena is also described in this section, and source terms are developed for specific phenomena. These source terms are then combined to form parametric accident consequences cases in Section 3.4.2.2.3.

Summary of Flammable Gas Behavior and Combustion Phenomena. All flammable gas burn accident scenarios begin by creating situations where the gases generated by the wastes accumulate in flammable concentrations. The source of gases is the waste. Gas generation rates and gas release rates are key to understanding possible accident scenarios. Key parameters in defining flammable concentrations are gas composition and corresponding combustion limits.

Ignition requirements (energy and temperature) are easily exceeded by a number of available ignition sources. Combustion phenomena (pressure and flame speeds) affect tank failure modes and waste entrainment phenomena. Tank failure modes, waste material aerosolization, and release phenomena determine the magnitude of consequences. There is a level of understanding regarding each of these key parameters and phenomena. Some are known quite well, while others are highly uncertain.

- **Gas Generation**—Gas generation rates are low compared with ventilation rates. Gas generation rates have been calculated based on measured headspace concentrations, ventilation rates, and empirical models based on measured gas generation from waste samples. Generation rates range from 2 to 1,500 L/day (4.9×10^{-5} to 3.7×10^{-2} ft^3/min). The highest generation rate reported is for Tank 241-SY-101.

  Both headspace gas concentration measurements and predictions show that gas generation in and of itself does not create a flammable gas hazard if the gases are released in a steady manner and ventilation is adequate. In the majority of tanks, passive natural convective ventilation provides enough dilution for the gases generated in the waste. In some tanks, however, the generation rate is high enough that active mechanical ventilation is required to prevent flammable gas buildup.

- **Gas Composition**—Measurements of retained gases, released gases, and gases present in tank headspaces indicate that gas composition varies significantly and that waste-generated gases contain significant amounts of hydrogen, ammonia, nitrous oxide, and nitrogen.

- **Gas Retention**—Studies have shown that some tanks store significant volumes of gas in the waste. Free gas can accumulate only in submerged solids lying beneath the free liquid level; gas escapes from unsubmerged solid layers by diffusion. Convective fluid layers cannot retain gas because bubbles rise through a liquid as fast as they are generated. Fewer than 60 tanks contain measurable gas volumes (HNF-SP-1193, *Flammable Gas Project Topical Report*). Only one tank (241-AN-103) contains a volume comparable to that stored in Tank 241-SY-101 before installation of the mixer pump.

  Soluble gases (mainly ammonia, with a small amount of nitrous oxide) are also dissolved in the liquid waste. However, evaporation of dissolved gas is a concern only when a free liquid surface is freshly exposed or agitated by a disturbance such as a seismic event or when liquid waste is transferred to another tank.

  Direct measurements of retained gas are not available for most tanks. Therefore, the amount of retained gas stored in each tank was estimated in WHC-SD-WM-ER-526, *Evaluation of Hanford Tanks for Trapped Gas*, based on two indirect methods. Only 58 of the 177 tanks indicated trapped gas and, of

these, only 20 to 25 tanks, including the 6 DSTs, stored relatively large volumes of gas. About 50 tanks have so little waste that gas retention is of little concern when released and mixed in the headspace because of the large dome-space dilution factor. However, both of these methods include significant uncertainties, as described in WHC-SD-WM-ER-594, *Evaluation of Recommendation for Addition of Tanks to the Flammable Gas Watch List*. Uncertainties arise because the models are elementary and do not represent adequately the physical situation of the waste in all tanks and because the current data lacks precision necessary to make estimates of the retained gas. Therefore, given the uncertainty in the methods and data, the conclusion is that all the tanks retain gas, and the retained gas amounts have not been specified for "evaluation basis" accidents.

- **Gas Release Events (GREs)**—Gases that are released from the waste in a nearly continuous manner can be managed quite effectively by ventilation. Less straight forward, however, is the situation where a significant amount of the gas is retained within the waste and released relatively rapidly in a GRE.

GREs have been observed in six of the DSTs (241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, 241-SY-101, and 241-SY-103). Data regarding GREs in these tanks has been reported in PNNL-11296, *In Situ Rheology and Gas Volume in Hanford Double-Shell Waste Tanks*. The large GREs that occurred in Tank 241-SY-101 before the mixer pump was installed were unique in size and frequency (130 to 200 m^3 of gas, or 35 to 70% of its 300- to 500-m^3 retained-gas inventory every 100 to 150 days). In contrast, the next highest mean release fraction is 16% in Tanks 241-AW-101 and 241-AN-105 or 14 m^3 and 26 m^3, respectively. The mean release volume for 241-AN-103 is 13.9 m^3; for 241-AN-104 it is 22.7 m^3; and for 241-SY-103 it is 14.1 m^3. None of the gas releases in the DSTs, other than in 241-SY-101 before the use of the mixer pump, has been large enough to create flammable mixtures after mixing in the tank headspace.

The ongoing study of gas retention behavior of SST waste forms has narrowed the number of plausible spontaneous release mechanisms to a few possibilities that are capable of only small releases (less than 10 m^3 compared with 100 to 200 m^3 in Tank 241-SY-101) (HNF-SP-1193). Observation of a number of the most notable flammable-gas-retaining SSTs indicates that no large GREs are occurring and that only a few SSTs experience small spontaneous GREs. The typical spontaneous GRE in an SST has a small release volume of tens of cubic feet of hydrogen.

Gas releases can be induced by waste-disturbing operations; but local disturbances do not trigger a general, large-scale gas release. Rather, gas is released only from the volume of waste actually disturbed.

Seismic events are also postulated to cause GREs. The fraction of the retained gas released increases with increasing earthquake severity. The release fraction in

DSTs is concluded to be higher than in SSTs, for a given seismic event, because of the waste strength properties (the SST waste being stronger) and waste configuration (DSTs have large volumes of supernate that can cause large disruptions of the underlying sludges). Gas release fractions of greater than 50% have been estimated for DSTs in a 100-yr earthquake and in SSTs for a 1,000-yr earthquake.

- **GRE Assumptions for Controls Selection**— Appendix K qualitatively assessed the risk posed by GREs for applying controls to prevent ignition. Each DST, SST, DCRT, AWF tank, IMUST, and catch tank has been placed in one of four facility groups, depending on whether the waste is postulated to present a hazard from large or small GREs. The GREs may be spontaneous or occur only during waste-disturbing (induced) operations. Ignition source controls and monitoring requirements are applied at times when and in locations where flammable conditions resulting from GREs can be present, as appropriate to this grouping scheme.

  Five tanks within the scope of Appendix K (excluding Tank 241-SY-101) that have had significant GREs are conservatively postulated to have the potential for large, spontaneous and large, induced GREs. These tanks have been assigned to Facility Group 1. Tanks that are postulated to have the potential for a small, spontaneous GRE, and for a large, induced GRE are assigned to Facility Group 2. The remaining SSTs, which show no propensity for spontaneous GREs but may produce a small induced GRE, are assigned to Facility Group 3. Facilities with little or no waste solids capable of retaining gases are categorized as non-GRE. It is assumed that the tanks in all facility groups undergo steady-state gas generation at all times.

- **Combustion Limits**—Combustion limits for waste gas fuels have been developed to account for nitrous oxide as a possible oxidizer rather than air. Experiments have determined that below 20% hydrogen, there is no significant difference in the flammability data for hydrogen-air or 1:1 or 3:2 hydrogen-to-nitrous oxide ratios in air. The lower flammability limit (LFL) was measured at (WHC-SD-WM-ES-219, *Laboratory Flammability Studies of Mixtures of Hydrogen, Nitrous Oxide, and Air)*:

Quiescent conditions, upward propagation	5% H_2
Quiescent conditions, downward propagation	8% H_2
Turbulent conditions, upward propagation	4% H_2
Turbulent conditions, downward propagation	6% H_2

  Studies at the California Institute of Technology (Ross and Shepherd 1996) indicate that the combustion limits for waste gas mixtures can be reasonably estimated by use of Le Chatelier's Rule.

- **Ignition**—Hydrogen, a major constituent of the flammable gases, ignites with a very small energy source: only 0.017 mJ to 0.1 mJ electrical spark energy is required (Fischer 1986; Dufresne and Karwat 1988). Installed equipment in the tank or ventilation system, activities being conducted in the tank, human errors, or natural phenomena (such as an earthquake or lightning) provide potential ignition sources.

- **Combustion Pressure**—Global burns represent events when the gas concentration in the entire vessel is above the LFL. For these deflagrations, the pressure in the vessel (e.g., tank) will be nearly uniform and bounded by the adiabatic isochoric (constant volume) complete combustion (AICC) pressure.

  Under lean combustion conditions, developed pressures will be less than the AICC pressure because of incomplete combustion. Combustion pressures are well below AICC until fuel concentrations are well above the LFL. AICC pressures are approached when the mixtures are above the limit for downward propagation (Ross and Shepherd 1996). Once concentrations exceed the lower limit for downward propagation, combustion pressures exceed about 4 atm gauge.

  If insufficient gas is available to create flammable concentrations in the well-mixed headspace, but a GRE creates a local plume of flammable gases, combustion of the plume will result in pressures less than the AICC pressures discussed above as the combustion energy is dissipated into the rest of the inert dome space volume. Tank pressures created by plume burns can range from very low and inconsequential to pressures high enough to challenge the structures of SSTs (greater than 75 kPa gauge [11 lb/in.^{2} gauge]).

- **Flame Speed**—Waste material entrainment during a tank headspace deflagration, described later, is modeled as a function of the flame speed. Flame speeds for lean waste gas mixtures in the tank headspace are expected to range from approximately 5 to 10 m/s (16.4 to 32.8 ft/s).

  Under certain conditions of sensitive gas mixtures and obstructed or turbulence generating geometries, flames can accelerate. If the deflagration speed is accelerated to more than about 100 m/s (328 ft/s), peak instantaneous pressure can be higher than the AICC pressure. If the deflagration is fast enough, a deflagration-to-detonation transition (DDT) may occur. Detonations are combustion fronts traveling at supersonic speeds. Detonation flame speeds can range up to 1,800 m/s (5,700 ft/s). The peak reflected pressures for detonations can be considerably above the AICC pressures, up to 35 times the precombustion pressures.

  The likelihood of DDT depends on flammable gas concentrations and vessel geometry. Lean mixtures cannot support DDT. DDT is more likely in ventilation ducting where the geometry is more conducive to flame acceleration than in the

tank headspaces. Evaluations of DDT potential in Hanford Site waste tanks have concluded that DDT is possible but unlikely.

- **Tank Failure Modes**—The tank failure mode (e.g., dome cracking, dome blowout, dome collapse) following a flammable gas burn primarily determines the amount of waste material that might be released to the atmosphere from tank dome debris and soil overburden falling on the waste. Unfiltered vent paths (e.g., ruptured HEPA filters, open risers, and lifted pit cover blocks) are created at tank pressures well below combustion pressures and tank failure pressures.

Because of the large uncertainties and differing opinions regarding tank failure modes, an evaluation using the Delphi method was conducted. The conclusion of WHC-SD-TWR-RPT-003, *DELPHI Expert Panel Evaluation of Hanford High-Level Waste Tank Failure Modes, Fragilities, and Release Quantities*, was that the tanks had two primary failure modes from excessive internal pressure: dome cracking and gross dome failure. Gross dome failure was characterized as an opening, in a "can opener" manner, in the center region of the dome, with a radius of 0.6 to 6.1 m (2 to 20 ft). The Delphi panel concluded that, based on existing stress analysis, there is no reason to expect complete dome collapse.

SSTs: In 100 Series SSTs, pressures up to 75 kPa gauge (11 lb/in.^{2} gauge) would be expected to deform the concrete. At pressures slightly above 75 kPa gauge (11 lb/in.^{2} gauge) the dome would be expected to crack extensively. Existing stress analyses predicted cracking pressures in the range of 75 to 103 kPa gauge (11 to 15 lb/in.^{2} gauge) internal pressure.

Tank cracking pressure for 200 Series SSTs has not been analyzed. Structural evaluation of the smaller 200 Series tanks concludes that they are significantly stronger than the larger 100 Series tanks.

The internal pressure at which catastrophic failure of the SSTs may first occur was not addressed by the Delphi Panel. However, for the 100 Series tanks, the Delphi Panel did conclude that, at peak pressures significantly greater than 75 to 103 kPa gauge (11 to 15 lb/in.^{2} gauge) (very rapid pressure rise up to 300 kPa gauge [44 lb/in.^{2} gauge]), the center portion of the dome would be blown out.

DSTs: The primary tank is not likely to fail until pressure reaches about 380 to 410 kPa gauge (55 to 60 lb/in.^{2} gauge). Below this pressure the primary tank will bulge, lifting the entire concrete dome and side walls. Existing stress analyses indicated yielding in the liner under a load of 410 kPa gauge (60 lb/in.^{2} gauge). At an assumed peak pressure of 972 kPa gauge (141 lb/in.^{2} gauge) from a flammable gas burn in a DST, the concrete above the steel liner would be shattered, the overburden soil would be blown away, and the steel liner would tear and fold back in a "can-opener" opening that could extend over a section in the center of the dome.

Failure modes involving fires in a DST annulus have also been evaluated. The conclusion is that the primary tank would buckle and fail allowing the gases to expand to the entire tank. The internal pressure acting on the secondary tank is estimated to be in the neighborhood of 482.6 kPa gauge (70 lb/in.^{2} gauge). Based on the evaluation, the dome could fail in a similar manner to the failure mode for a burn in the primary tank, by opening up the dome in the center region of tank.

DCRTs and Catch Tanks: DCRTs 244-BX, 244-TX, 244-U, and 244-S will rupture and the vaults will fail at 410 kPa gauge (60 lb/in.^{2} gauge). This conclusion is also applicable to catch tanks with wall thicknesses of 0.64 cm (1/4 in.). The 244-CR and 244-A DCRT primary vessels and vaults would withstand a 827 kPa gauge (120 lb/in.^{2} gauge) pressurization, but both would fail at 1,200 kPa gauge (174 lb/in.^{2} gauge). This conclusion applies to catch tanks with wall thicknesses of 0.95 cm (0.37 in.).

Source Term Analysis. Material release source terms have been developed for a number of possible accident situations including varying combustion phenomena, facility configurations, and facility failure modes.

- **Source Terms for Headspace Deflagrations in SSTs, DSTs, and AWF Tanks**—The source term for a deflagration in a tank headspace would be similar for scenarios where the headspace attains flammable concentration by the relatively slow accumulation of chronically released gases or the relatively rapid GRE.

  The amount of waste material released because of a deflagration accident is intuitively related to the severity of the deflagration. Waste material can be released both from the effects of a burn event (e.g., turbulent winds in the dome space and pressurized release) as well as from the impact of tank debris and soil overburden into the waste if tank structural failure were to occur. Available unfiltered release pathways vary with tank internal pressure. At low pressures (atmospheric to 14 kPa gauge [2 lb/in.^{2} gauge]), unfiltered release occurs through tank openings such as open risers, pit drains, and unsealed risers (including lifting of cover blocks). When pressure exceeds several kPa gauge, unfiltered pathways include failed HEPA filters. For SSTs, release through soil overburden may occur via cracks in the tank dome when pressures exceed about 75 kPa gauge (11 lb/in.^{2} gauge). The steel liners in DSTs provide more protection from such a release than SSTs because failure of the liner is not expected until pressure reaches about 380 to 410 kPa gauge (55 to 60 lb/in.^{2} gauge). Large tank openings can occur above about 410 kPa gauge (60 lb/in.^{2} gauge) as a large portion of the dome (up to 16.5 m [54 ft] in diameter) opens in a "can-opener" blowout.

- **Waste Entrainment and Release Caused By the Combustion Event**—Waste in the tanks would be entrained and made airborne as a result of a flammable gas deflagration or detonation. Release occurs because of the blowdown of the pressures produced by the burn. Unfiltered releases occur through tank openings

normally present or created by the combustion event. In addition, in the scenarios where tank dome cracking is predicted, material will be vented through the cracks and filtered by the soil overburden. The material released can include airborne activity present in the headspace before ignition; material suspended because of the combustion event; and materials suspended from ventilation system components such as ductwork, prefilters, and HEPA filters.

Considerable uncertainty exists in estimating the amount of material that would be aerosolized and the fraction of the aerosol that would be respirable. Information found in literature reports entrainment rates that vary over many orders of magnitude. However, the existing data is for dry powders and not the wet sludge or salt cake found in Hanford Site tanks. The materials in the Hanford Site tanks have rheologies that vary from water to sludge composed of salt solutions and suspended fine metal oxide particles with viscosity up to 1,000 poise, and drained salt cakes. In addition to waste that settles in the tank, the filling and draining of tanks deposits coatings of waste on the tank walls and equipment. This material is also subject to release. The mechanisms that can release aerosol during a deflagration event include the following:

- Aerodynamic entrainment of settled waste with waste deposited on tank walls and equipment and subsequent breakup into particles. This entrainment is a result of transient gas flow or pressure waves at various angles to these waste surfaces.

- Wall-deposited material and crust material releases by pressure-induced flexure of the surface

- Material suspended by the impact of falling debris into the waste if the deflagration is severe enough to cause structural damage to the tank dome.

- **Material Present in Tank Dome Spaces Prior to Combustion**—Some airborne activity is present in tank dome spaces at all times and some additional material may be released to the dome space during the gas release. WHC-SD-WM-TI-753, *Summary of Flammable Gas Hazards and Potential Consequences in Tank Waste Remediation System Facilities at the Hanford Site*, estimates this to be the equivalent of 0.21 L of waste in SSTs and 0.39 L of waste in DSTs.

- **Aerodynamic Entrainment**—Data related to aerodynamic entrainment of materials for Hanford Site wastes during flammable gas deflagration events is not available. Several estimates have been made including those reported in WHC-SD-WM-TI-753 and WHC-SD-TWR-RPT-003.

WHC-SD-WM-TI-753 relies on modeling based on wind entrainment of dry powders (Iversen 1984) to make rough estimates for suspended material. A review of waste entrainment literature (NUREG/CR-2651, *Accident Generated*

Particulate Materials and Their Characteristics—A Review of Background Information; Iversen 1984) showed that one of the important parameters for determining how much material is entrained from the waste is the speed of the flame front. Empirical equations (Iversen 1984) relating the entrainment to the flame-front velocity show a functional relationship involving the square of the velocity. Los Alamos National Laboratory calculated the waste entrained by the flame front sweeping over the waste surface of Tank 241-SY-101 to be 3.3 L (5.5 kg) at a flame speed of 100 m/s (328 ft/s) (LA-UR-92-3196). Using the functional relationship involving the square of the velocity, the aerodynamic entrainment at 10 m/s (32.8 ft/s) would be 100 times less, or 0.033 L. Extrapolating up to detonation velocities, WHC-SD-WM-TI-753 estimates an aerodynamic entrainment 36 times greater than the Tank 241-SY-101 value, or 120 L, at a flame speed of 600 m/s (1,969 ft/s). Flame speeds for detonations can exceed 600 m/s (1,969 ft/s). However, aerodynamic entrainment calculations for higher flame speeds are not performed because the applicability of the aerodynamic entrainment model for such conditions is unknown.

The Delphi Panel noted the differences between the waste surfaces in SSTs and DSTs and made separate estimates for each (WHC-SD-TWR-RPT-003). For SSTs, aerodynamic entrainment from the waste surface is based on values from DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, for a dry cohesionless powder at a wind speed of 9 m/s (20 mi/h). This resulted in 6.3 g or 3.8×10^{-3} L of respirable material being made airborne in the tank dome space. For DSTs, the Delphi Panel based the aerodynamic entrainment on the value for 22-m/s (50-mi/h) winds blowing across liquids as reported in DOE-HDBK-3010-94. This resulted in about 8 g or 4.8×10^{-3} L of respirable material being airborne in the tank dome space.

- **Pressure-Induced Flexure of Tank Surfaces**—No estimate has been made for material released as the result of pressure-induced flexure of tank surfaces. For the purposes of parametric consequence analysis, ignoring this source term is not considered to be significant given the uncertainty in other source terms and the large range of source terms considered.

- **Removal of Contaminated Equipment**—During removal of contaminated equipment from a tank (e.g., removal of the mixer pump from Tank 241-SY-101) there is a potential for additional material release. A burn during removal of the pump will cause high-velocity jets to flow out of the riser around the pump column. Because the pump assembly will be contaminated, these jets will entrain waste material. If a burn occurs during removal of the mixer pump, it is estimated that an additional 7.8 L or 12.8 kg of waste will be aerosolized directly into the atmosphere (LA-UR-92-3196).

- **Tank Venting**—The material present in the dome space following combustion will be vented through tank openings as the dome space blows down and returns to atmospheric pressure. The fraction vented is proportional to the combustion pressure attained. For this analysis it is assumed that a combustion pressure of 2 atm absolute will vent 50% of the gases in returning to atmospheric pressures. A combustion pressure of 4 atm absolute will vent 75% of the gases in returning to atmospheric pressures. This is conservative because some of the combustion energy will be consumed by distorting and displacing the tank structure and soil overburden (i.e., perform expansion work) and heat will be transferred to the tank wall and waste, cooling the gases.

- **Material Released from Ventilation Systems**—A portion of the material loaded on prefilters and HEPA filters will be released to the atmosphere because of the pressure pulse from the combustion event. WHC-SD-WM-TI-753 estimates the releases to be equivalent to 0.0001 L for SSTs (passively ventilated), 0.001 L for DSTs, and 0.006 L for AWF tanks. HNF-SD-WM-CN-099, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, estimated the release to be equivalent to 0.0364 L for AWF tanks. Calculations for flammable gases in the TWRS facilities were not updated to reflect this new value because the material release from the HEPA filters is insignificant when compared with the quantity of material lofted in the deflagration and, therefore, the impact on the results would not be significant.

- **Waste Entrainment and Release Caused By Falling Debris**—The source term related to debris impacting the waste surface can be significant and varies depending on the failure mode of the tank.

- **Material Release Following Dome Cracking**—Dome cracking failures can result in debris falling to the waste surface in SSTs. In this failure mode, concrete is spalled from the interior portion of the dome and falls onto the salt cake. The Delphi Panel estimated the material suspended because of this mechanism to be 4.2 kg or 2.5 L (WHC-SD-TWR-RPT-003). The driving force for venting this material is quite low, however, and this material was judged to be suspended after the combustion pressure was vented. The Delphi Panel estimated that only about 50 g or 3.0×10^{-2} L would be vented from the tank dome (WHC-SD-TWR-RPT-003).

- **Material Release Following A Dome Blowout**—For DSTs the Delphi Panel concluded that the ultimate failure mode may cause a rapid "can-opener" partial opening of a flap in the tank dome (WHC-SD-TWR-RPT-003). The Delphi Panel estimated material suspension from tank debris and soil overburden from a 12-ft-dia portion of the dome falling onto the waste surface. The panel estimated 5.5 kg of respirable material would be airborne in the tank dome based on splashing of waste liquids. Of this amount 200 g or 0.12 L would be vented

because of the displacement of dome space air from the volume of the falling debris.

- **Material Release Following A Complete Dome Collapse—** WHC-SD-WM-CN-051, *The Effects of Load Drop, Uniform Load, and Concentrated Loads on Waste Tanks*, analyzes the release from a collapsed dome in which the tank overburden is credited with reducing the respirable particles by a factor of 10. Because some of the overburden may be expelled by the deflagration, this factor was not credited. WHC-SD-WM-TI-753 estimates that 3.8 L of respirable waste would be released because of the collapse of the entire dome into the waste.

- **Source Terms for Headspace Deflagrations in a DCRT—** WHC-SD-WM-TI-753 estimates source terms for a DCRT based on tank rupture and pressurized venting of liquids and air based on an earlier study (WSRC-TR-93-445, *Consequences of a Hydrogen Deflagration in a Waste Tank (U)*), where the amount of material suspended from the rupture of the primary vessel of a tank with a liquid surface is analyzed. The release calculations are based on data on liquid entrainment from small-scale breaks in piping containing stratified layers of air and water. This data fits the geometry of most DCRTs (cylindrical) with a layer of liquid waste and a layer of gas above it. The release would then occur because the flammable gases burn and cause the vessel to fail. This analysis yields 18.3 L or 25.6 kg of respirable material (assumed to be 5% SST solids and 95% SST liquids).

3.4.2.2.3 Parametric Studies of Flammable Gas Deflagrations. Accident consequences are affected by ignition source availability; combustion phenomena such as flame speed and combustion pressures; tank structural response and failure modes; and material suspension and release phenomena. The source term specific to any given accident scenario must consider the appropriate combination of factors described previously. Because there is a large uncertainty associated with these phenomena, consequences are developed for a number of hypothetical situations to cover a wide range of possible consequences.

SSTs, DSTs, AWF Tanks—Several representative scenarios are described in the following paragraphs to provide a range of possible source terms and, thus, to evaluate accident consequences in a parametric manner. Four cases are each developed for SSTs and for DSTs/AWF tanks.

- **CASE 1 - SST Deflagration—Cracked Dome (Delphi Panel - Mechanistic Estimate)**—The Delphi Panel estimated releases for a dome-cracking scenario in SSTs (WHC-SD-TWR-RPT-003). The panel judged this failure mode to be appropriate to the SSTs because those tanks do not have a steel liner enclosing the dome. The material sources included the activity present in the tank free volume at all times plus that caused by activities in the tank, material suspended by the deflagration, and material made airborne by the impact of concrete spilled from the

interior of the dome. The material released during the deflagration is split between unfiltered paths (through open risers including the lifting of cover blocks) and the cracks that develop in the dome. The material released through dome cracks is filtered by flow through the soil overburden. The total release for this case ranged from 0.5 g to 20 g or 3.0×10^{-4} to 0.012 L of SST solids.

- **CASE 2 - SST Deflagration—Cracked Dome (Delphi Panel - Upper Estimate)**—Based on a review of the uncertainties associated with the Delphi Panel calculations, the panel concluded that a reasonable value is < 1-kg (or < 0.6 L) of released SST solids (WHC-SD-TWR-RPT-003). Because the panel judged the 1 kg release to be conservative relative to their calculations, they concluded that an uncertainty of about a factor of 10 to 20 should be associated with their mechanistic estimate.

- **CASE 3 - SST Deflagration (10 m/s Flame Speed)—No Dome Cracking or Filtering Through Soil Overburden**—This scenario assumes a combustion pressure of 2 atm gauge (67% of dome space vented), aerodynamic entrainment of 0.003 L (dry powder correlation at 10 m/s flame speed), a precombustion headspace loading of 0.21 L, and a ventilation system loading of 0.0001 L (passive ventilation). No release from falling debris is included and no filtering of the release through soil overburden is assumed. The total source term is 0.14 L of SST solids:

$$[0.67\times(0.003+0.21)+0.0001]L=0.14\ L.$$

- **CASE 4 - DST Deflagration—No Tank Damage**—This scenario represents a deflagration that results in an overpressure of 3 atm gauge (75% of dome space vented) but does not blow out the dome. Aerodynamic entrainment is 0.13 L based on the dry powder correlation at a flame speed of 20 m/s. The precombustion headspace loading is 0.39 L, with a ventilation system loading of 0.001 L. The total source term is 0.39 L of DST liquids:

$$[0.75\times(0.13+0.39)+0.001]L=0.39\ L.$$

- **CASE 5 - DST Deflagration—Dome Blowout (Delphi Panel Upper Estimate)**—The Delphi Panel judged that the dominant failure mode for DSTs would be a dome blowout because the completely enclosed steel primary tank would retain the combustion pressure until the top of the steel tank ruptures at several atmospheres overpressure. At this point the pressure is high enough to open the tank in a "can-opener" manner and blow much of the debris and soil overburden off the opened center region of the dome. The Delphi Panel estimated release quantities for a dome blowout scenario for DSTs (WHC-SD-TWR-RPT-003).

Material sources considered included airborne activity present in the tank free volume at all times, airborne activity from activities being performed in the tank at the time of a deflagration, liquid splashed from the impact of the solid debris on the liquid surface, and liquid sheared from the surface by aerodynamic entrainment. The Delphi Panel based the aerodynamic entrainment on the value for 22-m/s (50-mi/h) winds blowing across liquids as reported in DOE-HDBK-3010-94. The material released because of debris falling into the tank after the deflagration was based on debris from a 3.7-m- (12-ft-) dia section that fails. The total amount of material estimated to be released was 0.2 kg. Because of a lack of a dynamic model and other assumptions and uncertainties, the panel estimated the uncertainty on this value to be on the order of at least a factor of 2 to 5 for an upper estimate of <1 kg or <0.6 L of DST liquids.

A deflagration in the annulus of a DST or AWF tank would result in a source term similar to that for a primary tank headspace deflagration. The failure mode is between the annulus and the primary tank, which pressurizes the primary tank to 480 kPa (70 lb/in.^{2} gauge). At this overpressure, tank dome blowout is predicted. The rapid blowdown of the annulus into the primary tank would entrain waste material. The venting of the dome space through tank openings and cracks in the dome would release the entrained waste to the atmosphere. Filtering through soil overburden may occur, but may not be significant if the soil is blown off the tank by the venting of the high-pressure gases.

- **CASE 6 - SST Deflagration (10 m/s Flame Speed)—Collapse of Entire Dome** —This scenario assumes an aerodynamic entrainment of 0.003 L (dry powder correlation at 10 m/s flame speed), a precombustion headspace loading of 0.21 L, and a ventilation system loading of 0.0001 L (passive ventilation). The dome collapse results in an additional 3.8 L of respirable material being released. Because the dome collapse displaces all of the dome space air, all of the above material is released. The total source term is the sum of these contributors or 4.0 L of SST solids.

  - **DST Deflagration—Dome Collapse**—The DST deflagration with dome collapse scenario assumes an aerodynamic entrainment of 0.13 L (dry powder correlation at 20-m/s flame speed), a precombustion headspace loading of 0.39 L, and a ventilation system loading of 0.001 L. The dome collapse results in an additional 3.8 L of respirable material being released. Because the dome collapse displaces all of the dome space air, all of the above material is released. The total source term is the sum of these contributors or 4.3 L of DST liquids.

- **CASE 7 - DST Detonation—Dome Blowout**—This scenario assumes an aerodynamic entrainment of 120 L (dry powder correlation at 600 m/s flame speed), a precombustion headspace loading of 0.39 L, and a ventilation system

loading of 0.001 L. The debris falling on the waste surface following blowout contributes an additional 0.12 L. The total source term is 120 L of DST liquids.

Consequence Analysis for SSTs, DSTs, and AWF Tanks. The onsite and offsite inhalation radiological dose consequences were estimated using the methodology discussed in Section 3.4.1. Consequences are calculated for a number of cases to show the consequences for the range of source terms described above. In addition, consequences are calculated for different source materials. Headspace deflagration consequences are calculated for SST solids, DST liquids, and AWF tank liquids because these represent the material at the waste surface that would be released as a result of hydrodynamic entrainment and impact from falling tank and soil overburden debris. The results of the parametric radiological consequence analysis are displayed along with risk evaluation guidelines in Figure 3.4.2.2-1 for onsite receptors and in Figure 3.4.2.2-2 for offsite receptors.

The source terms for AWF tanks are similar to those for the DSTs. However, the consequences for AWF tanks are a factor of 0.23 lower than for the DSTs because of a lower ULD for AWF tank liquids relative to DST liquids.

Frequency Adjustments For Unlikely Combustion Phenomena and Tank Failure Modes. The source term and consequence analyses presented address a range of possible burn phenomena and tank failure modes. To compare the results of these parametric consequence analyses with risk guidelines, frequencies need to be assigned forming frequency consequence pairs. Frequency assignments for the accident scenarios are described in Section 3.4.2.2.5. These frequencies are generally based on the combined likelihood of a flammable condition to exist and a spark source to be present and thus represent the frequency of ignition. In order to compare the range of consequences with risk guidelines, the conditional probability that a burn will include flame acceleration and transition to detonation must be included in the frequency calculation. As indicated under hazard phenomena, observed flame acceleration in experiments required nearly optimum (high) concentrations of flammable gases. Conservative estimates of concentrations that are detonable or that can support DDT are lower than the observed experiments. DDT in ventilation systems was judged to be more likely than in the dome space proper. Ignition and DDT in the ventilation system can be expected to propagate as a detonation in the dome space because the concentration in the dome space would be at least as high as in the ventilation system for both loss of ventilation and GRE scenarios.

Loss of ventilation scenarios typically do not lead to concentrations that support DDT for SSTs or DSTs. Of the SSTs with active ventilation systems (which may be susceptible to ignition and DDT), only Tank 241-SX-108 has a maximum loss of ventilation scenario concentration of 11% hydrogen (maximum calculated concentration is reported as 11.0) (HNF-SD-WM-CN-116, *Calculation Note: Hydrogen Generations Rates at Steady-State, Flammable Gas Concentrations for Single-Shell Tanks*). Of the DSTs, only two tanks have maximum loss of ventilation scenario concentrations greater than 11% hydrogen (Tank 214-AN-107 at 16.0% hydrogen and Tank 241-SY-101 at 22.8% hydrogen) (HNF-SD-WM-CN-117, *Calculations of Hydrogen Release Rate at Steady State for Double-Shell Tanks*).

A DDT that occurs in the headspace of an SST, DST or AWF tank, or a DDT that occurs in the ventilation system and propagates back to the tank headspace is assigned to the "extremely unlikely" category for the purpose of presenting consequences of detonation cases. This assignment is based on several factors including the following:

- Headspace deflagrations are conservatively assigned to the "anticipated" category even though operating experience shows no reported deflagrations in over 7,000 tank years of operating history.

- DDT requires the presence of a "sensitive" flammable gas mixture, which requires a particularly large GRE. That is a GRE much larger than observed, even for Tank 241-SY-101 before the mitigation pump was installed. Such a large GRE and ignition would be more appropriately assigned to the "unlikely" category.

- The geometries of the tank dome space and ventilation system are such that, given a deflagration in a sensitive mixture, DDT is appropriately assigned to the DDT result class of "DDT may occur" rather than "DDT is likely" or "DDT is highly likely." (DDT result classes are described in NUREG/CR-4803, *The Possibility of Local Detonations During Degraded Core Accidents in the Bellefonte Nuclear Power Plant*.)

Structural response to a burn and the tank failure mode are also important phenomena in determining the consequences of a flammable gas accident. As indicated in the accident phenomena discussion of tank failure modes, the collapse of the entire tank dome into the waste is considered to be "unlikely" given a burn that is large enough to damage tank structures. SSTs are expected to crack and relieve the pressure; whereas, DST are expected to blowout the dome with debris falling into the waste. Therefore a deflagration that results in the collapse of the entire dome into the waste is assigned a frequency one category lower than for the ignition event.

DCRTs. Consequences for deflagrations in a DCRT are calculated for a waste mixture of 95% SST liquids and 5% SST solids with an 18.3-L source term. This source term results in a calculated radiological consequence of 4.4 Sv (4.4×10^2 rem) onsite and 3.8×10^{-3} Sv (3.8×10^{-1} rem) offsite (WHC-SD-WM-TI-753).

3.4.2.2.4 Flammable Gas Controls. The full set of flammable gas controls that applies to all affected facilities is detailed and lengthy. This section does not repeat or paraphrase each individual control. Instead, the basic concepts of the overall control strategy are presented. Consult Appendix K, , and HNF-3737 (for Tank 241-SY-101) to gain a working understanding of the bases for control derivation. Consult HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, to understand the detailed implementation of the controls and how these controls are applied to the full range of applicable facilities and structures.

The Appendix K control strategy is constructed around three factors affecting the nature and extent of postulated flammable gas hazards: (1) waste behavior, (2) operational activities being performed, and (3) location within a given TWRS waste receptacle where activities are being performed. More specifically, the factors are as follows:

- Type of waste behavior known or postulated to be possible for a given facility:

  - Steady-state gas release
  - "Large" GRE
  - "Small" GRE
  - Spontaneous GRE
  - Induced GRE.

  A large GRE is defined to be capable of pressurizing the dome space above atmospheric such that flammable gases may occupy pits and flow out of open risers and other spaces external to the dome space.

- The impact of tank farm operational activities on the waste contained in a facility or structure:

  - Nonwaste-disturbing activities

  - Locally waste-disturbing activities, including such work as grab sampling, which are not considered to be capable of affecting significant portions of the waste

  - Globally waste-disturbing activities such as salt well pumping, which more aggressively affect a larger fraction of the waste.

- The location or region within a waste receptacle where work activities are being performed:

  - Waste intrusive locations are those below the waste surface and within the vapor spaces of waste-intruding equipment where undiluted waste gas may accumulate.

  - Dome intrusive locations are those between the top of the risers and the waste surface, including ventilation systems up to the first mixing point.

  - Ex-tank intrusive locations are those outside tank openings directly connected to the dome space. This region also includes boundaries of greenhouses, as described in Appendix K.

  - Nonintrusive locations.

These three factors are used to specify the aspects of the three-pronged approach to flammable gas risk management (i.e., ventilation, monitoring, and ignition control) required across the range of TWRS facilities and operational activities. Controls differ from facility to facility or from activity to activity in a given facility depending on each factor.

Appendix K refers to two sets of ignition source controls that are each invoked depending on the facility and the type of activity performed in the facility. The ignition source controls address electrical equipment requirements, nonelectrical equipment and materials requirements, and work practices. Set 1 primarily applies to activities and locations that involve direct contact with waste and undiluted waste gases. Set 2 primarily applies to circumstances where flammable gas conditions may be postulated to occur in the dome space or ex-tank locations. To ensure consistent application and interpretation of industry standards used by these control sets, the Flammable Gas Equipment Advisory Board was formed to oversee implementation of the ignition source controls.

This three-pronged control strategy (ventilation, monitoring, and ignition source control) has been judged to be a practical means for preventing the accumulation of flammable gases where ignition sources may be present or to eliminate ignition sources where flammable gases may be present. The control strategy is summarized below.

Summary of Safety-Class SSCs and TSR Controls. Tables 3.4.2.2-1 and 3.4.2.2-2 list the Safety-Class and Safety-Significant SSCs and the TSR controls selected to lower the frequency of a flammable gas burn in TWRS waste-containing vessels. For each safety SSC and TSR control, the safety function is described and additional comments are provided as appropriate. The safety SSCs and TSR controls include the necessary and prudent controls required for (1) the specific accident analyzed; (2) burns in other enclosures along waste transfer routes (i.e., in other process pits, diversion boxes, vault pits, COBs, and encasement risers); and (3) other identified hazardous conditions that are represented by the analyzed accident. Because the consequences of the analysis have considerable uncertainty associated with them, equipment selected is given a designation of Safety-Class.

- **Safety SSCs**—The safety SSCs for the prevention or mitigation of deflagrations in TWRS facilities and represented hazardous conditions are summarized in Table 3.4.2.2-1. To prevent the buildup of flammable gases from steady-state releases, the ventilation system on tanks must be operable and operating. Thus, the ventilation systems on SSTs, DSTs (including AWF tanks), and DCRTs are designated Safety-Class.

  The annulus leak detection system is designated as Safety-Class. This will ensure that the system is available to detect and alarm the presence of waste in the annuli of DSTs or AWF tanks.

  Additional safety SSCs for Tank 241-SY-101 are summarized in HNF-3737.

For safety SSCs that require electrical power (i.e., SST, DST [including AWF], and DCRT ventilation systems and primary tank leak detection systems), a supporting SSC, the tank farm electrical distribution system, is required to ensure that the chosen safety SSCs have electrical power to perform their intended safety functions. In addition, the compressed air system is a supporting system for several safety SSCs (i.e., DCRT ventilation systems (except 244-CR TK-003), 244-AR TK-002 vault ventilation system, and tank level detection systems that use dip tubes).

- **TSR Controls**—The TSR controls for the prevention or mitigation of deflagrations in TWRS facilities and represented hazardous conditions summarized in Table 3.4.2.2-2 are primarily those required to ensure the operability of the Safety-Class and Safety-Significant SSCs; i.e., operability of the following:

  - SST ventilation systems
  - DST and AWF primary tank ventilation systems
  - DST and AWF annulus leak detection systems
  - DCRT primary tank ventilation systems.

  In addition, there are administrative controls to address the following items:

  - Prevent ignition sources, including monitoring of work activities and stop work controls.

  - Ensure that waste transfers do not create a flammable gas generation rate outside the assumptions of the analysis performed to establish ventilation performance requirements.

  - Prevent a flammable gas deflagration in catch tanks that is caused by generation of flammable gas in waste present in the catch tank because of leaks during waste transfers.

  - Identify MISFs and prevent flammable gas deflagrations in those facilities.

  - Ensure that the TWRS Emergency Preparedness Program includes specific emergency plans and procedures addressing required actions for possible flammable gas fires and explosions.

  - Prevent inadvertent intrusion into any structure potentially containing flammable gas.

  - Address Tank 241-SY-101 flammable gas hazards (See HNF-3737).

Defense-in-Depth. Running the available active ventilation systems can reduce the time at risk (i.e., the time that the gas concentrations exceed 100% of the LFL) following a large GRE (one that can cause the well-mixed dome space to exceed the LFL). The installed permanent gas

monitoring systems provide Defense-in-Depth protection for the public and workers against the risk of a flammable gas burn in the tanks judged to be most likely to experience a large spontaneous GRE. Leak detectors, material balances, and tank level monitoring measure leaked material that may create a flammable gas hazard. Flushing transfer lines after use reduces waste material in transfer lines to limit the production of flammable gases.

A portable exhauster will be used as a Defense-In-Depth measure for all tanks to be salt well pumped except Tanks 241-T-104 and 241-T-110 and the SX Farm tanks (if the tanks are actively ventilated). The portable exhauster is capable of being deployed to a tank if the flammable gas concentration exceeds 25 % of the LFL and it is determined that the exhauster could be beneficial to reduce the time at risk versus allowing passive ventilation to dilute the headspace below 25% of the LFL (Kinzer 1999). Use of a portable exhauster is an additional measure of conservatism that is not required as a result of analyzed consequences but is directed by RL (Wagoner 1998c). The portable exhauster is designed to provide a flow rate equal to or greater than 5,663 L/min. (200 scfm) and meets Ignition Control Set 2 and all environmental and regulatory requirements. The Defense-in-Depth measures are summarized in Table 3.4.2.2-3.

3.4.2.2.5 Accident Scenarios. Accident scenarios are developed for a number of situations so that frequency/consequence pairings can be estimated for comparison with risk guidelines. Although judged to be conservative because of technical uncertainties regarding flammable gas behavior, ignition source probabilities, combustion phenomena, and facility failure modes, these scenario results are not considered to represent final evaluation basis events. Because of the large uncertainties, bounding all of the uncertainties on the conservative side results in accident frequency/consequence pairings that can greatly exceed guideline values. Such conservative frequency/consequence pairings do not reflect the observation that in over 7,000 tank years of operation, no gas deflagration has been reported.

Definition of Possible Scenarios. The following analysis develops representative cases of deflagrations in TWRS facilities. Several scenarios are developed to provide estimates of accident frequencies and consequences. The scenarios address a slow accumulation of gases in a waste-containing vessel resulting from inadequate ventilation. This situation is representative of the hazard posed by a chronically low ventilation flow or a long-term ventilation outage leading to high flammable gas concentrations from chronic gas releases. Several cases are described for unique gas generation situations and vessel configurations. The analysis of this scenario leads to the definition of quantified ventilation requirements for TWRS facilities. Slow accumulation to flammable conditions may also occur when waste leaks or is inadvertently transferred to a vessel where ventilation flow is inadequate to dilute the generated gases.

A scenario is developed where waste leaks to a DST annulus. In this DST annulus scenario, waste leaks through the primary tank and accumulates in the annulus. In doing so, ventilation flow is cut off because ventilation air must flow through small channels that run under the primary tank. The small channels can be plugged by the leaked waste. Ignition and deflagration occur within the annulus and cause damage to the tank and confinement system. Other scenarios include waste leaking to a transfer pit that is sealed by cover blocks. The consequences for this scenario are represented by a fire in a contaminated area as described in

Section 3.3.2.4.3, "Fire in Contaminated Area." Leaks to catch tanks may also lead to a deflagration if ventilation is inadequate and an ignition source is present.

A second scenario represents situations where gas is retained within the waste and released relatively rapidly in a GRE. The released gases mix with the air in the tank headspace and ignition and burning occur within the tank headspace and above the waste surface.

A third scenario evaluates subsurface deflagrations involving the gases retained within the wastes.

A fourth scenario evaluates situations were gases accumulate in the vapor spaces of equipment inserted within the waste (e.g., sample drill pipe) where dilution of gases is limited, and the burns occur in geometries that are susceptible to detonations.

A final scenario evaluates situations where gases accumulate in waste transfer lines. Ignition causes a DDT in the long, narrow pipe.

Analysis Methodology. Accident frequencies are estimated on an order of magnitude basis by estimating the frequency that ignition sources are present when flammable conditions exist. Accident frequencies are further adjusted to account for unlikely but more severe combustion and structural response phenomena such as flame acceleration, DDT, and dome collapse.

Consequences for deflagrations in the larger underground storage tanks are calculated parametrically for a range of possible flammable gas quantities, combustion phenomena, tank failure modes, and waste entrainment phenomena.

The presentation of accident analysis results (assuming no controls) serves to illustrate the need for control strategies to manage the risk of flammable gas hazards in TWRS facilities and to emphasize the rigor at which controls need to be applied.

Inadequate Ventilation Leads to a Deflagration in the Headspace. Both headspace gas concentration measurements and predictions show that gas generation alone does not create a flammable gas hazard if ventilation is adequate. In the majority of tanks, passive natural convective ventilation provides enough dilution for the gases generated in the waste. In some tanks, however, the gas generation rate is high enough that active mechanical ventilation is required to prevent flammable gas buildup. Degradation of ventilation can result in the slow buildup of gas concentrations in the tank headspaces.

- **Single-Shell Tanks**—Based on gas generation rates reported in HNF-SD-WM-CN-116, 10 of the SSTs could reach LFL conditions if the ventilation currently being provided to these tanks (eight are actively ventilated and two are passively ventilated) were reduced to only that provided by barometric breathing. Reducing venting below barometric breathing is not considered to be credible because the tanks are not sealed vessels. The time until LFL conditions are reached

for these 10 SSTs is included in Table 3.4.2.2-4. The appropriate hydrogen concentration in the gas mixture when LFL conditions are reached for the steady-state accumulation transient is 3.7% H_2 (HNF-SD-WM-CN-116). This hydrogen concentration at the LFL differs from that used to assess flammability following a GRE (2.5% H_2) based on differences in the gas composition present in the dome space from steady-state releases and GREs. The flammable gas accumulation transient for three representative SSTs is shown in Figure 3.4.2.2-3. Of the 149 SSTs, 132 never reach 25% of the LFL (represented by Tank 241-B-101), 17 can exceed 25% of the LFL but not 100% of the LFL (represented by Tank 241-A-103), and the SST with the fastest accumulation rate (Tank 241-SX-108) requires approximately 200 days under degraded ventilation to attain the LFL for downward propagation (hydrogen concentration in this mixture of approximately 7.4% H_2 or about 200% of the LFL). The maximum concentration reached is 11% hydrogen. Transition to detonation has not been observed in tests involving mixtures at this low concentration.

- **Double-Shell Tanks**—The flammable gas accumulation transient for the worst-case DST is shown in Figure 3.4.2.2-4. For this transient, which is based on gas generation rates for current tank contents reported in HNF-SD-WM-CN-117, a loss of active ventilation can result in an accumulation of flammable gases to LFL conditions in 32 days for Tank 241-SY-101. The next shortest time to LFL is calculated to be 50 days for Tank 241-AN-107. Twenty-one of the 28 DSTs, based on current contents, cannot not attain LFL conditions. Tank 241-SY-101 can reach the LFL for downward propagation (approximately 7.4% H_2 in this mixture) in approximately 70 days and can reach a concentration of over 20% hydrogen in about 1 yr.

- **Accident Frequencies Without Controls**—Accident frequencies have not been calculated for this scenario. If no ventilation were provided to these tanks, a deflagration would be anticipated. Ventilation is provided to the tanks; therefore, the frequencies are most strongly affected by the probability that a loss of ventilation extends sufficiently long to allow gases to accumulate to flammable concentrations. A loss of ventilation is unlikely to result in a total loss of flow because the tanks are not sealed. At a minimum, atmospheric breathing will cause air exchanges between the tank headspace and the atmosphere. As summarized in Table 3.4.2.2-4, the estimated transient time to reach the LFL and 200% of the LFL is quite long. The frequency for a situation where ventilation is lost for this length of time is not dominated by routine equipment failures or human errors. Rather, it would appear that a catastrophic failure initiator would need to occur (e.g., a large seismic event), and even then, there would be considerable time to take action to restore ventilation flow. Based on the assumption that no ventilation would be provided in the "without controls" scenario, the accident frequency without controls is assigned to the "anticipated" category.

The frequency for a deflagration that could result in the collapse of the entire dome is assigned a frequency class of "unlikely." The frequency of a deflagration that could transition to detonation is assigned a frequency class of "beyond extremely unlikely" because the loss of ventilation does not result in concentrations high enough to support DDT for nearly all tanks.

Accident Consequences. The gases in the tank headspace will be well mixed during this long-term loss of ventilation transient. In addition, the headspace will be quiescent because the ventilation will not be running. If ignition occurs when the concentration just exceeds the LFL (for upward propagation), combustion completeness would be very low, developed pressures would be very low, and source terms would be very small (less than the low-end values presented in Section 3.4.2.2.3, "Parametric Studies of Flammable Gas Deflagrations"). If the gas accumulation transient continues until concentrations exceed the LFL for downward propagation and ignition occurs, combustion pressures would approach the AICC pressure or about 4 to 5 atm gauge (405 to 507 kPa gauge [58.8 to 73.5 lb/in.^{2} gauge]). The headspace deflagration cases presented in Section 3.4.2.2.3 would apply. The SST deflagration cases with dome cracking would be appropriate, and the dome blowout case (10 m/s flame speed) would be applicable for DSTs and AWF tanks. Consequences are shown in Table 3.4.2.2-5. To convert material releases to radiological consequences, ULD values for SST solids are used for deflagrations in SSTs and ULD values for DST and AWF tank liquids are used for deflagrations in DST and AWF tanks, respectively. The source term material releases in DSTs and AWF tanks are the same, but the radiological consequences differ because of differences in the ULDs (see Table 3.4.1-9). AWF tank consequences are a factor of 4.4 less than the consequences for a DST.

Toxicological consequences as calculated by the methodology described in Section 3.4.1.2, are based on peak averaged concentrations and depend on the assigned accident frequency class. Toxicological consequences were calculated for the headspace deflagration cases by averaging the release over 200 s as indicated in WHC-SD-WM-TI-753. Consequences for the loss of ventilation scenario without controls are shown in Table 3.4.2.2-5 assuming a frequency assignment of "anticipated." Toxicological consequences are based on sum-of-fractions of risk guidelines for a unit release of chemical and gases for SST solids and DST and AWF liquids (see Table 3.4.1-13). Toxicological consequences for DSTs and AWF tanks are the same because the material releases are the same, and the sum-of-fraction of risk guidelines for a unit release is the same for the two sets of tanks.

- **Accident Scenario With Controls**—Controls are provided to maintain adequate ventilation such that flammable conditions do not develop. If ventilation fails, gas monitoring is initiated; and if concentrations exceed 25% of the LFL, the potential for ignition sources is minimized by deenergizing equipment and stopping operations and activities in the facility. Safety SSCs and TSR controls thus prevent a flammable condition from developing and prevent ignition sources if ventilation is lost for an extended period of time. With controls, the accident is prevented. Because the analysis is based on current tank contents, however, prevention credits an Administrative Control program that evaluates gas generation rates and reevaluates ventilation system performance requirements before initiating significant changes in

key parameters that affect gas generation rates (i.e., waste temperature, waste volume, organic complexant concentrations, decay heat load). Accident frequencies and consequences assuming the failure of controls are described in Section 3.4.3.

Double-Contained Receiver Tank Deflagration. Flammable gases are introduced into the headspace of a DCRT by several processes: (1) gases in solution are transferred with SST waste and can be released to the headspace because of the increased mass transfer provided by the tank filling operation; (2) gases are produced in the tank during storage by radiolysis and organic decomposition; and (3) gases can be produced by chemical adjustment of the SST waste before transfer into a DST.

The gas evolution rate during the filling and storage phases of DCRT operation have been analyzed to determine the ventilation requirements for these facilities (HNF-SD-WM-CN-118, *Calculation of Flammable Gas Mixtures in Double-Contained Receiver Tanks*). This documents the analysis of the filling of each DCRT (244-BX, 244-S, 244-TX and 244-U) from the SSTs that will be salt well pumped through their respective DCRTs. Filling from only a single tank was analyzed (i.e., filling the DCRT from multiple tanks simultaneously has not been analyzed to date).

Soluble gases transported to and released in the DCRT included ammonia, hydrogen, and methane. In addition, hydrogen generation in the DCRT was considered to be caused by radiolysis, thermal degradation of organic chemicals, and corrosion of the tank. The DCRT was assumed to be filled to 80% of its volume at a rate of 15.1 L/min (4 gal/min). The analysis indicated that DCRT headspace concentrations can vary significantly depending on the waste transfer. Some waste transfers produce negligible concentrations; whereas, others may produce concentrations that exceed 25% of the LFL.

The analysis concluded that 1.4 L/min (3 ft^3/h) of ventilation flow is adequate to maintain the DCRT headspace gas concentrations below 25% of the LFL during salt well pumping of all SSTs (one at a time in any single DCRT) with the exception of Tanks 241-SX-101, 241-SX-103, 241-SX-105, and 241-U-106. None of the analyzed transfers caused concentrations that exceeded the LFL. More data is required before Tank 241-SX-101 can be evaluated adequately. Additional controls or operational restrictions can result in calculated gas concentrations remaining below 25% of the LFL for Tanks 241-SX-103, 241-SX-105, 241-T-104, and 241-U-106. These controls can include one or more of the following: (1) limit the DCRT fill level to less than 50%, (2) limit pumping rate to less than 7.6 L/min (2 gal/min), or (3) provide ventilation at a rate of at least 2.3 L/min (5 ft^3/h).

If ventilation is lost and the transfer of waste into the DCRT continues or a large volume of waste is stored in the DCRT, gas concentration may exceed the LFL. The most severe case analyzed (transfer liquids from 241-SX-105 through 244-S DCRT) resulted in the LFL being exceeded after 308 h without ventilation flow; 200% of the LFL is exceeded after 902 h. The maximum achievable concentration is 750% of the LFL (HNF-SD-WM-CN-118).

WHC-SD-WM-RPT-048, *Safety Study of Interim Stabilization of Non-Watchlist Single-Shell Tanks*, studies hydrogen accumulation in DCRTs as part of a larger study on interim stabilization of non-watch list tanks. Evaluation of this event concluded that the primary receiver vessel would be the most likely location for hydrogen to accumulate because this is the place that the hydrogen is generated. It was determined that no design provisions were made to provide filtered air flow through the primary receiver vessel from the ventilation system. The ventilation flow provided by the vault ventilation system is therefore unquantified. Measurable ventilation flow is limited to the instrument air provided by the waste level measurement dip-tube system (typically 1.4 to 2.1 L/min [3 to 4.5 ft^3/h] total flow, although flow can be increased if needed).

WHC-SD-WM-RPT-048 also concludes that potential ignition sources existed within the primary receiver vessel and that deflagrations or detonations were credible given this condition. Installed equipment in the DCRT, ventilation system, or natural phenomena (e.g., earthquake or lightning) provide an ignition source and combustion occurs.

- **Accident Frequency Without Controls**—A frequency of deflagration in a DCRT without controls has been calculated (WHC-SD-WM-RPT-048) to be in the range of 10^{-2} to 10^{0}/yr ("anticipated" category).

- **Accident Consequences**—Radiological consequences for a DCRT deflagration are described in Section 3.4.2.2.3. Toxicological consequences are calculated based on the same material release (18.3 L) averaged over 200 s as indicated in WHC-SD-WM-TI-753. Consequences without controls are included in Table 3.4.2.2-5 assuming an assigned frequency category of "anticipated."

- **Accident Scenario With Controls**—Controls are provided to maintain adequate ventilation such that flammable conditions do not develop. If ventilation fails, gas monitoring is initiated; and if concentrations exceed 25% of the LFL, the potential for ignition sources is minimized by deenergizing equipment and stopping operations and activities in the facility. Safety SSCs and TSR controls thus prevent flammable conditions from developing, preventing the accident. Prevention also credits an administrative control program that evaluates gas generation rates and reevaluates ventilation system performance requirements before initiating transfers to these facilities. Key elements of this program include an evaluation of waste gas generation rate to assess the potential flammable gas concentrations in the headspace from steady-state generation, released soluble gases, and gases (like ammonia) generated during chemical addition. The evaluation must consider the effects of transferring more than one tank at a time into a DCRT if this type of operation is planned.

Deflagration in the Double-Shell Tank Annulus. Waste may enter the annulus in two ways: a leak of the primary tank or a mistransfer into the annulus. If enough waste is introduced (46,000 L [12,152 gal]) the waste will fill the annulus to a depth of 20.3 cm (8 in.), enough to cover the channels, and the annulus ventilation system will fail. The failure will occur because the annulus ventilation air is supplied from the bottom center of the secondary tank. The air proceeds through channels in the refractory concrete pad that separates the primary tank from the

secondary tank. (Note: AWF tanks have an air inlet at mid-tank in the annulus in addition to the inlet in the bottom center.) The air is then exhausted from the annulus by the annulus ventilation system. If enough waste enters the annulus, it will plug the inlets and prevent the annulus from being ventilated. (Note: The supplied air is not forced through the channels, but is only drawn through them because of the annulus ventilation system.) This may lead to the buildup of flammable gases in the annulus. Installed equipment in the annulus or annulus ventilation system, activities being conducted in the annulus, human errors, or natural phenomena (e.g., earthquake or lightning) provide ignition sources that can cause a deflagration to occur.

- **Accident Frequency Without Controls**—The frequency of deflagration without controls in the annulus is in the range of 10^{-4} to 10^{-2}/yr (WHC-SD-WM-TI-753).

- **Accident Consequences**—As described in Section 3.4.2.2.2, the source term for a deflagration in a DST annulus is similar to that for a deflagration in the primary tank dome space. Consequences without controls are calculated assuming an assigned frequency of "unlikely" and reported in Table 3.4.2.2-5.

- **Accident Scenario With Controls**—The annulus leak detection system is credited with detecting and alarming the presence of waste in the annuli of DSTs or AWF tanks. This will allow actions to prevent the accumulation of flammable gases in the annulus. Thus, with controls this accident can be prevented.

GRE Leads to a Deflagration in the Headspace. Phenomena leading to flammable conditions resulting from a GRE are described in Section 3.4.2.2.2, including estimated frequencies for GREs that are sufficiently large to threaten tank structural integrity. In addition, an accident requires an ignition source to be present where and when the flammable condition exists.

- **Accident Frequency Without Controls**—Accident frequencies for deflagrations following a GRE are estimated in WHC-SD-WM-CN-041, *Tank Farm Deflagration Rates due to Various Ignition Sources*. The methodology considers ignition sources from various tank farm equipment, operations, and activities, including faulted and upset conditions. Natural phenomena (e.g., lightning, seismic events, and range fires) were also included. Unmitigated cases assume a large number of activities performed on each tank each year and that equipment used is normal, commercial, off-the-shelf equipment not designed to be used in a flammable environment.

  Accident frequencies were estimated by combining GRE frequencies with the probability that an ignition source will be present when a flammable condition exists. GRE frequencies are based on "intrinsic" releases and seismically induced releases. The GRE frequency and portion of time that a hazard exists, used in the accident frequency calculations, include and are dominated by the seismically induced releases. In addition, the accident frequencies calculated in WHC-SD-WM-CN-041 include the assumption that GREs of concern (hundreds of cubic meters) could be caused by waste-disturbing operations and activities. This assumption is conservative relative

to the observations from experiments and experience with waste-disturbing operations, which indicate that local waste disruptions do not suddenly trigger releases of large volumes (tens of cubic meters) of gas. The accident frequency calculation includes consideration for GREs and ignition sources being independent events as well as for GRE and ignition sources to be combined in common cause events such as a waste-disturbing activity that causes a GRE. The activity also supplies the ignition source.

The order of magnitude estimates for unmitigated (i.e., without controls) deflagration frequencies are shown in Table 3.4.2.2-6. The calculations include estimates for various ignition source categories. Ignition sources resulting from installed equipment relate to the instrumentation and equipment that is permanently installed in a tank. Ignition sources are dominated by high voltage (120 V) electrical equipment such as waste high-level detectors in DSTs and video cameras and lights in a few tanks, or electrostatic spark sources such as fiberglass liquid observation wells and riser sleeves. Low-voltage instrumentation was not a significant contributor to ignition sources.

The most probable ignition sources from normal operations external to the tank are sparks and hot metal from drilling and welding near the tank. These ignition sources could enter the tank through tank openings. Ignition assumptions include the probability that the ignition sources enter the headspace, and the probability that the ignition sources initiate a deflagration outside the tank dome that then propagates back into the dome and causes a headspace deflagration.

Ignition sources resulting from natural phenomena were also considered. These phenomena include large seismic events that could cause equipment to impact other equipment resulting in mechanical sparks and lightning strikes. The deflagration frequency for natural phenomena is dominated by a large seismic event.

The final ignition source category addresses activities that are performed in the tank. The frequency category "anticipated" is assigned to uncontrolled activities performed in the headspace and more notably to waste-disturbing activities that are assumed to have a 0.01 probability of causing a large GRE and a coincident ignition source.

The accident frequencies are considered to be conservative for the following reasons:

- The seismically induced GRE with the failure of active ventilation systems is the most likely to cause flammable gas to be available and ignite. The seismically induced GRE frequencies are considered conservative because attenuation factors were not included (see GRE frequencies).

- The number of activities assumed to be performed on each tank per year is significantly (at least an order of magnitude) higher than actual experience.

- The combined calculated deflagration frequencies result in an estimate of more than one deflagration per year per tank. This is significantly higher than observations where no deflagration has been reported in over 7,000 tank years of service (for SSTs and DSTs).

- **Accident Consequences Without Controls**—Source terms and radiological consequences for several headspace deflagration cases are described in Section 3.4.2.2.3. Radiological consequences for the various cases would be the same as described for the accident scenario where inadequate ventilation leads to a deflagration in the headspace. Given the assigned frequency category of "anticipated" for a deflagration resulting from a GRE, the toxicological consequences would also be the same as for the accident scenario where inadequate ventilation leads to a deflagration in the headspace. The consequences without controls are shown in Table 3.4.2.2-5.

- **Accident Scenario With Controls**—Controls for this accident are targeted at preventing the coincidence of flammable gas and ignition sources. With the exception of Tank 241-SY-101, GRE mitigation controls have not been developed. The mixer pump in Tank 241-SY-101 is credited with mitigating naturally occurring (rollover) GREs. Without the mixer pump, the unmitigated naturally occurring (rollover) GRE is stated as a 296.8-m^3 (10,480-ft^3) release assuming a frequency of approximately 3/yr (LA-UR-92-3196). The mixer pump is not analyzed for mitigation of GREs or deflagrations that may be caused by a seismic event. Without the mixer pump, the GRE induced by a seismic event and resulting deflagration would be similar (in terms of frequency and consequences) to those postulated for other DSTs. The control strategy is to prevent ignition. Controls include equipment modifications to reduce the likelihood of electrical, mechanical, and electrostatic sparks, and administrative controls to manage how and when activities are performed such that ignition sources are not introduced into flammable locations. Controls to reduce the consequences of a deflagration (e.g., limiting tank structural damage or filtering releases) were concluded to not be practical for this accident.

  Detailed controls for managing the risk of the flammable gas hazard and qualitative conclusions regarding the effectiveness of those controls are provided in Appendix K.

- **Accident Frequency With Controls**—Because GREs include fuels and an oxidizer, and can occur spontaneously or be induced by seismic events, flammable conditions cannot be prevented entirely. Ignition source controls are not totally effective, especially considering the human element during staffed work activities and sparks that may be caused by lightning or a large seismic event. Therefore, this accident cannot be prevented. An accident frequency with controls, therefore, is calculated to estimate how effective controls may be in general.

  Calculated accident frequencies with controls from WHC-SD-WM-CN-041 are summarized in Table 3.4.2.2-7. The calculated frequencies with controls are reduced

from those calculated without controls by (1) modifying equipment to reduce ignition potential and (2) implementing administrative controls to reduce the likelihood that ignition sources would be introduced into flammable locations. The accident frequency with controls is dominated by waste-disturbing activities that may cause both a GRE of concern and a coincident ignition source. The probability for an ignition source during these events is dominated by human failure to implement Administrative Controls (e.g., failure to properly bond and ground equipment). The effects of gas monitoring and work stoppage during manned activities is not assessed in these calculations. Of nearly equal likelihood are deflagrations caused by large seismic events for which no controls have been developed. A general conclusion is that deflagration accident frequencies with controls are one category lower than those without controls.

- **Accident Consequences With Controls**—Source terms and radiological consequences are the same as without controls; the controls reduce the accident frequency. Toxicological consequences are reduced because they depend on the assigned accident frequency class. Toxicological consequences for the assigned frequency classes with controls are shown in Table 3.4.2.2-8.

Gas Retention Within the Waste and Ignition That Leads to a Deflagration. A subsurface deflagration can be postulated as caused by the retention mechanisms (i.e., the ignition of a subsurface bubble by an intrusive activity, such as core sampling, or natural phenomena, such as lightning). Nakayama and Vogt (1996) analyze this phenomon and assume that a bubble 1 m in diameter could exist within the waste. The analysis concludes that the pressure pulse from the bubble that ignites will be transmitted by the fluid and that oscillations of the bubble as it expands and contracts will send waves through the waste. Nakayama and Vogt (1996) state: ". . . this may lead to a release of significant volume of the subsurface gas into the headspace." The subsequent ignition of the gases in the headspace and the associated consequences lead to a deflagration in the headspace scenario.

Gas retention, however, is also studied in Gauglitz et al. (1996). The configuration, limiting size, and maximum void fraction of gas bubbles can be predicted with a fair degree of accuracy. While most wastes are capable of retaining gas fractions on the order of 30%, the size of individual bubbles (both round and dendritic) is quite limited (HNF-SP-1193). The analysis in Nakayama and Vogt (1996) does not specifically treat smaller bubbles. While no scale criterion has been developed to determine the effect of bubble size on subsurface deflagration potential, it is clearly impossible to ignite a bubble on a scale comparable with the quenching distance, typically 2 mm or less (WHC-SD-WM-RPT-281, *Deflagration and Detonation Hazards in Hanford Tank Farm Facilities*).

In addition, studies of gas release resulting from seismic events indicate that a large energy input is needed to release significant quantities of gas. It is improbable that the energy released during the combustion of one or several gas bubbles is sufficient to cause a large gas release from the rest of the waste. However, because there are remaining technical uncertainties in this area and because potential consequences can be high, the highest level of control

(Ignition Control Set #1) is applied to equipment that is located in a waste-intrusive region (i.e., below the waste surface).

Gas Retention Within Equipment and Ignition That Leads to a Deflagration or Detonation. On September 28, 1995, an Occurrence Report (RL-WHC-TANKFARM-95-0078, *Vapor Sampling of Core Sampling Drill String Exceed Lower Explosive Limit*) was issued because flammable gas inside the drill string used for push mode core sampling Tank 241-S-107 was in excess of the LFL. Another incident occurred one month later in Tank 241-BY-110. In both incidents, the cause was attributed to encountering gas pockets in the waste, which in turn caused flammable gases to enter and accumulate in the drill string in concentrations that were in excess of the LFL. Flammable gas is known to have accumulated in drill strings in several other tanks.

The frequency and consequences associated with deflagrations or detonation inside of waste-intruding equipment has not been analyzed for the various locations and different equipment applied to this hazard. However, consequences of deflagrations and detonations have been analyzed for core sample drill strings as reported in Appendix J of WHC-SD-WM-SAD-035, *A Safety Assessment of Rotary Mode Core Sampling in Flammable Gas Single Shell Tanks: Hanford Site, Richland, Washington*. This analysis assumed that the bottom of the drill string was pure hydrogen and that the hydrogen would diffuse into the nitrogen purge gas if purge flow were lost.

Based on this hypothetical scenario, the analysis then assumed that this represents a scenario where retained gas (which includes an oxidizer) can accumulate to detonable concentrations. With an ignition source, a deflagration overpressure of 630 kPa (91 lb/in.^{2} gauge) was calculated. If a transition to detonation occurs, an overpressure of about 1,500 kPa (216 lb/in.^{2} gauge) was estimated. Based on the detonation overpressure, the drill string was conservatively assumed to fail. Subsequent to this analysis, testing was performed to determine combustion behavior inside of a drill string and drill string response (HNF-SD-WM-TRP-269, *Report on Ignitability Testing of Flammable Gases in a Core Sampling Drill String*). Stoichiometric mixtures of hydrogen and air were ignited inside 9.1-m- (30-ft-) and 16.8-m- (55-ft-) long sections of standard 5.72-cm- (2.25-in.-) outside diameter drill string. Combustion pressures were measured and ranged from less than 69 to 1,370 kPa gauge (10 to 198 lb/in.^{2} gauge). The drill string did not fail in any test.

The consequences of a burn within the drill string are limited to the release of the material in one core sampler, or 0.39 kg (0.24 L) of waste. The amount of material that may be respirable was not calculated; therefore, the consequences for burns inside of a piece of equipment that can trap relatively undiluted gases is very uncertain. Given the uncertainty in consequences and the fact that flammable conditions have been observed in the field on several occasions, the highest level of control (Ignition Control Set #1) is applied to prevent the accident. See Section 3.4.2.2.6 for a discussion of the activities that are underway to quantify uncertainties and assess the effectiveness of various control options.

Transfer Line Deflagration or Detonation. Flammable gases are introduced into the transfer line during salt well pumping. The flow rate during salt well pumping is very small, typically 0.19 to 19 L/min (0.05 to 5 gal/min). This leaves headspace in the transfer line (i.e., the transfer line is not completely full of liquids). Pumping an SST can take an extended period of time (months to years), and gases can be transferred to the line headspace by several mechanisms. The gases can be transferred in with SST waste, can be produced in the transfer line by radiolysis and organic decomposition, or can enter the transfer line from the DCRT.

The concentration of flammable gases in the transfer lines has never been measured. The analysis documented here assumes that concentrations are reached that allow a deflagration or detonation to occur. There are no known ignition sources in the transfer lines; however, natural phenomena (e.g., an earthquake or lightning) could provide an ignition source. The resulting pressure is 1,462 kPa absolute (211 lb/in.^{2} absolute) (Nakayama and Vogt 1996). If a detonation were to occur in the transfer line, a maximum theoretical pressure of 2.8 MPa (411 lb/in.^{2}) would result (NUREG/CR-2726, *Light Water Reactor Hydrogen Manual*). The burst pressure for Schedule 40, 2-in. pipe is 57.9 MPa (8,400 lb/in.^{2}), and for Schedule 10 S, 2-in. pipe the burst pressure is 51.7 MPa (7,500 lb/in.^{2}). Both the deflagration pressure and the detonation pressure are well within the calculated burst pressures. Valves, jumpers, or other equipment located in the process pits may fail. (See Section 3.4.2.9, "Spray Leak in Structure or From Waste Transfer Lines," for spray leaks and Section 3.4.2.7, "Surface Leak Resulting in Pool," for pool leaks.)

The frequency of a deflagration in a transfer line without controls has not been calculated because of a lack of data regarding flammable gas concentrations inside transfer lines. Because results of a deflagration are limited to spray leaks or surface leaks that are analyzed elsewhere, a detailed frequency analysis for this initiator is not warranted.

The likelihood of developing flammable conditions can be reduced by flushing transfer lines following use to minimize the amount of waste stored in the line, thus minimizing gas generation. In addition, gas concentrations are monitored before initiating manned work activities that could introduce an ignition source in a transfer line.

See Section 3.4.2.2.6 for a discussion of the activities that are underway to quantify uncertainties and assess the effectiveness of various control options.

3.4.2.2.6 Summary. In this section the results of comparing accident case frequency-consequence pairings with risk guidelines are summarized. Conservatism and uncertainties, as well as the plans for resolution of the Flammable Gas Safety Issue, are also summarized.

Comparison With Evaluation Guidelines. Conclusions regarding flammable gas accident consequence comparisons with risk evaluation guidelines, based on the quantitative estimates provided in this section, are not appropriate at this time because of technical uncertainties in flammable gas behavior and accident phenomena that can affect risk estimates significantly. Although there is considerable technical uncertainty regarding accident frequencies and

consequences, the results clearly imply a need to institute controls to prevent or mitigate hazards associated with flammable gas in TWRS facilities. The accident analysis results do not provide a detailed representation of the flammable gas risk posed by waste stored in every waste receptacle. All waste storage tanks and the balance of waste receivers (e.g., catch tanks or transfer systems) do not contain waste in forms and quantities capable of approaching the consequences presented in these analyses.

Summaries of the parametric cases for headspace deflagrations in SSTs, DSTs, AWF tanks, and DCRTs are shown in Figure 3.4.2.2-1, Figure 3.4.2.2-2, and Table 3.4.2.2-5.

Remaining Uncertainties and Their Impact on Risk Estimates. Key technical uncertainties important to estimating flammable gas accident risk remain. Formal sensitivity analysis has not been performed to quantitatively assess the relative importance of each item; however, based on a qualitative review of the above analysis, important parameters include those indicated in the following subsections.

- **Gas Retention and Release**—The specific amount and rate at which retained gas can be released from the waste in each tank (spontaneously or during a waste disturbance, including waste-disturbing operations and seismic events) is still uncertain. This analysis does not attempt to quantify risk from GREs on a tank-specific basis. As indicated, however, the risk may be small for a number of tanks with little retained gas (e.g., tanks with little waste solids inventory, such as Tank 241-SY-103). Risk may also be small for tanks where mechanisms for a large release are unlikely such as in SSTs. Estimates of GRE frequencies are based on a study of a few special tanks that exhibit more severe behavior than most.

- **Flame Acceleration and Transition to Detonation**—The highest consequence case results from assumptions regarding detonations. Uncertainties include the probability that a DDT can occur, but the consequences resulting from a detonation are uncertain because of uncertainties in tank failure modes and waste material suspension phenomena. The frequency with which gas concentrations high enough to support DDT can be attained has not been analyzed, but is assumed to be low. This analysis does not rule out DDT. The analysis assumes a very high aerodynamic entrainment from a detonation based on an extrapolation of an empirical correlation that did not specifically test entrainment during detonations.

- **Tank Failure Modes and Resulting Material Releases**—The collapse of the entire dome into the waste following a deflagration has not been ruled out, but the Delphi Panel (WHC-SD-TWR-RPT-003) concluded it was not a principal failure mode. The dome collapse case for an SST is the only parametric case where calculated radiological consequence values exceed offsite guidelines. This case is judged to be "unlikely" given a deflagration.

- **Dilution and Mixing in Tank Headspaces**—Gas releases observed to date in SSTs and DSTs have not been large enough to cause a well-mixed headspace to exceed the

LFL (with the exception of Tank 241-SY-101 prior to mitigation). Risk in these cases arises from a plume of flammable gas. Several analyses to date indicate that the portion of the release that is flammable at any one time is small, flammable conditions are short lived, pressures resulting from combustion are below those that would fail the tank structure, and thus, consequences are small. However, another analysis indicated that a large fraction of the plume may be flammable and that only a small portion of the retained gas in a number of tanks need be released to cause conditions that could challenge the tank structure if the plume were ignited. In this analysis, however, plume releases are assumed to be a significant contributor to calculated GRE accident frequencies and tank failures.

- **Within-Waste Burns**—The probability (or even possibility) of a within-waste burn to occur and result in significant consequences is uncertain.

- **Consequences of Burns Inside Waste Intruding Equipment**—The consequences of these events are largely unanalyzed. Assuming that a burn, even a detonation, within waste intruding equipment (e.g., a core sampling drill string) could result in the collapse of the entire dome may be bounding but may not be very accurate and represents a large consequence for a flammable condition that has been observed in the field on several occasions.

- **Deflagrations Caused By Seismic Events**—Evaluations of GREs indicate that the frequency of GREs large enough to cause structural damage is likely to be dominated by GREs caused by seismic events. Evaluations of accident frequencies have indicated that the effectiveness of controls to prevent deflagrations may be limited by accidents for which seismic events provide a common cause (flammable gases being present and ignited by sparks resulting from the seismic events). In addition, seismic events can affect more than one facility at a time, providing a scenario for multiple deflagrations simultaneously. Finally, the most severe burn phenomenon (i.e., detonation), requires high concentrations of flammable gases to be present. A large seismic event may be the only credible cause for the very large gas releases required to create such high gas concentrations. Therefore, uncertainties in gas-release behavior, and spark-source probability given a seismic event, have a large impact on the understanding of flammable gas risk.

- **Adequacy of Controls**—Given the technical uncertainties, an accurate quantitative assessment of the effect of controls is not possible at this time. Effective implementation of ventilation controls can prevent accidents resulting from steady-state (chronic) generation of flammable gases. The assessment of the adequacy of controls to reduce the frequency of accidents resulting from GREs is hampered by the uncertainties regarding actual tank GRE behavior as well as the contribution to GRE risk from phenomena that are difficult to control, such as spark sources during manned activities and natural phenomena.

The flammable gas hazard control strategy expeditiously implements achievable and practical controls to manage postulated flammable gas risks. While doing so, progress toward safety issue resolution will continue to concentrate on the remaining uncertainties regarding the quantification of risk and effectiveness of controls.

Appendix K provides a valid, formalized process for selecting controls to minimize the risk of activities where the flammable gas hazard is likely to be present. The control suite represents the best available knowledge on how to practically minimize the hazard of flammable gas presence and minimize any potential for ignition.

Path Forward for Flammable Gas Safety Issue Resolution. The consequence analysis presented in this section indicates that consequences can be severe for certain combustion phenomena (detonations) and tank failure modes (dome collapse or rupture of a DCRT), but might be much less severe for more probable phenomena (deflagrations) and failure modes (dome cracking and venting through soil overburden). Conservative evaluations indicate that deflagration frequencies might be high, although operating history indicates that the frequency is much lower than the assigned frequencies in this section. However, these evaluations indicate that accidents resulting from GREs cannot be prevented because ignition source controls cannot be assured to be absolute in preventing sparks. Controls for large seismic event scenarios that are a common cause for flammable conditions and coincidental sparks have not been identified. Within the resolution possible in this analysis, the risk calculated for bounding events cannot quantitatively be shown to be within risk guidelines. Refined methods to quantify accident frequencies and consequences are needed to provide an accurate estimate of flammable gas risk. In particular, the uncertainties that are key to risk estimates need to be quantified, and the impact of additional control measures (e.g., control of gas retention and GRE behavior) needs to be quantified so that final decisions regarding controls and risk acceptability can be made.

A strategy for resolution of the Flammable Gas Safety Issue for SSTs and DSTs has been developed (Payne 1999). A flammable gas accident analysis model will be developed to provide quantification of the technical uncertainty of the risk associated with flammable gas hazards. This analysis model will use waste-type tank groupings and data sets instead of the facility groupings used in the current approach. The model will be used to complete a refined safety analysis that will include an evaluation to ensure that the controls are consistent with the flammable gas hazard. The overall objective is to optimize control strategies for continued safe operation of TWRS. The strategy for resolution of the Flammable Gas USQ that remains open for other TWRS ancillary facilities includes obtaining flammable gas sampling data and performing additional engineering and safety analyses to provide a basis for assessing, and potentially revising, the existing control strategies.

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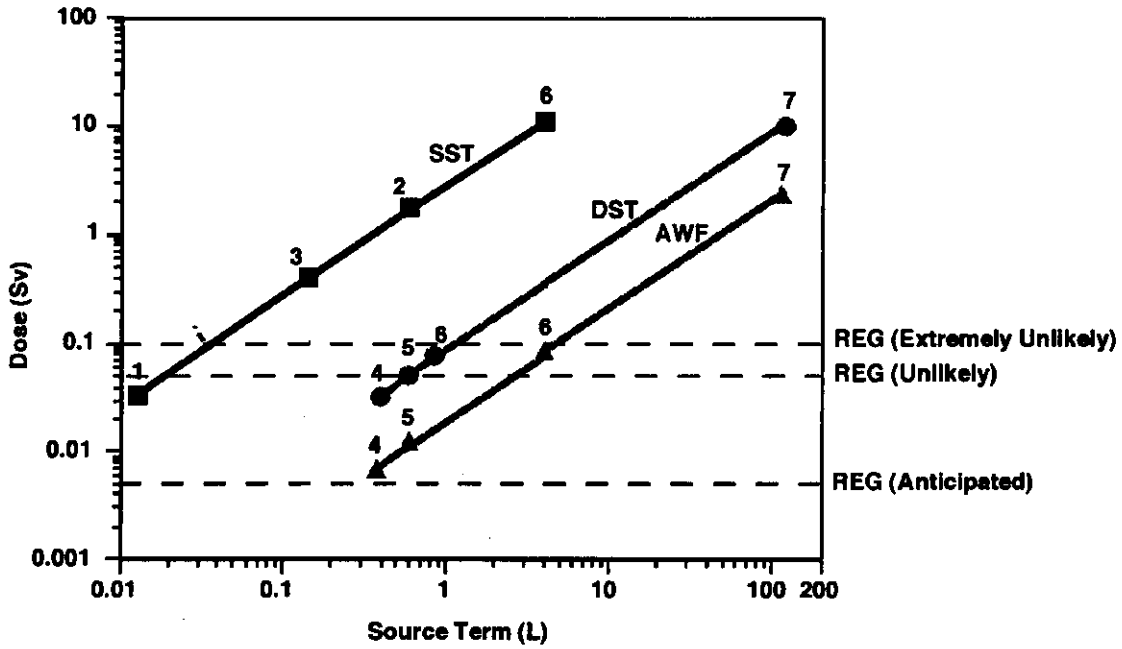
Figure 3.4.2.2-1. Results of Parametric Dose Consequence Analysis for Single-Shell Tanks, Double-Shell Tanks, and Aging Waste Facility Tanks—Headspace Deflagrations (Onsite Receptor).



Case 1: Deflagration - Cracked dome in an SST (Delphi Panel - mechanistic estimate).
Case 2: Deflagration - Cracked dome in an SST (Delphi Panel - upper estimate).
Case 3: Deflagration (10 m/s flame speed) - No dome cracking or filtering through soil overburden in an SST.
Case 4: Deflagration in a DST/AWF tank - No tank damage.
Case 5: Deflagration - Dome blowout in a DST/AWF tank (Delphi Panel - upper estimate).
Case 6: Dome collapse in an SST, DST or AWF tank.
Case 7: Detonation - Dome blowout in a DST/AWF tank.

AWF = Aging Waste Facility.
DST = double-shell tank.
REG = risk evaluation guideline.
SST = single-shell tank.

To convert Sv to rem, multiply by 100.

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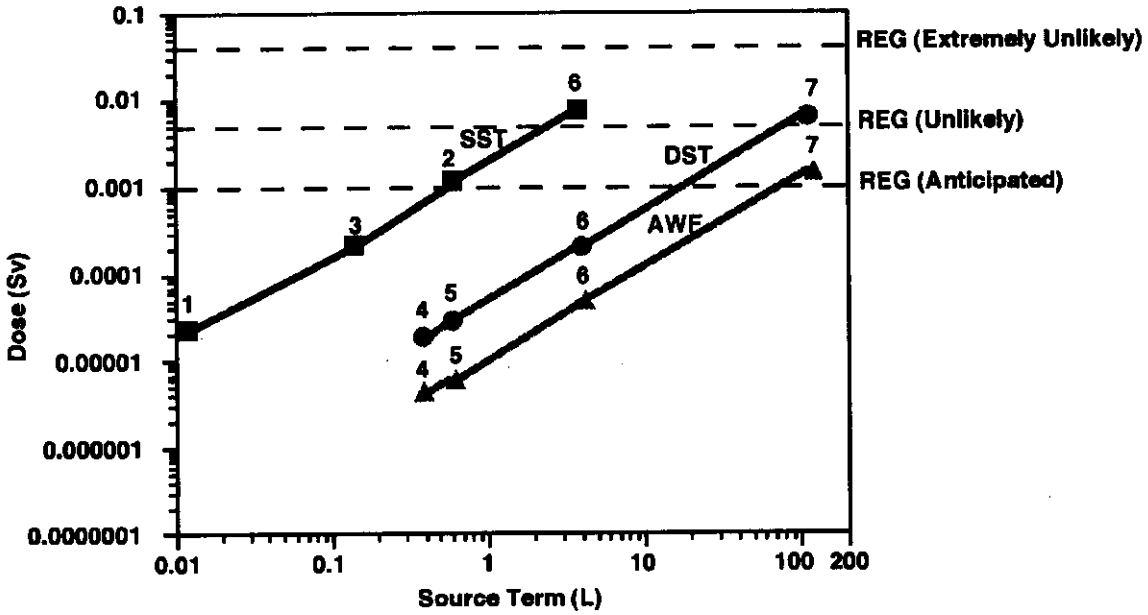
Figure 3.4.2.2-2. Results of Parametric Dose Consequence Analysis for Single-Shell Tanks, Double-Shell Tanks, and Aging Waste Facility Tanks—Headspace Deflagrations (Offsite Receptor).



Case 1: Deflagration - Cracked dome in an SST (Delphi Panel - mechanistic estimate).
Case 2: Deflagration - Cracked dome in an SST (Delphi Panel - upper estimate).
Case 3: Deflagration (10 m/s flame speed) - No dome cracking or filtering through soil overburden in an SST.
Case 4: Deflagration in a DST/AWF tank - No tank damage.
Case 5: Deflagration - Dome blowout in a DST/AWF tank (Delphi Panel - upper estimate).
Case 6: Dome collapse in an SST, DST or AWF tank.
Case 7: Detonation - Dome blowout in a DST/AWF tank.

AWF = Aging Waste Facility.
DST = double-shell tank.
REG = risk evaluation guideline.
SST = single-shell tank.

To convert Sv to rem, multiply by 100.

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Figure 3.4.2.2-3. Loss of Ventilation—Gas Accumulation Transient in Single-Shell Tanks.

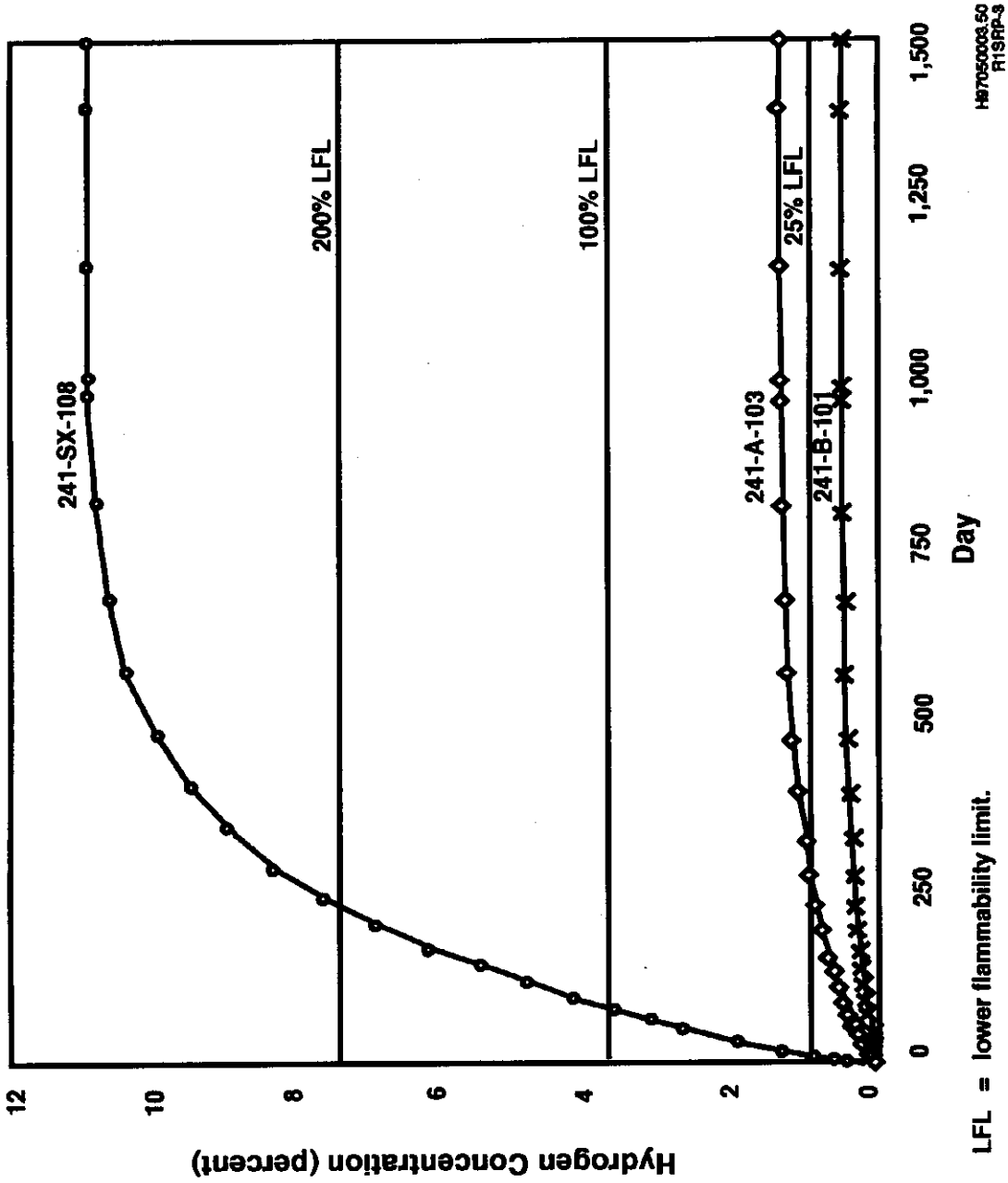
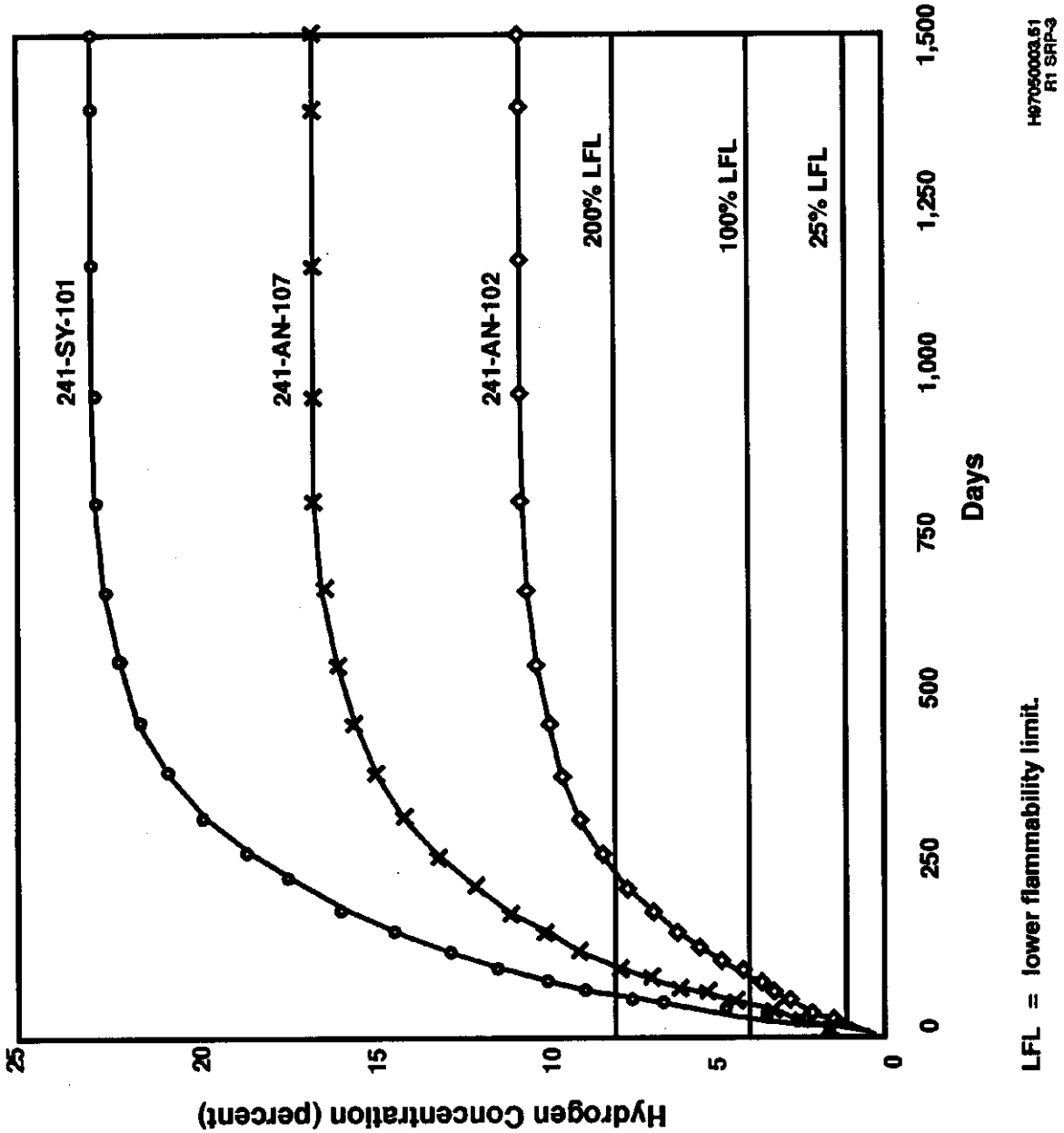


Figure 3.4.2.2-4. Loss of Ventilation—Gas Accumulation Transient in Double-Shell Tanks and Aging Waste Facility Tanks.



LFL = lower flammability limit.

Table 3.4.2.2-1. Summary of Safety Structures, Systems, and Components for Flammable Gas Deflagrations. (2 sheets)

Structures, systems, and components	Safety classification	Safety function	Comments
Waste tanks	Safety-Class	The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during a tank overpressurization event, thus decreasing the consequences of the Flammable Gas Deflagrations accident.	Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.
Double-shell and aging waste facility primary tank ventilation systems	Safety-Class	The safety functions of the DST and AWF primary tank ventilation systems are to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	--
Single-shell tank ventilation systems	Safety-Class	The safety function of the SST active and passive ventilation systems is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	--
Double-contained receiver tank ventilation systems	Safety-Class	The safety functions of the DCRT ventilation systems are to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	
244-AR TK-002 ventilation system	Safety-Class	The safety function of the 244-AR tank TK-002 ventilation system is to prevent the accumulation of flammable gases due to steady-state releases thus decreasing the frequency of the Flammable Gas Deflagrations accident.	--
244-CR TK-003 ventilation system	Safety-Class	The safety function of the 244-CR TK-003 ventilation system is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	--

Table 3.4.2.2-1. Summary of Safety Structures, Systems, and Components for Flammable Gas Deflagrations. (2 sheets)

Structures, systems, and components	Safety classification	Safety function	Comments
Primary tank leak detection systems	Safety-Class	The safety function of the primary tank leak detection systems is to provide an alarm of tank waste from misroutes or other system leaks into the tank annulus to alert operators to take action to prevent a flammable gas deflagration in the DST or AWF tank annulus, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	--
Additional safety SSCs for Tank 241-SY-101 remediation activities and operations	--	--	See HNF-3737 for additional controls that have been identified for remediation activities and operations associated with Tank 241-SY-101.

HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Actions and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

LA-UR-92-3196, 1996, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, Rev. 14a, Los Alamos National Laboratory, Los Alamos, New Mexico.

AWF = aging waste facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air.
SSC = structure, system, and component.
SST = single-shell tank.

Table 3.4.2.2-2. Summary of Technical Safety Requirement Controls for the Flammable Gas Deflagrations Accident. (3 sheets)

Control	Safety function	Comments
DST and AWF tank ventilation systems	Ensures operability of the active ventilation system to prevent the accumulation of flammable gases due to steady-state releases.	--
SST ventilation systems - active	Ensures operability of the active ventilation system to prevent the accumulation of flammable gases due to steady-state releases.	--
SST ventilation systems - passive	Ensures the HEPA breather filter isolation valve is open and no blank installed to prevent the accumulation of flammable gases due to steady-state releases.	--
DCRT ventilation systems*	Ensures the inlet air supply is greater than or equal to 3 ft^3/h to prevent the accumulation of flammable gases due to steady-state releases and releases caused by the addition of chemicals to the single-shell tank waste in preparation for transfer to the double-shell tanks.	--
244-AR TK-002 ventilation system	Ensures the inlet air supply is greater than or equal to 3 ft^3/h to prevent the accumulation of flammable gases due to steady-state releases.	--
Primary tank leak detection systems	Ensures that a system (i.e., the annulus conductivity probe system or the annulus continuous air monitor [CAM] system) is operable to detect leaks of waste from the primary tank.	--
Flammability controls with the following key element: • Flammable Gas Facility Groups defined in Appendix K.	Controls ensure that flammable gas hazards are managed.	--
Ignition Controls • Intrusive Controls - Stop intrusive activities in tanks with a potential flammable gas hazard when lightning is identified within a 48-km (30-mi) radius of the tank farm.	Reduces frequency of lightning as an initiator of a flammable gas deflagration.	For exemptions to this control, see Section 3.4.2.12.3, "Natural Phenomena-Lightning."
• Flammable Gas Ignition Controls detailed in Appendix K.	Reduces frequency of a flammable gas deflagration.	
Flammable Gas Monitoring Controls detailed in Appendix K for: • Manned Work Activity • Unmanned Operations • Non-GRE Facilities • DCRT Ventilation Requirements	Reduces frequency of a flammable gas deflagration.	--

Table 3.4.2.2-2. Summary of Technical Safety Requirement Controls for the Flammable Gas Deflagrations Accident. (3 sheets)

Control	Safety function	Comments
Transfer Controls • Waste Compatibility Controls - Evaluate pumped and received tank prior to waste transfers to ensure that controls for flammable gas deflagrations are applied to the final state of the tank.	Ensure final tank states remain within analyzed topography of the flammable gas deflagrations accident.	--
Emergency Preparedness Program with the following key element: • Response procedures	Mitigate the consequences of a flammable gas deflagration.	--
HEPA Filter Controls • HEPA filter source term - Verify periodically that the HEPA filter housing radiation level is ≤2.0 E-03 Sv/h (≤200 mrem/h) on contact. - Replace the HEPA filters and prefilters before filter housing radiation levels exceed 2.0 E-03 Sv/h (200 mrem/h).	Reduce consequences from a possible HEPA filter failure by limiting the inventory available	Applies to all HEPA filters, prefilters, and inlet filters in the ventilation system. Also protects accident analysis assumptions regarding HEPA filter release amounts.
Process instrumentation and measuring and testing equipment • Identification and traceability of TSR-related instrumentation and equipment shall be maintained. • Instrumentation and equipment shall have a functional test or calibration as applicable at appropriate intervals to verify required performance. • Records shall be maintained to provide evidence that the instrumentation and equipment are within the functional test or calibration when used.	Ensures instrumentation used to monitor the concentration of flammable gases is maintained	--
Excavation controls reduce the likelihood of inadvertently intruding into any structure potentially containing flammable gas	Prevent ignition of flammable gas	--
Additional controls for Tank 241-SY-101 remediation activities and operations	--	See HNF-3737 and HNF-IP-1266 for additional controls that have been identified for remediation activities and operations associated with Tank 241-SY-101.

Table 3.4.2.2-2. Summary of Technical Safety Requirement Controls for the Flammable Gas Deflagrations Accident. (3 sheets)

Control	Safety function	Comments

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington. In the case of Tank 241-SY-101, see HNF-3737 and HNF-IP-1266 for detailed descriptions and bases.

HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Actions and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-IP-1266, 1999, *Tank Farms Operations Administrative Controls*, Lockheed Martin Hanford Corporation, Richland, Washington.

LA-UR-92-3196, 1996, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, Rev. 14a, Los Alamos National Laboratory, Los Alamos, New Mexico.

*For 244-CR TK-003 flow rate of 3 ft^3/h is not required. Ventilation system is required to be operable.

AWF = aging waste facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
GRE = gas release event.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 3.4.2.2-3. Summary of Defense-in-Depth Controls for Flammable Gas Deflagrations.

Control	Safety function	Comments
Operate active ventilation systems	Reduces the "time at risk" following a large gas release event.	--
Flammable gas monitoring instrumentation	Provide indication of the concentration of flammable gases in waste tanks and waste transfer-associated structures	--
Leak detectors, material balances, and tank level monitoring	Detect leaked material that may create a flammable gas hazard	--
Flush transfer lines after use	Reduce waste material in transfer lines to limit the production of flammable gases	--
Portable exhausters	Exhausters reduce the time at risk if 25% of the LFL is reached.	Required per RL direction*
Defense-in-Depth Controls for Tank 241-SY-101		
For defense-in-depth controls specific to Tank 241-SY-101, see HNF-3737		

*Wagoner, J. D., 1998c, *Authorization Basis Amendment Package Transmittal for Saltwell Jet Pumping of Single-Shell Tanks*, (letter 98-TWR-013 to H. J. Hatch, Fluor Daniel Hanford, Inc., April 2), U.S. Department of Energy, Richland Operations, Richland, Washington.

*Kinzer, J. E., 1999, *Further Interpretation for Portable Exhauster Installation Contained Within the Saltwell Pumping Safety Evaluation Report, Revision 0* (Letter 99-OPD-040 to R. D. Hanson, Fluor Daniel Hanford, Inc., June 22), U.S. Department of Energy, Office of River Protection, Richland, Washington.

HNF-3737, 1999, *Tank 241-SY-101 Safety Basis for Remediation Actions and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

Table 3.4.2.2-4. Flammable Gas Accumulation Transient Following a Loss of Ventilation.

Tank	Time to reach 25% of the LFL (days)	Time to reach 100% of the LFL (days)	Maximum hydrogen concentration (% H_2)
Single-Shell Tanks[a]			
241-A-101	25	150	7.4
241-B-203	57	828	4.0
241-C-105	35	220	6.0
241-C-106	30	169	7.0
241-SX-107	20	104	9.6
241-SX-108	17	86	11.0
241-SX-110	28	159	7.2
241-SX-111	30	172	6.9
241-SX-112	36	234	5.8
241-SX-114	23	119	8.8
Double-Shell Tanks/Aging Waste Facility Tanks[b]			
Bounding current DST (241-SY-101)	7	32	22.8
Bounding current AWF tank (241-AZ-101)	24	127	8.4
Double-Contained Receiver Tanks[c]			
Bounding analyzed transfer through a DCRT (241-SX-105 through 244-S DCRT)	NA[d]	12	29

[a]HNF-SD-WM-CN-116, 1997, *Calculation Note: Hydrogen Generation Rates at Steady-State, Flammable Gas Concentrations for Single-Shell Tanks*, Rev. 0-A, Fluor Daniel Hanford, Inc., Richland, Washington.

[b]HNF-SD-WM-CN-117, 1997, *Calculations of Hydrogen Release Rate at Steady State for Double-Shell Tanks*, Rev. 0-A, Fluor Daniel Hanford, Inc., Richland, Washington.

[c]HNF-SD-WM-CN-118, 1997, *Calculation of Flammable Gas Mixtures in Double-Contained Receiver Tanks*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

[d]Ventilation performance is set to maintain concentration <25% of the LFL.

AWF = aging waste facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
LFL = lower flammability limit.
NA = not applicable.

Table 3.4.2.2-5. Summary of Consequences and Frequencies of Flammable Gas Deflagrations Without Controls. (2 sheets)

Accident case	Source term (L)	Source material	Radiological Sv (rem)				Toxicological SOF				Frequency
			Onsite		Offsite		Onsite		Offsite		Without controls
			Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Steady-State Accumulation and Ignition Results in Headspace Deflagrations											
SST dome cracking (Delphi Panel[a])	1.2 E-02	SST solids	3.0 E-02 (3.0 E+00)	5.0 E-03 (5.0 E-01)	2.0 E-05 (2.0 E-03)	1.0 E-03 (1.0 E-01)	2.4 E+00	1 (ERPG-1)	5.6 E-03	1 (PEL-TWA)	Anticipated
SST dome cracking—Delphi upper estimate[b]	6.0 E-01	SST solids	1.5 E+00 (1.5 E+02)	5.0 E-03 (5.0 E-01)	1.0 E-03 (1.0 E-01)	1.0 E-03 (1.0 E-01)	1.2 E+02	1 (ERPG-1)	2.8 E-01	1 (PEL-TWA)	Anticipated
SST—no dome cracking or filtering through soil overburden	1.4 E-01	SST solids	3.5 E-01 (3.5 E+01)	5.0 E-03 (5.0 E-01)	2.4 E-04 (2.4 E-02)	1.0 E-03 (1.0 E-01)	2.8 E+01	1 (ERPG-1)	6.6 E-02	1 (PEL-TWA)	Anticipated
SST dome collapse	4.0 E+00	SST solids	9.9 E+00 (9.9 E+02)	5.0 E-02 (5.0 E+00)	6.7 E-03 (6.7 E-01)	5.0 E-03 (5.0 E-01)	4.2 E+02	1 (ERPG-2)	6.6 E-01	1 (ERPG-1)	Unlikely
DST—no structural failure	3.9 E-01	DST liquids	2.7 E-02 (2.7 E+00)	5.0 E-03 (5.0 E-01)	1.8 E-05 (1.8 E-03)	1.0 E-03 (1.0 E-01)	2.0 E+01	1 (ERPG-1)	1.6 E-02	1 (PEL-TWA)	Anticipated
DST—dome blowout (Delphi Panel[a])	6.0 E-01	DST liquids	4.1 E-02 (4.1 E+00)	5.0 E-03 (5.0 E-01)	2.8 E-05 (2.8 E-03)	1.0 E-03 (1.0 E-01)	3.0 E+01	1 (ERPG-1)	2.5 E-02	1 (PEL-TWA)	Anticipated
DST dome collapse	4.3 E+00	DST liquids	6.8 E-02 (6.8 E+00)	5.0 E-02 (5.0 E+00)	2.0 E-04 (2.0 E-02)	5.0 E-03 (5.0 E-01)	1.6 E+01	1 (ERPG-2)	1.8 E-01	1 (ERPG-1)	Unlikely
DST dome blowout—detonation	1.2 E+02	DST liquids	8.2 E+00 (8.2 E+02)	NA	5.6 E-03 (5.6 E-01)	NA	NA[b]	--	NA[b]	--	Beyond extremely unlikely
DCRT deflagration	1.8 E+01	95% SST liquids, 5% SST solids	4.4 E+00 (4.4 E+02)	5.0 E-03 (5.0 E-01)	3.8 E-03 (3.8 E-01)	1.0 E-03 (1.0 E-01)	1.0 E+03	1 (ERPG-1)	1.1 E+00	1 (PEL-TWA)	Anticipated
Gas Release Event and Ignition Results in Headspace Deflagrations											
SST dome cracking (Delphi Panel[a])	1.2 E-02	SST solids	3.0 E-02 (3.0 E+00)	5.0 E-03 (5.0 E-01)	2.0 E-05 (2.0 E-03)	1.0 E-03 (1.0 E-01)	2.4 E+00	1 (ERPG-1)	5.6 E-03	1 (PEL-TWA)	Anticipated
SST dome cracking—Delphi upper estimate[a]	6.0 E-01	SST solids	1.5 E+00 (1.5 E+02)	5.0 E-03 (5.0 E-01)	1.0 E-03 (1.0 E-01)	1.0 E-03 (1.0 E-01)	1.2 E+02	1 (ERPG-1)	2.8 E-01	1 (PEL-TWA)	Anticipated

Table 3.4.2.2-5. Summary of Consequences and Frequencies of Flammable Gas Deflagrations Without Controls. (2 sheets)

Accident case	Source term (L)	Source material	Radiological Sv (rem)				Toxicological SOF				Frequency
			Onsite		Offsite		Onsite		Offsite		Without controls
			Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
SST—no dome cracking or filtering through soil overburden	1.4 E-01	SST solids	3.5 E-01 (3.5 E+01)	5.0 E-03 (5.0 E-01)	2.4 E-04 (2.4 E-02)	1.0 E-03 (1.0 E-01)	2.8 E+01	1 (ERPG-1)	6.6 E-02	1 (PEL-TWA)	Anticipated
SST dome collapse	4.0 E+00	SST solids	9.9 E+00 (9.9 E+02)	5.0 E-02 (5.0 E+00)	6.7 E-03 (6.7 E-01)	5.0 E-03 (5.0 E-01)	4.2 E+02	1 (ERPG-2)	6.6 E-01	1 (ERPG-1)	Unlikely
DST—no structural failure	3.9 E-01	DST liquids	2.7 E-02 (2.7 E+00)	5.0 E-03 (5.0 E-01)	1.8 E-05 (1.8 E-03)	1.0 E-03 (1.0 E-01)	2.0 E+01	1 (ERPG-1)	1.6 E-02	1 (PEL-TWA)	Anticipated
DST—dome blowout (Delphi Panel[a])	6.0 E-01	DST liquids	4.1 E-02 (4.1 E+00)	5.0 E-03 (5.0 E-01)	2.8 E-05 (2.8 E-03)	1.0 E-03 (1.0 E-01)	3.0 E+01	1 (ERPG-1)	2.5 E-02	1 (PEL-TWA)	Anticipated
DST dome collapse	4.3 E+00	DST liquids	6.8 E-02 (6.8 E+00)	5.0 E-02 (5.0 E+00)	2.0 E-04 (2.0 E-02)	5.0 E-03 (5.0 E-01)	1.6 E+01	1 (ERPG-2)	1.8 E-01	1 (ERPG-1)	Unlikely
DST dome blowout—detonation	1.2 E+02	DST liquids	8.2 E+00 (8.2 E+02)	1.0 E-01 (1.0 E+01)	5.6 E-03 (5.6 E-01)	4.0 E-02 (4.0 E+00)	4.5 E+02	1 (ERPG-3)	3.7 E-01	1 (ERPG-2)	Extremely unlikely
Deflagration in DST annulus	6.0 E-01	DST liquids	4.1 E-02 (4.1 E+00)	5.0 E-02 (5.0 E+00)	2.8 E-05 (2.8 E-03)	5.0 E-03 (5.0 E-01)	2.3 E+00	1 (ERPG-2)	2.5 E-02	1 (ERPG-1)	Unlikely

Note: Consequence and frequency estimates are provided for information only. Because of technical uncertainties that can affect risk estimates significantly, conclusions regarding consequence comparison to risk evaluation guidelines, based on these estimates, are not appropriate at this time.

[a]WHC-SD-TWR-RPT-003, 1996, *DELPHI Expert Panel Evaluation of Hanford High-Level Waste Tank Failure Modes, Fragilities, and Release Quantities*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[b]SOF values are not calculated for accidents with frequencies less than extremely unlikely because the methodology does not permit the calculation.

DCRT = double-contained receiver tank.
DST = double-shell tank.
ERPG = Emergency Response Planning Guideline.
NA = not applicable.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
SST = single-shell tank.
TWA = time-weighted average.

Table 3.4.2.2-6. Frequency Estimates for Headspace Deflagrations Without Controls.

Ignition source category	SST headspace deflagration frequency	DST headspace deflagration frequency
Installed equipment	Unlikely	Anticipated
Activities external to the tank	Unlikely	Unlikely
Tank-intrusive activities	Anticipated	Anticipated
Natural phenomena	Unlikely	Unlikely
Combined	Anticipated	Anticipated

DST = double-shell tank.
SST = single-shell tank.

Table 3.4.2.2-7. Frequency Estimates for Headspace Deflagrations With Controls.

Ignition source category	SST headspace deflagration frequency	DST headspace deflagration frequency
Installed equipment	Extremely unlikely	Unlikely
Activities external to the tank	Extremely unlikely	Extremely unlikely
Tank-intrusive activities	Unlikely	Unlikely
Natural phenomena	Unlikely	Unlikely
Combined	Unlikely	Unlikely

DST = double-shell tank.
SST = single-shell tank.

Table 3.4.2.2-8. Summary of Consequences and Frequencies of Flammable Gas Deflagrations With Controls. (2 sheets)

Accident case	Source term (L)	Source material	Radiological Sv (rem)				Toxicological SOF				Frequency
			Onsite		Offsite		Onsite		Offsite		With controls
			Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Steady-State Accumulation and Ignition Results in Headspace Deflagrations											
SST deflagration	NA	SST solids	NA	NA	NA	NA	NA[b]	--	NA[b]	--	Prevented
DST deflagration	NA	DST liquids	NA	NA	NA	NA	NA[b]	--	NA[b]	--	Prevented
AWF deflagration	NA	AWF liquids	NA	NA	NA	NA	NA[b]	--	NA[b]	--	Prevented
DCRT deflagration	NA	95% SST liquids, 5% SST solids	NA	NA	NA	NA	NA[b]	--	NA[b]	--	Prevented
Gas Release Event and Ignition Results in Headspace Deflagrations.											
SST dome cracking (Delphi Panel[a])	1.2 E-02	SST solids	3.0 E-02 (3.0 E+00)	5.0 E-02 (5.0 E+00)	2.0 E-05 (2.0 E-03)	5.0 E-03 (5.0 E-01)	1.3 E+00	1 (ERPG-2)	2.0 E-03	1 (ERPG-1)	Unlikely
SST and DST dome cracking—Delphi upper estimate[a]	6.0 E-01	SST solids	1.5 E+00 (1.5 E+02)	5.0 E-02 (5.0 E+00)	1.0 E-03 (1.0 E-01)	5.0 E-03 (5.0 E-01)	6.3 E+01	1 (ERPG-2)	9.9 E-02	1 (ERPG-1)	Unlikely
SST—no dome cracking or filtering through soil overburden	1.4 E-01	SST solids	3.5 E-01 (3.5 E+01)	5.0 E-02 (5.0 E+00)	2.4 E-04 (2.4 E-02)	5.0 E-03 (5.0 E-01)	1.5 E+01	1 (ERPG-2)	2.3 E-02	1 (ERPG-1)	Unlikely
SST dome collapse	4.0 E+00	SST solids	9.9 E+00 (9.9 E+02)	1.0 E-01 (1.0 E+01)	6.7 E-03 (6.7 E-01)	4.0 E-02 (4.0 E+00)	2.0 E+01	1 (ERPG-3)	3.4 E-01	1 (ERPG-2)	Extremely unlikely
DST—no structural failure	3.9 E-01	DST liquids	2.7 E-02 (2.7 E+00)	5.0 E-02 (5.0 E+00)	1.8 E-05 (1.8 E-03)	5.0 E-03 (5.0 E-01)	1.5 E+00	1 (ERPG-2)	1.6 E-02	1 (ERPG-1)	Unlikely
DST—dome blowout (Delphi Panel[a])	6.0 E-01	DST liquids	4.1 E-02 (4.1 E+00)	5.0 E-02 (5.0 E+00)	2.8 E-05 (2.8 E-03)	5.0 E-03 (5.0 E-01)	2.3 E+00	1 (ERPG-2)	2.5 E-02	1 (ERPG-1)	Unlikely
DST dome collapse	4.3 E+00	DST liquids	6.8 E-02 (6.8 E+00)	1.0 E-01 (1.0 E+01)	2.0 E-04 (2.0 E-02)	4.0 E-02 (4.0 E+00)	4.5 E+00	1 (ERPG-3)	1.3 E-02	1 (ERPG-2)	Extremely unlikely
DST dome blowout—detonation	1.2 E+02	DST liquids	8.2 E+00 (8.2 E+02)	NA	5.6 E-03 (5.6 E-01)	NA	Na[b]	--	Na[b]	--	Beyond extremely unlikely

Table 3.4.2.2-8. Summary of Consequences and Frequencies of Flammable Gas Deflagrations With Controls. (2 sheets)

Accident case	Source term (L)	Source material	Radiological Sv (rem)				Toxicological SOF				Frequency
			Onsite		Offsite		Onsite		Offsite		With controls
			Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Deflagration in DST annulus	NA	DST liquids	NA	NA	NA	NA	NA[b]	--	NA[b]	--	Prevented

Note: Consequence and frequency estimates are provided for information only. Because of technical uncertainties that can affect risk estimates significantly, conclusions regarding consequence comparison to risk evaluation guidelines, based on these estimates, are not appropriate at this time.

[a]WHC-SD-TWR-RPT-003, 1996, *DELPHI Expert Panel Evaluation of Hanford High-Level Waste Tank Failure Modes, Fragilities, and Release Quantities*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[b]SOF values are not calculated for accidents with frequencies less than extremely unlikely because the methodology does not permit the calculation.

AWF = aging waste facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
ERPG = Emergency Response Planning Guideline.
NA = not applicable.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
SST = single-shell tank.
TWA = time-weighted average.

Section 3.4.2.3
Reserved for Future Use.

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3.4.2.4 Organic Solvent Fire. This section evaluates risks associated with the presence of separable-phase organic solvents in the Hanford Site waste tanks. If ignited, burning organic solvents can liberate sufficient energy to release hazardous materials from the tanks. This analysis applies to SSTs, DSTs, and DCRTs. The category of SSTs includes both 100 Series (2 million L [500,000 gal and larger]) and 200 Series (208,000 L [55,000 gal]) tanks. The category of DSTs also includes the AWF tanks.

The four significant generators of organic solvents at Hanford were: (1) REDOX plutonium separations operations, (2) uranium recovery operations (U Plant), (3) strontium recovery operations (B Plant), and (4) PUREX. Most of the organic solvents remaining in the tanks in 1998 are expected to be tributyl phosphate-normal paraffin hydrocarbons (TBP-NPH) mixtures left over from the PUREX process.

3.4.2.4.1 Estimate Of Total Number Of Tanks Still Containing Separable Phase Organic Solvents. The number of waste tanks that may have separable organic solvent phases in them is not known. Not all tanks received solvents, and most of the solvents that were sent to the tanks have evaporated or undergone chemical degradation to form organic species that would not be present as a separable, liquid phase. Tank 241-C-103 is, however, known to have an organic solvent layer floating on the waste surface. Other tanks have vapor space concentrations of organic solvent vapor higher than can be explained, except by the presence of liquid phase solvents in the waste.

A screening test has been developed that uses the results of the ongoing tank vapor space sampling program to predict the presence of significant quantities of separable phase solvents in tanks. The screening tests will identify specific tanks as having or not having any remaining separable organic solvent phase. The screening methodology uses vapor characterization data in conjunction with an evaporation model to estimate the size of solvent pools that feed vapors into tank headspaces. For tanks that fall below a derived criteria line, possible solvent pools are sufficiently small that consequences of postulated fires fall below applicable risk guidelines, and the risk can be concluded to be acceptable with no additional evaluation. The screening test predicts either that a pool is not present, or that a pool may be present. If the screen predicts that a pool may be present, it is assumed a pool is present, unless an alternate method of confirming or dismissing its presence is used. If the screen predicts that a pool is not present, it is a positive test that a pool is not present. The screening test and model is described in WHC-SD-WM-CN-032, *Analysis of Consequences of Postulated Solvent Fires in Hanford Site Waste Tanks*. As of March 1997, the vapor spaces of 75 tanks have been sampled. Applying the screening criteria to the 75 tanks identified 12 tanks as potentially having solvent pools or a large subsurface layer of solvent. The 12 tanks are 241-B-103, 241-BX-103, 241-BX-104, 241-BY-101, 241-BY-107, 241-BY-108, 241-C-101, 241-C-102, 241-C-103, 241-C-204, 241-T-111, and 241-TY-103. The results of the vapor space sampling and the screening are documented in PNNL-11490, *Screening for Organic Solvents in Hanford Waste Tanks Using Total Non-Methane Organic Compound Vapor Concentrations*.

As noted above, the actual number of tanks that contain solvent is not known. The ongoing headspace vapor sampling program and the screening criteria will answer the

question when the sampling program is complete. However, for FSAR purposes, an approximate number of tanks is needed to quantify the risk that is attributable to organic solvent fires.

The following estimate predicts a specific number of tanks that may contain a separable organic solvent phase. This number will be used as a multiplier to estimate facility-based accident frequencies.

Single-Shell Tanks. Before 1980, wastes containing immiscible organic solvents were transferred to SSTs. The bulk of the solvents was not sent to the tanks, but some solvent was entrained with the aqueous phase, which was sent to the tanks. Using historical records, 67 SSTs were identified as potential receivers of organic solvent (WHC-MR-0132, *A History of the 200 Area Tank Farms*; WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Areas*; WHC-SD-WM-ER-352, *Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Areas*; and WHC-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Areas*). The ongoing vapor space sampling program (PNNL-11490) has sampled and screened 75 SSTs. There are 53 tanks in common between the historical list of receiver tanks and the list of tanks that have been vapor space sampled. Seventy nine percent (53/67) of the tanks that potentially received organic solvent have been vapor sampled.

Of the 75 tanks that have been sampled, 12 have shown a positive result. Five of the twelve tanks, 241-BX-104, 241-BY-107, 241-C-101, 241-C-204, and 241-T-111, are not on the historical list of potential solvent receivers. However, Tanks 241-BY-107 and 241-C-101 are connected by cascade lines to Tanks 241-BY-108 and 241-C-103, respectively. Both Tanks 241-BY-108 and 241-C-103 are on the historical list of solvent receivers and show very strong solvent signatures in the vapor sampling. It is reasonable to expect that Tanks 241-BY-107 and 241-C-101 would also show a positive vapor signature. Therefore, Tanks 241-BX-104, 241-C-204, and 241-T-111 are the only tanks that show a positive vapor sample that are neither on the historical receiver list nor are connected to a tank that is a historical receiver of organic solvent.

Because 79% of the historical receivers have been sampled, it is reasonable to use a simple linear extrapolation ($7/53 = x/67$) to estimate the total number of historical receivers that might still contain solvent. This extrapolation predicts a total of 8.8 tanks, which is rounded up to 9 tanks as a small conservatism. In addition to the 9 tanks predicted by the extrapolation, 5 tanks identified above as nonhistorical receivers that have positive screenings are added for a total of 14 SSTs that potentially contain organic solvent.

There may be additional tanks in the group of nonhistorical receivers that have not been vapor sampled.

Double-Shell Tanks. There were two activities that resulted in organic solvents being sent to DSTs. One was the transfer of waste streams containing entrained solvents directly from PUREX to the tanks farms, and the other was the result of pumping supernate from SSTs to DSTs.

After 1980, the SSTs were not used to receive waste and were isolated. Wastes, including entrained organic solvents, were sent to DSTs. The only facility sending wastes at that time was PUREX. The waste stream containing the solvents is identified as organic wash waste. Records from PUREX and the tank farms indicate that organic wash waste was collected in tanks G-8 and R-8 at PUREX. These two tanks were periodically transferred to Tanks 241-AW-103, 241-AW-104, and 241-AW-105. Some supernate from these three tanks was pumped to the 242-A Evaporator for volume reduction. Evaporator feed sampling of the AW tanks did not indicate floating organics. Any solvent that was evaporated as part of the waste would have been collected as condensate in 242-A Evaporator Tank C-100 and ultimately transferred to low-level disposal facilities (not tanks). Since restart of the 242-A Evaporator in 1994, no organic solvents have been detected in Tank C-100. Therefore, it is not likely that solvents sent to the AW tanks ended up in other DSTs. However, Tanks 241-AW-103, 241-AW-104, and 241-AW-105 potentially contain separable phase organic solvent.

Three DSTs potentially contain a separable organic solvent phase because they were the receivers for transfers from SSTs that received organic solvents. Tank 241-AN-101 received salt well liquor from 241-A, 241-AX, 241-B, 241-BX, and 241-BY tank farms. Tank 241-SY-102, the staging tank for transfers from 200 West to 200 East Areas, received salt well liquor from 200 West Area tanks that had received organic solvents. Tank 241-AY-101 received liquid from the salt well pumping of 241-C-102, 241-C-107, and 241-C-110. All three of these 241-C tank farm tanks were historical receivers of wastes containing organic solvent.

A total of six DSTs (241-AW-103, 241-AW-104, 241-AW-105, 241-SY-102, 241-AY-101 and 241-AN-101) may contain separable phase organic solvent.

Number of Tanks—Conclusion. This analysis predicts that at least 20 tanks (14 SSTs and 6 DSTs) potentially contain separable phase organic solvents.

From Table 3.4.2.4-1, the frequency of having a pool or puddle fire in a single DST or SST is 8.5×10^{-5}/yr. (Pool and puddle fires are defined in the following section.) Multiplying by 20 gives a total frequency of 1.7×10^{-3}/yr. If this estimate were in error by a factor of 3 (that is, if there were actually 60 tanks that contained solvent instead of 20), the total frequency would be 5.1×10^{-3}/yr. Both total frequencies are in the same frequency category. Risk is a function of frequency and consequences. The consequences are the same independent of the frequency. Because the consequences are the same and the frequencies are in the same category, total risk would also fall in the same category, and the same radiological and toxicological risk guidelines would apply to either 20 tanks or 60 tanks. The estimate of the number of tanks that can have a pool/puddle fire can vary significantly without changing the overall risk associated with a pool/puddle fire.

In the case of a wick-stabilized fire, which applies only to SSTs, the predicted number of tanks that will have positive vapor screenings is 14. One of the 14 tanks is 241-C-103, a tank known to have a solvent pool on the waste surface. Therefore, a wick-stabilized fire would not occur in Tank 241-C-103. This leaves 13 tanks that could have a wick-stabilized fire. The total frequency for wick-stabilized fires for 13 tanks is given in Table 3.4.2.4-1 as 1.4×10^{-2}/yr, which

is in the anticipated frequency category. Because the anticipated frequency category is the range from 1×10^{-2} to 1/yr, additional SSTs with positive vapor screenings will not change the frequency category. Identifying additional SSTs with positive vapor screenings will not change the overall risk associated with a wick-stabilized fire.

Definition of Possible Scenarios. This analysis evaluates the frequency and consequences of three scenarios for combustion of organic solvent with headspace air:

- **Pool Fires**—Pools are a layer of solvent floating on top of liquid waste or a layer that is trapped in a depression on top of solid waste. In either case, a pool has an area greater than 1 m^2 (10.8 ft^2). A pool may exist in SSTs, DSTs, and DCRTs.

- **Puddle Fires**—Puddles are less than 1 m^2 (10.8 ft^2) and exist in a depression in a solid waste surface. Puddles should occur mainly in SSTs. Many SSTs have a solid surface that can form a depression where the solvent could collect. However, a few DSTs have a floating crust (i.e., 241-SY-101) that may form a depression where solvent could collect. Therefore, the analyses include puddles for both SSTs and DSTs.

- **Wick-Stabilized Fires**—A wick-stabilized fire configuration would be a sludge or salt cake that is permeated with solvent. The sludge or salt cake would act as a wick, and the solvent would burn. Wick-stabilized fires may occur in SSTs.

The distinction is made between pools and puddles because of the screening criteria, which can differentiate between puddles (smaller than 1 m^2 [10.8 ft^2]) and pools (larger than 1 m^2 [10.8 ft^2]). As will be shown in this analysis, 1 m^2 (10.8 ft^2) is also a useful limit from a consequence point of view, because the burning of a puddle does not generate enough heat or pressure to produce consequences (without controls) that exceed risk guidelines.

The important distinctions between pool fires and wick-stabilized fires on salt cake or sludge are the rate of flame spread and ease of ignition. This analysis will show that the wick-stabilized fire has a much lower flame spread rate versus a pool fire and has a higher probability of occurrence.

Two other potential reactions involving organic solvent were considered for analysis, solvent reactions with organic-nitrate/nitrite salts and the contribution of solvent vapors to headspace flammability.

Potential condensed phase reactions between organic-nitrate/nitrite salts are analyzed in Section 3.4.2.6. A solvent fire can initiate the organic salt-nitrate reaction, given all the necessary conditions specified in Section 3.4.2.6. The organic salt-nitrate reaction dominates the combined consequences. A solvent-initiated organic salt-nitrate reaction is not analyzed here as a separate accident.

Solvent vapors would only be a significant contributor to headspace flammability (i.e., greater than 25% lower LFL) if (1) the tank contained a significant solvent pool (e.g., greater than 1 m^2 [10.8 ft^2]) or an even larger solvent layer deeper in the waste solids, and (2) the solvent air interface temperature is above about 72 °C (161.6 °F) for degraded PUREX solvent such as that contained in Tank 241-C-103 (which may be the most volatile solvent left in the tank farms). Babad (1996) demonstrates that higher volatility components have already evaporated from the tanks. Of the 75 tanks that have been vapor sampled, the largest vapor contribution to headspace flammability is about 2% of the LFL. This result is from Tank 241-C-103, the only tank known to have a separable phase organic pool. Based on this evaluation and available headspace vapor sample data, it is reasonable to assume that the solvent contribution to headspace flammability is small. This assumption will be verified as additional tank headspaces are sampled. The flammable gas accidents analyzed in Section 3.4.2.2 dominate. A solvent vapor accident scenario is not analyzed here as a separate accident.

3.4.2.4.2 Scenario Development. Table 3.4.2.4-2 shows which organic solvent scenarios apply to each of the different types of tanks. As can be seen from Table 3.4.2.4-2 and the preceding discussion, accident analyses are only required for solvent pool and puddle fires in the three types of tanks and for wick-stabilized fires in the SSTs.

Because neither the total number of tanks with separable phase organic layers nor the volumes of organic solvent that may be present in those tanks is known, it is not possible to use a single scenario to bound this accident. Instead, several scenarios, each of which maximizes a different result, were analyzed. The four results are as follows:

- Maximum tank pressure
- Maximum tank vacuum
- Maximum radiological release
- Maximum toxicological impact.

Each of the four results was calculated for the different combinations of solvent fire type (pool, puddle, and wick-stabilized), tank type (SST, DST, and DCRT), and type of ventilation system (active or passive). Eighteen different scenarios were calculated to evaluate the different potential combinations and to establish the worst-case scenarios. Calculations for all 18 models are found in WHC-SD-WM-CN-032. The effects of varying the parameters in the scenarios are discussed in Section 3.4.2.4.4 of this analysis. The scenarios that have the maximum results are presented in Table 3.4.2.4-3 of this section. The column labeled "Case" has both a letter designator and a descriptive title. The letter designator is taken from the spreadsheet used to calculate the consequences and is included in most tables in this section so that readers may cross-reference to the spreadsheet found in WHC-SD-WM-CN-032.

The maximum cases for pressure and vacuum shown in Table 3.4.2.4-3 do not result in a loss of containment as the result of structural damage for the subject tanks (see overpressure discussion in Section 3.4.2.4.4). Because the maximum pressure and vacuum cases do not result

in a path to the environment as the result of structural damage to the tanks, they do not represent the bounding cases for radiological and toxicological doses. Therefore, these scenarios were not developed further.

Six cases from Table 3.4.2.4-3 are developed for accident scenarios without controls and are the bounding accidents. The cases include the following:

1. Case Q represents the bounding radiological and toxicological accident for SST wick-stabilized fires.

2. Case G represents the bounding radiological accident for an SST fire.

3. Case H represents the bounding toxicological accident for an SST fire.

4. Case K represents the bounding radiological accident for a DST fire.

5. Case L represents the bounding toxicological accident for a DST fire.

6. Case P represents both the bounding radiological and toxicological accident for a DCRT fire.

Scenarios Without Controls.

- **Initiators**—An evaluation of potential initiators, including results from testing laboratories, is given in WHC-SD-WM-CN-032. The only initiators with sufficient energy to ignite solvent pool/puddle fires are lightning and vehicle fuel fires. A wick-stabilized fire may be initiated by lightning, vehicle fuel fires, and hot metal resulting from use of a cutting torch (not sparks or slag from welding). A wick-stabilized fire requires less energy to initiate and to maintain the necessary conditions for combustion.

  A flammable gas deflagration is also a potential initiator. The consequences of a flammable gas deflagration (see Section 3.4.2.2) are much greater than the consequences of a solvent fire. Because the deflagration consequences would dominate the combined consequences of both accidents, a deflagration-initiated solvent fire is not evaluated here as a separate accident.

  The organic salt-nitrate reaction is another potential initiator. The consequences of the organic salt-nitrate (see Section 3.4.2.6) are much greater than the consequences of a solvent fire. Because the organic salt-nitrate reaction consequences would dominate the combined consequences of both accidents, an organic salt-nitrate initiated solvent fire is not evaluated here as a separate accident.

- **Ventilation Paths**—In the following scenarios, several vent paths were postulated to evaluate possible cases.

A minimal vent path was postulated to evaluate the maximum pressure generated by a pool fire. For SSTs, this minimal vent was based on the HEPA vent pipe, a path with an equivalent orifice size of 9.5 cm (3.75 in). For DSTs and DCRTs, the minimal vent was zero. Zero is a conservative default value chosen because a reliable, realistic vent path size is not known. Using zero for maximum pressure cases in DSTs and DCRTs does not result in tank failure, so there is no need to refine the maximum pressure model further.

A large vent path case was considered to evaluate maximum vacuum resulting from the cooldown of the tank after the fire extinguishes. A circular opening, 1.27 m (50 in.) in diameter covered by a hinged plate, was assumed to open at a pressure difference of 6.89 kPa (1 lb/in.^{2}). This flapper valve was hypothesized to simulate the venting through large risers (in tank pits) that are covered by caps held in place by gravity. The flapper valve closes when the pressure is vented and seals the tank. This creates a vacuum in the tank as the tank cools. The 1.27-m (50-in.) dia was selected by looking at what was physically possible and what would yield bounding values for vacuum. Depending on the tank farm, risers as large as 1.1 and 1.2 m (42 and 46 in.) are found in pump pits. A combined opening equivalent of 1.27 m (50 in.) in dia could be achieved by a combination of two risers. The 1.27-m- (50-in.-) dia equivalent opening is also large enough to vent all of the hot gases from the burning solvent. The venting is limited by the degree of heatup of headspace gases by the fire not by the 1.27-m- (50-in.-) dia opening. Therefore, the maximum vacuum case is achieved with a 1.27-m- (50-in.-) dia opening.

The quantity of solvent burned is much more important than the size of the vent path. Therefore, the size of the vent path (as long as there is a vent path) is not a key parameter for radiological consequences. For toxicological consequences, the key parameter is the release rate to achieve high downwind concentrations. Release rate is maximized by large vent paths. Therefore, the 1.27-m- (50-in.-) dia vent path is used in the cases that maximize toxicological consequences. Additional vent paths are specified in the cases, but the toxicological consequences are dominated by the 1.27-m- (50-in.-) dia vent path. To evaluate the cases for maximum radiological and toxicological consequences in SSTs, combinations of the 9.5-cm- (3.75-in.-) dia and 1.27-m- (50-in.-) dia vent paths were used. For DSTs, combinations of a 0.24-m- (9.6-in.-) dia and the 1.27-m- (50-in.-) dia vent paths were used to determine the highest consequences. The 0.24-m- (9.6-in.-) dia opening was picked as representing a breather filter and small leak paths. For DCRTs, a 0.1-m- (4-in.-) dia vent path, roughly the size of the tank vent line, was used.

- **Bounding Radiological & Toxicological Wick-Stabilized Fire in SST, Case Q**—It is possible that solvent could intrude into the underlying sludge or salt cake in an SST following salt well pumping of drainable liquids from a tank. Exposed salt cake that is saturated with solvent has the potential to burn like a candle using the sludge or salt cake as a wick. The burning surface would slowly increase and would eventually cover approximately 40 m^2 (431 ft^2).

  For a solvent liquid level equal to the solids level in the tank, the flame propagation rate would be approximately 0.1 cm/s (WHC-SD-WM-CN-032). The case of a solvent liquid level above the solids level is a pool or puddle fire and is addressed later. If the liquid level was below the solids level, ignition would not occur.

  The tank does not structurally fail and create a pathway to the environment as a result of either the pressure (30.3 kPa [4.4 lb/in.^{2} gauge]) or the vacuum (-4.8 kPa [-0.7 lb/in.^{2} gauge]) transients. Because of the relatively low pressure, there is little difference between the cases evaluated for active and passive ventilation systems. The case using a powered ventilation system (241-SX or 241-C Tank Farms) produced the highest radiological and toxicological consequences. The vent path was modeled as a 9.5-cm (3.75-in.) orifice. The only paths to the environment are through a ruptured HEPA filter and through risers that do not have covers bolted in place. The quantity of solvent burned, 130 kg, is limited by oxygen availability. The fire self extinguishes.

  This fire would be bounded, in terms of consequences, by the pool fire. However, it is more likely to occur and, therefore, must meet different guidelines.

- **Bounding Radiological SST Fire, Case G**—In this scenario, a pool of solvent is postulated to burn on the waste surface of an actively ventilated SST. The active ventilation system results in more radioactive material being exhausted from the tank, even after the fire has extinguished. Actively ventilated SSTs are found in Tank Farms 241-SX and 241-C.

  In this and all pool scenarios, the pool size is assumed to be 210 m^2 (2,260 ft^2) so that flame spread is not limited before the fire is extinguished by oxygen depletion. Unlimited flame spread produces the largest pressure transient.

  A flame spread rate of 10 cm/s is used. An upper bound for flame spread rate was picked by examining several sets of experimental data that are documented in WHC-SD-WM-CN-032. One data set was based on experiments conducted on mixtures of TBP and NPH similar to PUREX solvent. These mixtures were burned in closed compartments. Flame spread rates varied from 1.3 to 3.3 cm/s. A second set of data was based on open air tests with jet fuel. Flame spread rates ranged from 8 to 10 cm/s. While the data for jet fuel may not apply directly to confined solvent fires, the tests provide an experimental basis for defining an upper bound of approximately 10 cm/s for flame spread rates in waste tanks.

The tank dome does not collapse and create a pathway to the environment as a result of either the pressure transient, 200 kPa (29 lb/in.^{2} gauge), or the vacuum transient, -0.7 kPa (-0.1 lb/in.^{2} gauge). The high pressure is the result of the small vent path through the filter, which is modeled as a 9.5-cm (3.75-in.) orifice. See the overpressure assumption discussed in Section 3.4.2.4.3. Releases could also occur through any risers that do not have covers bolted to the flanges. The fire burns until the oxygen is depleted, consuming 146 kg (322 lb) of solvent.

- **Bounding Toxicological SST Fire, Case H**—A pool (210 m^2 [2,260 ft^2]) of solvent burns on the waste surface. The tank is passively ventilated. The vent path is modeled as a 9.5-cm (3.75-in.) orifice and a 1.27-m (50-in.) orifice. The large vent path results in the toxic material in the headspace being ejected from the tank rapidly. Because toxicological guidelines are based on concentration, this case produces the largest toxicological consequence.

  The tank does not fail structurally as a result of either the pressure transient (12.4 kPa [1.8 lb/in.^{2} gauge]) or vacuum transient (-46.9 kPa [9-6.8 lb/in.^{2} gauge]). The low pressure is a result of the large vent path from the tank. The pressure transient ruptures the breather filter on the tank. The only release path to the environment is through the ventilation system and any risers that do not have covers bolted to the flanges. The fire burns until the oxygen is depleted. The quantity of solvent burned is 84 kg (185 lb).

- **Bounding Radiological DST Fire, Case K**—A puddle of solvent (1 m^2 [10.8 ft^2]) burns on top of the waste surface. This scenario may not be physically possible because the surface of DST waste is expected to be a liquid, and the solvent would spread over the surface of the waste to the greatest extent possible. However, floating crusts have been identified in some DSTs, notably Tank 241-SY-101. The puddle fire case yields the highest radiological dose for a DST, and a floating crust may make the configuration possible. Therefore, this case is used as the bounding case for a DST.

  The DST does not fail structurally as a result of either the pressure transient (6.2 kPa [0.9 lb/in.^{2} gauge]) or the vacuum transient (-0.69 kPa [-0.1 lb/in.^{2} gauge]). The tank has a powered ventilation system. The vent path is modeled as a 0.24-m (9.6-in.) orifice. The pressure transient ruptures the HEPA filters on the ventilation system. The only release path to the environment is through the ventilation system and any risers that do not have covers bolted to the flanges. The fire burns until the oxygen is depleted. The quantity of solvent burned is 132 kg (291 lb). The powered vent system continues exhausting radioactive material from the tank after the fire extinguishes, resulting in the bounding radiological case.

- **Bounding Toxicological DST Fire, Case L**—A pool of solvent (210 m^2 [2,260 ft^2]) burns on top of the waste surface. The tank has a powered ventilation

system. The vent path is modeled as a 1.27-m (50-in.) orifice and a 0.24-m (9.6-in.) orifice. The large vent path results in the toxic material in the headspace being ejected from the tank rapidly. Because toxicological guidelines are based on concentration, this case produces the largest toxicological consequence.

The DST does not fail structurally as a result of either the pressure transient (13.8 kPa [2 lb/in.^{2} gauge]) or the vacuum-transient (-35.9 kPa [-5.2 lb/in.2 gauge]). The pressure transient ruptures the HEPA filters on the ventilation system. The only release path to the environment is through the ventilation system and any risers that do not have covers bolted to the flanges. The fire burns until the oxygen is depleted. The quantity of solvent burned is 92 kg (203 lb).

- **Bounding Radiological and Toxicological DCRT Fire, Case P**—The same scenario results in the bounding case for both toxicological and radiological consequences for a DCRT fire. A pool of solvent (34 m^2 [366 ft^2]) burns on top of the waste surface. Thirty-four square meters (366 ft^2) is equal to the maximum waste surface area in the DCRT.

  The DCRT does not structurally fail as a result of either the pressure transient (126 kPa [18.3 lb/in.^{2} gauge]) or the vacuum transient (-8.3 kPa [-1.2 lb/in.^{2} gauge]). The vaults surrounding the DCRTs have powered ventilation systems. The vault ventilation system has a duct to the DCRTs. However, there is no identifiable ventilation inlet to the DCRTs. Therefore, the DCRT is modeled as having a passive ventilation system.[1] The vent path is modeled as a 0.1-m (4-in.) orifice. The pressure transient ruptures the HEPA filter on the vault ventilation system. The only release path to the environment is through the vault ventilation system and any risers that do not have covers bolted to the flanges. The fire burns to oxygen extinguishment. The quantity of solvent burned is 2.12 kg (4.67 lb).

- **Accident Frequencies Without Controls**—The accident frequency without controls is based on the frequency of the initiating event. For the solvent fires, the accident frequency is the sum of the frequencies of the three initiating events. Lightning and vehicle fuel fires have sufficient energy to initiate any of the fires described. Hot metal resulting from operation of a cutting torch may have sufficient energy to ignite a wick-stabilized fire.

  For evaluation of the frequencies for lightning strikes and vehicle fuel fires, the SSTs, DSTs, and DCRTs are evaluated as one group rather than separate groups.

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[1]The 244-U DCRT does have an air inlet on the tank. No radioactive material has been transferred through this DCRT. Additional information on 244-U DCRT ventilation flows will be required to complete calculations. Because any accident involving a DCRT would have smaller consequences than an accident with an SST or DST, 244-U is bounded.

For evaluation of the frequency of wick-stabilized fires initiated by flame cutting, only SSTs are evaluated. Pieces of metal heated by flame cutting do not have sufficient energy to ignite pools or puddles.

The frequency of lightning strikes is based on information contained in WHC-SD-WM-ES-387, *Probability, Consequences, and Mitigation for Lightning Strikes to Hanford Site High Level Waste Tanks*. There are approximately 0.06 lightning flashes (strikes to ground) per square kilometer per year at Hanford. The surface area of a tank is approximately 5×10^{-4} km^2 (2×10^{-4} mi^2). The frequency of lightning hitting a tank is:

$$F\text{ (lightning strike)} = F\text{ (lightning)} \times \text{area of tank}$$

$$F\text{ (lightning strike)} = (6 \times 10^{-2}\text{ strikes/km}^2\text{/yr}) \times (5 \times 10^{-4}\text{ km}^2) = 3 \times 10^{-5}\text{ strikes/yr.}$$

In Lindberg (1995), it is assumed that one collision per year between a vehicle and a riser results in a punctured fuel tank. It is also assumed that there are 1,560 entries per year into tank farms. A collision that punctures a fuel tank is not sufficient by itself to start a fire. The following conditions are also needed to start an organic solvent fire: the probability of the riser breaking (5×10^{-1}), the probability of the vehicle fuel igniting (1×10^{-2}), the probability of the burning fuel going down the riser (1×10^{-1}), and the probability of the tank having organic solvent in it (1×10^{-1}). The probabilities given for the riser breaking, fuel igniting, and burning fuel going down the riser are taken from Lindberg (1995). The probability of a tank having solvent in it is 20/177 (1.1×10^{-1}). This number comes from the number of tanks estimated to contain solvent (20) given in Section 3.4.2.4. Therefore the probability of having an organic solvent fire, given a collision, is as follows:

$$P\text{ (organic fire)} = (5 \times 10^{-1})\,(1 \times 10^{-2})\,(1 \times 10^{-1})\,(1.1 \times 10^{-1}) = 5.5 \times 10^{-5}.$$

The overall probability without controls for having a solvent fire initiated by a vehicle fuel fire accident on a per tank basis is as follows:

$$P\text{ (collision)} \times P\text{ (organic fire)} = P\text{ (no controls)}$$

$$(1) \times (5.5 \times 10^{-5}) = 5.5 \times 10^{-5}.$$

Flame or torch cutting on a tank or its attachments (i.e., a riser or a ventilation duct) in a place where hot chunks of metal could fall to the waste surface is not a common activity; however, it is an anticipated activity. Therefore, a frequency of 1×10^{-2} cutting events per tank per year is used in this analysis. The probability of

igniting solvent-permeated sludge or salt cake is estimated at 1×10^{-1} (WHC-SD-WM-CN-032). The overall probability without controls of having a wick-stabilized fire caused by flame cutting is as follows:

Frequency of torch cutting per tank (1×10^{-2}/yr) x probability of igniting solvent (1×10^{-1}) = 1×10^{-3}/yr.

The combined probability without controls of igniting a pool fire is the sum of the probabilities for lightning and vehicle fuel fires:

$$P\ (\text{lightning}) + P\ (\text{vehicle fuel fires}) = P\ (\text{pool fire})$$

$$(3 \times 10^{-5}) + (5.5 \times 10^{-5}) = 8.5 \times 10^{-5}$$

The combined probability without controls of igniting solvent-permeated sludge or salt cake is the sum of the probabilities for lightning, vehicle fuel fires, and flame cutting:

$$P\ (\text{lightning}) + P\ (\text{vehicle fuel fire}) + P\ (\text{flame cutting}) = P\ (\text{wick-stabilized})$$

$$(3 \times 10^{-5}) + (5.5 \times 10^{-5}) + (1 \times 10^{-3}) = 1.085 \times 10^{-3} \approx 1.1 \times 10^{-3}$$

The probabilities without controls for the bounding cases are summarized in Table 3.4.2.4-1. The probabilities are also converted from a per tank basis to a facility basis in Table 3.4.2.4-1. The column labeled "Number of tanks" is the number of SSTs and DSTs estimated in Section 3.4.2.4 to contain a separable organic solvent phase.

Scenarios With Controls. The controls specified in this analysis eliminate two of the three possible initiators, vehicle fuel spills and flame cutting. The scenario with controls is, therefore, an organic solvent fire initiated by lightning.

- **Frequencies With Controls**—The frequency bin for the accidents with controls is "unlikely." The controls eliminate vehicle fuel fires and flame cutting as initiators. Only lightning, with a frequency of 3×10^{-5}/yr/tank, remains as an initiator. When multiplied by the number of tanks at risk, the frequency shifts to the "unlikely" category.

3.4.2.4.3 Source Term Analysis. The source terms for accidents without and with controls are the same. The two contributors to both the radiological and toxicological source terms include the material loaded on the HEPA filters and the material released from the tank as a result of fire. The materials released by the fire include solvent smoke, headspace gases, and aqueous boiloff.

HEPA Filter Loading. For SSTs, the material loaded on the filters is assumed to be SST solids. The vast majority of SSTs do not have layers of supernate. Any material that accumulates on the filters would be best represented by SST solids. On DST filters, the material is assumed to be DST liquid. Virtually all of the DSTs have liquid surfaces. Therefore, any material that accumulates on the filters is DST liquid. For DCRTs, the material is assumed to be SST liquids. The material that is pumped through the DCRTs is SST liquid. The material that is accumulated on the DCRT filters is best represented by SST liquid.

It is assumed the filters are changed when they have a maximum contact reading on the filter housing of 2.0×10^{-3} Sv/h (200 mrem/h). This information is used to back-calculate the quantity of material on the filter for the maximum release from a ruptured filter. The method and assumptions for calculating the material loading on the HEPA filters is given in WHC-SD-WM-CN-054, *Waste Tank Ventilation System Waste Material Accumulations* and HNF-SD-WM-CN-099, *Radiological and Toxicological Analysis of Tank 241-AY-102 and Tank 241-C-106 Systems*. The quantities of material released by a HEPA filter rupture, taken from WHC-SD-WM-CN-054 and HNF-SD-WM-CN-099, are as follows:

- Passively ventilated SST, 1.27×10^{-4} L
- Actively ventilated SST, 1.9×10^{-2} L
- Actively ventilated DST, 3.6×10^{-2} L
- Passively ventilated DCRT, 2.28×10^{-3} L.

Solvent Smoke. The term solvent smoke is used to include the airborne release of the radionuclide content of burning solvent, the release of P_2O_5, CO, and NO_2 combustion products from the burning solvent, and soot resulting from incomplete combustion of the solvent.

The pool fire will cause the airborne release of a fraction of the radionuclide content of the solvent. Radionuclide release was based on the following quantification of terms:

$$S = M \times C \times ARF \times RF \times LPF$$

where:

S = source term (kg)

M = mass of material at risk (kg)

C = concentration of contaminant in material at risk (kg/kg)

ARF = aerosol release fraction (fraction of contaminant in material at risk which is released as an aerosol) (dimensionless)

RF = respirable fraction of released aerosol (dimensionless)

LPF = leak path factor (fraction of aerosol which escapes to the environment) (dimensionless).

The mass of material at risk (M) was equated to the mass of solvent burned during the course of the fire. This mass was computed by means of a computer model explained in WHC-SD-WM-CN-032.

The concentration of radionuclides in solvent (C) was based on measurements performed on a solvent sample retrieved from Tank 241-C-103. Tank 241-C-103 is the only tank known at this time that definitely contains a separable organic solvent phase. It has a thin layer of degraded PUREX-type solvent floating on the surface of the waste. The Tank 241-C-103 solvent is the model used for this analysis. The analytical measurements are reported in PNL-9403, *Waste Tank Organic Safety Project: Analysis of Liquid Samples from Hanford Waste Tank 241-C-103.*

The ARF was quantified on the basis of empirical results summarized in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. For large pools, which are predicted to burn to oxygen extinction in minutes, a bounding ARF of 0.03 was used. For small pools (puddles), the burn to oxygen extinction is predicted to take many minutes, allowing time for heatup of underlying waste. A higher ARF of 0.1 was selected from the data in DOE-HDBK-3010-94 for puddle fires. The respirable fraction (RF) was conservatively assumed to be unity for all cases. The leak path factor (LPF) was calculated by the previously referenced computer model for each case analyzed. Retention was credited only on the basis of incomplete venting of headspace gases during the fire cycle. Aerosol depletion, which would likely be significant for the puddle fires, was conservatively neglected.

Toxic gas species formed by combustion of solvent were assumed to be adequately represented by CO, NO_2, and P_2O_5. The dominant toxic gas species formed by the burning of solvent (a mixture of kerosene-like hydrocarbons and TBP) were identified as the pollutants formed by the burning of hydrocarbon liquids, accounting for the presence of phosphorous contained in TBP. The burning of hydrocarbons (i.e., in engines or power plants) produces H_2O and CO_2 as the main products of combustion. Smaller amounts of CO, NO_2 and particulates are identified as the main toxicological pollutants (Pollution Control Technology 1973). Phosphorous contained in the TBP would be oxidized during the burning process, forming phosphorous oxides, represented in this analysis by P_2O_5. For CO and NO_2, emission factors were used to quantify the masses formed by combustion. Emission factors used for CO and NO_2 were 0.0425 and 5.5×10^{-3}, respectively (WHC-SD-WM-SARR-001, *Safety Analysis of Exothermic Reaction Hazards Associated With the Organic Liquid Layer in Tank 241-C-103—Supplement 1: Risk from Organic Solvent Fires in C-103 Following Interim Stabilization*). The emission factor is defined as the mass of pollutant formed per mass of fuel burned. P_2O_5 formation was quantified by stoichiometry for the oxidation of TBP:

$$C_{12}H_{27}PO_4 + 18\ O_2 \rightarrow 12\ CO_2 + 13.5\ H_2O + 0.5\ P_2O_5.$$

Based on this equation, the mass ratio of P_2O_5 to TBP is 0.27. TBP vapors were assumed to comprise 16% by mass of fuel burned. This vapor mass fraction was taken from measurements at 100 °C (212 °F) reported in PNL-9403 for solvent samples retrieved from Tank 241-C-103. Therefore, an emission factor for P_2O_5 is 0.27(0.16) = 0.0432 kg P_2O_5/kg fuel.

The LPF value computed from the computer model was used for toxic gas releases. RF was assigned a value of unity.

The calculated quantities of solvent burned, equivalent solvent mass for radionuclide release, the masses of soot, P_2O_5, CO, and NO_2, released are shown in Table 3.4.2.4-4.

Headspace Gases. Headspace gases can contain a number of toxic substances. A bounding (worst case), steady-state composite is assumed in all cases analyzed herein. The composition of headspace gases is quantified in Table 3.4.1-11. Radioactive content of headspace air before a pool fire is not included in these calculations because it is insignificant compared with the maximum radiological cases analyzed. The quantity of radioactive material suspended in the headspace air, before an accident, would be in the range of tenths of a gram to a few grams. The maximum radiological release cases analyzed for this accident release multiple kilogram quantities of solvent and aqueous solution. The suspended material present before an accident is not significant compared with the accident release quantities.

Aqueous Boiloff. The pool fire could cause aerosolization of waste by evaporating water or possibly by entrainment as the result of air flow. Entrainment of solid waste by aerodynamic forces has been discounted in this study for the following reasons:

1. The solid waste surface is envisioned as a consolidated mass containing sufficient water to assure a reasonable degree of cohesiveness. Such a surface would not be susceptible to erosion and entrainment by low-velocity air currents.

2. Air currents along the horizontal waste surface outside the inflamed pool area are expected to be of relatively low velocity, probably 1 m/s or less. Entrainment of a consolidated, cohesive solid by air flows having velocities of this magnitude is judged to be minimal. Higher velocity plumes would likely exist above the inflamed surface, but these higher velocity flows would not impinge on the solid waste surface.

3. Aerosols generated by a solvent fire are likely to exist in liquid form at the temperature of the waste-air interface. Unburned hydrocarbons, mixed with phosphoric acid (phosphoric acid would be formed when P_2O_5 reacted with water vapor) would likely form an aerosol that would settle and coat waste with a viscous liquid layer that would further inhibit aerodynamic entrainment of solid waste.

Waste aerosolization resulting from moisture evaporation is quantified on the basis of releases from boiling liquids.

The mass of liquid at risk is computed as the mass of water that could be evaporated by heat transferred from the flame to the inflamed surface. One of the important parameters of flame heat transfer rate is particulate content of the fuel. Because the solvent being burned is expected to have a high particulate content, the flame heat transfer rate of pure kerosene was considered too low for this analysis. Therefore, a flame heat transfer rate was extrapolated between pure kerosene and burning rubber gloves. The burning rubber gloves account for the particulates

expected in the solvent. Using a flame heat transfer rate of 57 kW/m^2 (an average of values for burning of rubber gloves and burning of kerosene [NUREG 1320, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*]), an average specific burning rate of 1.2 kg/m^2 min, and a latent heat of water of 2.26 MJ/kg, the mass of water evaporated per mass of fuel burned is as follows:

$$\frac{57\ \text{kJ}}{\text{s m}^2} \times \frac{60\ \text{s}}{\text{min}} \times \frac{\text{m}^2\ \text{min}}{1.2\ \text{kg fuel}} \times \frac{1\ \text{kg H}_2\text{O}}{2260\ \text{kJ}} = \frac{1.26\ \text{kg H}_2\text{O}}{\text{kg fuel}}$$

The value of M applicable to aqueous boiloff in the above equation was computed for each case by multiplying the mass of fuel burned by 1.26. The calculation of the mass of fuel burned is explained in WHC-SD-WM-CN-032.

ARF was assigned a value of 0.002 on the basis of release fractions for boiling liquids as recommended in DOE-HDBK-3010-94. RF was assigned a conservative value of unity for all cases. LPF was computed in WHC-SD-WM-CN-032 to account for the fraction of reaction products vented from the tank over the course of the fire. No credit was taken for aerosol depletion.

The concentrations of nuclides in SST, DST, and DCRT liquids, expressed in terms of ULDs, are given in Table 3.4.1-9. The concentration of toxic analytes in these liquids is evaluated from sum-of-fraction per unit release rate data, also presented in Table 3.4.1-13.

The masses of material released as the result of the aqueous boiloff are as follows:

Case	Mass (kg)
G	3.68×10^{-1}
H	6.35×10^{-2}
K	3.33×10^{-1}
L	2.32×10^{-1}
P	1.66×10^{-3}
Q	3.28×10^{-1}

Relative Contributions. Table 3.4.2.4-5 shows, on a percentage basis, the contribution of the different sources to the total radiological dose. Table 3.4.2.4-5 shows onsite dose. The contributions of the different sources to offsite dose would be proportional to the contributions shown in Table 3.4.2.4-5. The offsite dose is calculated from the onsite dose using a ratio of χ/Q factors, so the contributions to offsite dose would be proportional.

The steady-state content of radionuclides in the headspace gases before the beginning of a fire is expected to be negligible, as explained under the heading "Headspace Gases." Therefore, no radionuclide concentration is assigned to the headspace gas.

Table 3.4.2.4-6 shows, on a percentage basis, the contribution of the different sources to the total toxicological dose. The table is based on the total sum-of-fractions of the onsite dose for the "unlikely" case. Both the solvent smoke and headspace gases contain corrosives and irritants, systemic poisons, and central nervous system poisons. These toxics, from both solvent smoke and headspace gases, are combined as a single percentage in the table. Particulates, which are a component of the solvent smoke, are shown as a separate percentage in the table.

3.4.2.4.4 Consequence Analysis. The controls presented in Section 3.4.2.4.6 are preventive rather than mitigative.

The toxicological consequences are given as the toxic sum-of-fractions. Because toxicological consequence calculations are specific to the accident frequency (guideline limits included in the calculation are a function of accident frequency category), toxic sum-of-fractions with controls differ from sum-of-fractions results without controls (even though the chemical concentrations at the receptor locations are the same in both unmitigated and mitigated scenarios). Table 3.4.2.4-8 presents the accident consequences for the scenarios described for organic solvent fires.

For Case Q, Entrained (Table 3.4.2.4-8), the toxicological consequences to the onsite and offsite receptors are 4.16 and 8.79×10^{-3}, respectively, when an accident frequency of "unlikely" is evaluated.

Key Parameters and Assumptions. The objective of this section is to show how sensitive the predicted consequences of solvent pool fires are to key assumptions used in the analysis.

Solvent Composition. The consequence analysis assumes that the organic solvent is the same composition as the solvent sampled in Tank 241-C-103 (see PNL-9403 for the chemical analysis of the compounds). Tank 241-C-103 is the only tank known to have a floating pool of organic solvent. The mixture in Tank 241-C-103 is 70% TBP and 30% NPH. The mixture is characteristic of degraded PUREX solvent. When heated, the composition of the vapor phase above the solvent is about 84% NPH and 16% TBP. The combustion energy was calculated on the basis of vapor phase composition. The combustion energies of both NPH (44.5 MJ/kg) and TBP (28.8 MJ/kg) exceed that of ketones and other non-NPH or non-TBP separable phase organic compounds found in the tanks. Therefore, the NPH/TBP mixture is assumed to be a bounding mixture in terms of energy released per unit mass.

Organic complexant salts (e.g., hydroxyethylethylenediaminetriacetic acid [HEDTA] and ethylenediamimetetraacetic acid [EDTA]) and their degradation products (e.g., NTA, IDA, ED3A) are not soluble in the organic solvents. Solvent combustion would not be enhanced by the dissolved complexant salts. Condensed phase combustion of the organic complexants is discussed in Section 3.4.2.6.

Flame Spread Rate. The analyses have been carried out using a radial spread rate of 10 cm/s. This spread velocity is a bounding high value and was used to arrive at bounding estimates of peak pressure and vent rates for postulated fires. More realistic

estimates of flame spread rates for solvent fires in waste tanks are of the order of 1 cm/s (WHC-SD-WM-SARR-001, *Safety Analysis of Exothermic Reaction Hazards Associated With the Organic Liquid Layer in Tank 241-C-103*).

In general, higher spread velocities lead to a quicker burn to oxygen extinction because the inflamed area at a given point in time (following ignition) is larger for higher spread rates. Shorter burns allow less time for heat transfer, so temperature and pressure in the headspace reach higher levels as spread rate increases.

Radiological consequences vary with the total quantity of nuclides released during the course of a fire. The quantity of contaminants released from a tank is maximized when an active ventilation system purges contaminants from the tank headspace following fire extinction. Fire spread velocity (for large pools) determines how quickly the fire burns to extinguishment but does not greatly affect the quantity of contaminants made airborne. Therefore, the assumed value of spread velocity, 10 cm/s, does not significantly affect radiological consequences predicted for the bounding case involving active ventilation.

The toxicological concentration in a downwind plume depends on the release rate, and because the vent rate from a tank increases with fire spread velocity, toxicological consequences tend to increase with fire spread velocity. Because toxicological consequences have been based on a bounding spread velocity, lower toxicological consequences would be predicted by analyses based on more realistic, lower spread velocities. The relative importance of spread rate on toxicological consequence may be illustrated by comparing headspace vent rate computed for a large pool case, with spread velocities of 10 cm/s and 1 cm/s. The calculated vent rates are 43.1 m^3/s and 7.3 m^3/s, respectively. Because downwind toxic concentrations vary roughly linearly with vent rate, the lowering of spread rate by a factor of 10 would lower calculated toxicological consequences by approximately a factor of 6. By the same token, higher spread velocities would cause an increase in calculated vent rates and, therefore, an increase in predicted toxicological consequences. However, because a bounding high spread rate (10 cm/s) has been used in FSAR assessments, the chances that a solvent fire could spread faster than 10 cm/s are discounted as highly unlikely.

The discussions provided above on the impact of fire spread velocity on radiological and toxicological consequences apply for relatively large pools. For small pools (i.e., the 1 m^2 [10.8 ft^2] case), spread velocity is not an important factor in determining consequences. The reason is that the entire pool area becomes inflamed early during the course of a fire. Consequences would be driven by fire parameters applicable to the whole inflamed pool area, not by the small quantity of burning that would occur during the time of fire spread.

In summary, fire spread velocity affects predicted toxicological consequences for large pools, but spread velocity is unimportant for small pools. A bounding high velocity is used to analyze all FSAR pool fire sequences, so variations from the assumed velocity would result in lower predicted consequences. Radiological consequences are relatively insensitive to spread velocity, provided that structural insults on the tank by the fire do not result in significant radiological consequences.

Overpressure. An important assumption embodied in the discussion above is that the tank does not suffer dome collapse from the increased internal tank pressure from the fire with its potentially larger radiological consequences. The maximum overpressure resulting from a solvent fire in a DST is calculated to be 207 kPa (30 lb/in.^{2} gauge). This pressure will not result in DST dome collapse, as documented in LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*. The maximum overpressure calculated for the SST accident is 200 kPa (29 lb/in.^{2} gauge), given the SST structure does not fail. A structural analysis, WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks,* predicts that the concrete in the SST dome would crack at a pressure of 76 kPa (11 lb/in.^{2} gauge). As the dome cracks, more flow openings are created; hence the pressure is maintained constant until all the solvent fire extinguishes because of lack of oxygen. The concrete would adhere to the rebar, and the dome would not collapse. The predicted cracking would allow the pressure to vent to the soil above the tank. The approximately 2.4 m (8 ft) of soil on top of the tank would act as a filter and prevent a release to the atmosphere. Note that consequence calculations conservatively assume that all material is released via unfiltered vent paths.

Solvent Pool Area. The FSAR analyses have been carried out using pool areas in the range of 1 m^2 to 210 m^2 (10.8 ft^2 to 2,260 ft^2). The parametric analysis of the different pool fire cases shows that the maximum radiological doses occur with active ventilation systems. The release quantities are nearly the same for large and small pools. The reason for the insensitivity is that the quantity of radionuclides made airborne by the fire is proportional to the quantity of solvent burned, which is limited by the oxygen content of headspace air, not by the quantity of solvent in the tanks.

Toxicological consequences are predicted to be sensitive to pool area for the limiting SST and DST cases in which large vent paths are specified. This sensitivity may be illustrated by comparing overall toxicity sum-of-fractions for a 1-m^2 (10.8-ft^2) pool and a 210-m^2 (2,260-ft^2) pool. The onsite sum-of-fractions for these cases are 0.25 and 6.2, respectively. Thus, an increase in pool area by a factor of 210 results in an increase by a factor of 25 in calculated toxicological consequences.

The larger pool area used in the FSAR pool fire cases (210 m^2 [2,260 ft^2]) is a bounding high value. This area, roughly half the area of a 22.9-m- (75-ft-) dia waste tank, was selected by calculation to be sufficiently large so that fire spread (at 10 cm/s) would not be limited by pool area. Therefore, larger pool areas (greater than 210 m^2 [2,260 ft^2]) would not affect predicted consequences. For smaller pools, predicted toxicological consequences would be lower, as quantified in the foregoing paragraph.

Pool fires in DCRTs have been analyzed under the assumption that a solvent pool covered the entire waste surface (i.e., the pool area was assumed to be a maximum value [34.1 m^2]). A reduction in postulated pool area is predicted to result in lower consequences.

In summary, radiological consequences are predicted to be relatively insensitive to pool area. The reason is that the quantity of nuclides made airborne is limited by the mass of solvent burned which is, in turn, limited by the oxygen inventory in headspace air. Toxicological consequences are predicted to be sensitive to pool area because the vent rate of toxic gases increases with pool area for pools smaller than 210 m^2 (2,260 ft^2) in SSTs and DSTs. Because toxicological consequences were computed for pool areas of 1 m^2 (10.8 ft^2) and 210 m^2 (2,260 ft^2), consequences for pool sizes in this range would fall within the range computed for FSAR sequences. A pool that is 210 m^2 (2,260 ft^2) in area is larger than the area that can become inflamed before a lack of oxygen puts out the fire. Therefore, 210 m^2 (2,260 ft^2) provides the theoretical maximum consequences.

Fire Extinguishment at 13% Oxygen. Solvent pool fires in waste tanks are postulated to self-extinguish when headspace oxygen concentration falls to 13% on a molar basis. This assumption is based on results of solvent fire tests reported by Malet et al. (1983) and Jordan and Lindner (1983) and is consistent with the oxygen flammability limit for hydrocarbons (Lewis and Von Elbe 1987). Malet et al. (1983) reports oxygen extinguishment at 13% to 14.5% oxygen (molar basis), and Jordan and Lindner (1983) reports oxygen extinguishment in the 11% to 17.5% oxygen (molar basis) range. The tests conducted by Malet et al. (1983) are more representative of the Hanford Site scenario. The low end of Malet et al. (1983) results, 13%, was selected. The 13% limit is near the low end of the range (11% to 17.5%) measured in Jordan and Lindner (1983) and provides additional assurance that 13% is a reasonable number.

Toxicological consequences are driven mainly by release rate, a parameter that is not sensitive to oxygen extinguishment levels in the range of 13% O_2. Combustion rates are calculated to slow as extinguishment is approached. Thus, average release rates for the limiting cases of large vents would be little affected by the oxygen extinguishment level. Two other phenomena affect fire extinguishment: (1) limited fuel inventory and (2) oxygen supply by active ventilation.

Limited fuel inventory causes fire extinguishment before oxygen is depleted to the extinguishment level. The maximum solvent burn limited by headspace oxygen (13% extinguishment level in bounding SSTs and DSTs) is approximately 150 kg (50 gal). Therefore, any pool that contained less than 150 kg (50 gal) of solvent would extinguish earlier than predicted, resulting in lower radiological consequences. Toxicological consequences would be appreciably less only if solvent inventory was much less than 150 kg (50 gal). This is because release rate, which drives toxicological consequences, is determined by fire dynamics when oxygen levels are appreciably higher than the extinguishment limit.

The second phenomenon, a continuing supply of oxygen during the burn period, is not applicable to pool fire scenarios in Hanford Site waste tanks. The internal pressurization caused by the fire will prevent inflow induced by either the passive breathing systems found on most SSTs and the low volume, powered ventilation systems found on the DSTs, and some SSTs. See WHC-SD-WM-CN-032 for calculation of pressures. Because internal pressure would prevent oxygen inflow during the fire, the fire would extinguish on low oxygen level or on limited fuel inventory.

A reignition scenario was not included because reignition appears to be a low probability outcome of a pool fire; itself a low probability accident. Extensive studies of confined solvent fires (Malet et al. 1983) provide direct experimental evidence that pool fires self-extinguish at an oxygen concentration in the range of 13% by volume and do not reignite when air reenters. Reignition was not observed in any of the six small-scale tests (0.3-m^3 vessel) or any of the nine large-scale tests (400-m^3 concrete enclosure) reported by Malet et al. (1983).

For sufficiently small fires, pressurization caused by the fire may not overpressurize the ventilation system, and a continuing fire could result. This small fire scenario is discounted because of the following:

1. Small puddles would be unlikely to contain a solvent inventory greater than 150 kg (50 gal), hence consequences would be bounded by the cases analyzed.

2. Passive aerosol depletion mechanisms would mitigate consequences of a small fire continuing over many hours. Consequences would, therefore, be bounded by cases analyzed where passive depletion mechanisms have been neglected.

3. Soot aerosol from a small continuing fire would plug filters in the ventilation system, effectively shutting off the air inflow, which would cause the fire to self-extinguish.

In summary, fire extinguishment has been assumed to occur at 13% oxygen. While toxicological consequences are insensitive to extinguishment parameters, radiological consequences could be different if the oxygen extinguishment level were different than 13%. Consequences for fires over very small pools, where extinguishment could be limited by solvent inventory, are expected to fall below consequences for the bounding cases analyzed.

Tank Parameters. Tank parameters have been chosen to maximize the potential consequences of solvent pool fires. Specific parameters and their impact on calculated consequences are discussed as follows.

- **Headspace Air Volume**—In general, headspace air volumes were chosen to be bounding high volumes in order to maximize the mass of solvent burned. Radiological consequences increase with increasing solvent mass burned, so bounding large headspace volumes result in bounding radiological consequences. An example of the potential variation in headspace volume is presented as follows for SSTs.

  The maximum headspace volume assumed for SSTs is 4,816 m^3 (170,000 ft^3) and is estimated as the total volume of a 1-million-gallon SST, minus a minimum waste volume of 26,500 L (7,000 gal).

  The minimum headspace volume can be estimated by considering a full tank holding 1 million gallons (3,752 m^3 [134,000 ft^3]) of waste. Headspace volume for a full tank

is calculated as 4,816 m^3 (170,000 ft^3) + 26.5 m^3 (900 ft^3) - 3,752 m^3 (134,000 ft^3) = 1,044 m^3 (36,900 ft^3). Thus, headspace volume in SSTs varies from ~1,048 m^3 (37,000 ft^3) to 4,816 m^3 (170,000 ft^3). The smaller volume is 37/170 = 0.22 of the value assumed in FSAR cases, indicating that radiological consequences would be roughly 22% of the value predicted on the basis of the bounding headspace volume.

- **Vent Path Flow Capacity**—Tank vent path flow capacity was assigned several values to cover a range of possible values. A maximum pressure case was studied by assigning minimal vent path equivalent orifice sizes. For SSTs, the minimal vent was a 0.1-m- (3.75-in-) dia orifice that simulated the flow admittance of the HEPA filter vent pipe. For DSTs and DCRTs, the minimal vent was assigned a flow admittance of zero because of lack of better knowledge.

Maximum vacuum cases were run for SSTs and DSTs under the assumption that flapper valves, which opened at 6.89 kPa (1 lb/in.^{2} gauge), relieved pressure but closed on inflow. The flapper valve concept simulated the lifting of riser cover plates and pit covers with subsequent closure during post-fire cooldown.

These extremes in vent path flow admittances resulted in bounding pressures and vacuums that were reviewed by structural analysts. It was concluded that the bounding pressure and vacuum transients would not cause tank dome collapse. Therefore, it is concluded that dome collapse would not occur for any real pool fire accident and that radiological consequences for solvent pool fires could be ascribed to contaminants released from the fire itself. Source terms attributable to dome collapse are, thus, not applicable to pool fire accidents.

The large flapper valve vent path assumption leads to calculated vent rates that are bounding high values. Because toxicological consequences are driven by the release rate, the flapper valve vent cases resulted in bounding toxicological consequences. The impact of vent path flow admittance on toxicological consequences may be illustrated by comparing the total sum-of-fractions for SST large pool fires in tanks having a minimal vent (0.1-m- [3.75-in.-] dia orifice) with the sum-of-fractions calculated for the flapper valve and large orifice (1.27-m- [50-in.-] dia). The toxicological sum-of-fractions for these two cases is 0.59 and 6.2, respectively. These results differ by a factor of 10.5, illustrating the sensitivity of toxicological consequences to vent path flow admittance.

In summary, tank parameters used to analyze solvent pool fires were selected to yield bounding predicted consequences. Considering the range in possible headspace air volumes, predicted radiological consequences could be lower by a factor of five for a tank having a minimal headspace air volume. Bounding large vent paths result in bounding toxicological consequences that are a factor of 10 larger than would be computed for the minimal vent path.

- **Carryover of Aerosols with Vented Gases**—Radionuclides released from waste by a solvent pool fire would be airborne in particulate form. Inside the tank, the airborne particles would agglomerate and be depleted by sedimentation and plateout on surfaces. Such depletion would mitigate the release of radioactive material to the environs and thereby mitigate radiological consequences as compared with predictions that neglect aerosol depletion.

  Aerosol depletion has been neglected in all FSAR solvent fire cases analyzed. This neglect introduces a factor of conservatism into predicted consequences. For the large pool cases in SSTs and DSTs where the fire is calculated to extinguish within minutes, aerosol depletion is judged to be relatively unimportant; aerosol depletion has the potential to decrease calculated consequences by a factor of two or less. On the other hand, aerosol depletion would be more significant for the small pool cases in which the fire persists for nearly an hour. The relatively long time for aerosol agglomeration and fallout would probably lead to depletion factors as large as 10. A depletion factor of 10 would reduce calculated radiological consequences by a similar factor.

  Aerosol depletion would be less important with regard to toxicological consequences because only a fraction of the toxins would be particulate in form. Headspace gases, CO, and NO_2 would be present in gaseous form and would not be subject to aerosol depletion.

  In summary, aerosol depletion, a factor that would in reality mitigate accident consequences, has been neglected in the FSAR pool fire analyses. Aerosol depletion could mitigate radiological consequences of small pool fires by an order of magnitude, but would be less important for large pool cases.

Conclusions. The following conclusions summarize the sensitivity of predicted consequences to key assumptions and parameters:

1. Radiological consequences are predicted to vary mainly with the quantity of solvent burned. The dominant parameter is headspace air volume. Bounding large headspace volumes were assumed in FSAR analyses; considering the range in headspace volumes of SSTs and DSTs, predicted radiological consequences could vary from 20% to 100% of those predicted for the bounding cases.

2. Toxicological consequences are predicted to be driven mainly by the rate of release of toxic materials from the tank. Bounding values of vent path size, pool size, and pool spread rate have been used in the bounding toxicological cases. Possible ranges of these parameters can lead to predicted toxicological consequences that are an order of magnitude or lower than predicted for the bounding case.

3. Aerosol depletion, a factor that would mitigate accident consequences, could mitigate radiological consequences of small pool fires by an order of magnitude but would be less important for large pool cases.

3.4.2.4.5 Comparison With Guidelines. Table 3.4.2.4-8 compares the accident consequences (without controls) with the risk guidelines. As stated previously, the accident frequencies, both without and with controls, fall within the unlikely (10^{-4} to 10^{-2}) range. Review of consequences versus risk guidelines shows that radiological releases exceed both onsite or offsite risk guidelines for two scenarios. Case Q, a wick-stabilized fire on salt cake or sludge, and case G, a pool fire in an actively ventilated SST, exceed onsite risk guidelines for onsite radiological releases. The calculated release for case G is 6.09×10^{-2} Sv (6.09 rem) versus a risk guideline of 5.0×10^{-2} Sv (5.0 rem) and a release of 5.62×10^{-2} Sv (5.62 rem) for case Q versus a guideline of 5.0×10^{-2} Sv (5.0 rem) for the release without controls.

For toxicological releases, several cases exceed onsite guidelines. No offsite guidelines are exceeded. For the accident scenarios that are above the risk guidelines, discussion of continuing safety and risk assessment activities that are planned and underway is provided in the following section.

3.4.2.4.6 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems, and Components. The SST, DST, and AWF tanks have been designated Safety-Class with the safety function of maintaining gross structural integrity in the event of a tank vacuum or overpressurization event as a result of an organic solvent fire. These safety SSCs are summarized in Table 3.4.2.4-9.

Technical Safety Requirement Controls. Controls that reduce the probability of accidents are given in Table 3.4.2.4-7. The tanks where these controls are applied are identified by number in Table 3.4.2.4-10. All of the controls identified in Table 3.4.2.4-7 apply to each tank identified in Table 3.4.2.4-10 as having organic solvent fire potential.

Of the 177 DSTs and SSTs, 75 SSTs have been vapor-space sampled. Sixty-three of the sampled tanks do not have a positive test for organic solvent. Twelve of the sampled tanks have a positive test. The 102 tanks that have not been vapor-space sampled are assumed to potentially contain separable phase organic solvents and will have applied the controls specified in this section. The twelve tanks that have shown a positive test when vapor-space sampled will have applied the controls specified in this section. The 63 tanks that did not have a positive result when vapor-space sampled will not have applied the controls specified in this section. All tanks that will have controls applied are identified by a "Yes" in Table 3.4.2.4-10.

Defense-in-Depth. Defense-in-Depth controls are identified in Table 3.4.2.4-11.

Planned Safety and Risk Assessment. The safety SSCs and TSR controls developed for this accident provide a means to manage the interim risk associated with the organic solvent

hazard even though the risk guidelines are exceeded. However, additional safety and risk assessment is required to close the organic solvent issue and to reduce the risk to within the established guidelines. The organic solvent hazard is part of the existing safety issue on organics. WHC-EP-0914, *Project Plan for Resolution of the Organic Waste Tank Safety Issues at the Hanford Site*, outlines the steps that will be taken to resolve this safety issue. Also see Section 3.4.2.6 for a discussion of activities that are being undertaken as a result of this plan to address and resolve the safety issues associated with the organic salt-nitrate reaction hazard.

Two main elements defined in the project plan are related to organic solvents. The first element is the identification of the tanks in which the hazard exists. Identifying the hazard is a process involving vapor sampling of tank headspaces for nonmethane hydrocarbons and interpreting the results. The second element is improving the combustion model used for predicting tank behavior and refining/confirming the calculational release model used for predicting the amount of waste material released from the tank under accident conditions. It is expected that the combined results of the sampling process (identifies how many tanks are potential solvent tanks) and the improved combustion/calculational release models will show that the risk of organic solvent fires is within the risk guidelines, and that no additional measures (beyond those described in this FSAR) are required to mitigate the risk.

WHC-EP-0914 provides the logic and associated actions that are necessary to resolve and ultimately close the organic solvent issue. Specific project activities outlined in the plan include the identification of organic solvent tanks and improvements in calculational models. Consult the latest revision of the plan for details regarding these actions and their scheduled completion dates.

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Table 3.4.2.4-1. Summary of Annual Accident Frequencies Without Controls.

Scenario	Frequency lightning (per tank)	Frequency vehicle fire (per tank)	Frequency flame cutting (per tank)	Number of tanks	Accident Frequency (facility basis)
SST wick-stabilized fire	3.0 E-05	5.5 E-05	1.0 E-03	13	1.4 E-02
SST pool/ puddle fire	3.0 E-05	5.5 E-05	NA	14	1.2 E-03
DST pool/ puddle fire	3.0 E-05	5.5 E-05	NA	6	5.1 E-04
DCRT pool/ puddle fire	3.0 E-05	5.5 E-05	NA	6	5.1 E-04

DCRT = double-contained receiver tank.
DST = double-shell tank.
NA = not applicable.
SST = single-shell tank.

Table 3.4.2.4-2. Applicable Organic Solvent Accident Scenarios.

Scenario	Single-shell tanks	Double-shell tanks	Double-contained receiver tanks
Solvent pool fire	Yes	Yes	Yes
Wick-stabilized fire in salt cake or sludge	Yes	No	No
Condensed-phase organic reaction	Solvent fire can initiate given all conditions for condensed-phase reaction. Condensed-phase reaction dominates. See Section 3.4.2.6	No	No
Solvent contribution to head space flammability	Insignificant (less than 2% lower flammability limit). Flammable gas accident dominates. See Section 3.4.2.2.	Insignificant; same as single-shell tank	Insignificant; same as single-shell tank

Table 3.4.2.4-3. Bounding Cases from Parametric Studies.

Case	Tank type	Bounding parameter	Onsite radiological consequences Sv (rem)	Onsite toxicological consequences (SOF)	Pressure or vacuum kPa (lb/in.^{2} gauge)
Q Wick-stabilized fire in salt cake or sludge	SST	Radiological dose	5.62 E-02 (5.62 E+00)	10.5	
E Maximum pressure	SST pool passive vent	Pressure (9.5-cm orifice)			200 (29)
F Maximum vacuum	SST pool passive vent	Vacuum (137-cm orifice)			-46.9 (-6.8)
G Maximum radiological[1]	SST pool active vent	Radiological dose	9.3 E-02 (9.3 E+00)		
H Maximum toxic[1]	SST pool passive vent	Toxicological dose		44.3	
I Maximum pressure	DST pool	Pressure (sealed tank)			212 (30.8)
J Maximum vacuum	DST pool passive vent	Vacuum (127-cm orifice)			-55.2 (-8)
K Maximum radiological[1]	DST puddle (100 ft^3/min active vent)	Radiological dose	2.38 E-02 (2.38 E+00)		
L Maximum toxic[1]	DST pool (100 ft^3/min active vent)	Toxicological dose		40.5	
M Maximum pressure	DCRT pool	Pressure (sealed tank)			210 (30.5)
N Maximum vacuum	DCRT pool passive vent	Vacuum (10-cm orifice)			-8.27 (-1.2)
P Maximum radiological and toxicological	DCRT pool passive vent	Radiological and toxicological dose	6.46 E-04 (6.46 E-02)	4.68	

[1]Consequences for cases G, H, K, and L are calculated in Attachment 6, HNF-SD-WM-CN-099, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington.

DCRT = double-contained receiver tank.
DST = double-shell tank.
SOF = sum-of-fractions.
SST = single-shell tank.

Table 3.4.2.4-4. Solvent Mass Radionuclide Releases.

Case	Solvent burned (kg)	Equivalent solvent mass for radionuclide release calculations (kg)	Soot release (kg)	P_2O_5 release (kg)	CO release (kg)	NO_2 release (kg)
G	146.0	4.38	4.26	0.92	0.905	0.117
H	84.0	0.756	5.02	1.09	1.06	0.138
K	132.0	13.2	0.806	0.172	0.175	0.022
L	92.1	2.76	5.72	1.23	1.21	0.157
P	2.12	0.0197	0.131	0.028	0.28	0.004
Q	130.0	13.0	2.86	0.61	0.66	0.078

Table 3.4.2.4-5. Contributions to Radiological Dose.

Case	Headspace gas	Solvent smoke (%)	Aqueous boiloff (%)	HEPA filter rupture (%)
G	NA	0.2	74.8	25.0
H	NA	0.3	95.9	3.8
K	NA	1.8	97.8	0.4
L	NA	0.6	98.8	0.6
P	NA	0.1	31.7	68.2
Q	NA	1.0	72.0	27.0

HEPA = high-efficiency particulate air (filter).
NA = not applicable.

Table 3.4.2.4-6. Contributions to Toxicological Dose.

Case	Aqueous boiloff (%)	Headspace gases and solvent smoke (%)	Particulates (%)	HEPA filter (%)
G	0.5	18.7	45.0	35.8
H	2.0	32.9	65.0	0.1
K	1.7	37.8	53.5	7.0
L	2.0	32.4	65.4	0.2
P	1.0	30.0	68.0	1.0
Q	0.4	15.0	33.0	51.6

HEPA = high-efficiency particulate air (filter).

Table 3.4.2.4-7. Summary of Technical Safety Requirement Controls. (2 sheets)

Control	Safety function	Comments
Ignition controls • Intrusive Controls – Stop intrusive activities in tanks with a potential organic solvent hazard when lightning is identified within a 48-km (30-mi) radius of the tank farm.	Reduces frequency of lightning as an initiator of an organic solvent fire.	--
– If flame cutting is performed where debris could fall onto the waste surface in a tank with a potential organic solvent hazard, a barrier or device is required to prevent hot metal from falling on the waste surface.	Reduces frequency of flame cutting as an initiator of an organic solvent fire.	Pieces of hot metal from flame cutting may be capable of igniting salt cake or sludge that has entrained organic solvent in it.
• Vehicle controls – Vehicle access within the tank farms shall be limited to vehicles with fuel systems protected from damage caused by potential collisions with tank structures.	Prevent vehicle fuel system damage (i.e., fuel system leaks) in the event of collisions with tank structures within the tank farms.	--
– Physical barriers shall be established around tank structures outside the tank farm boundary to restrict vehicle access in the vicinity of aboveground waste tank structures. – Speed limit controls within tank farms.		
Emergency Preparedness Program with the following key element: • Response procedures.	Mitigate the consequences of an organic solvent fire.	Shutdown of active ventilation system will help prevent re-ignition.
HEPA filter controls • HEPA filter source term – Verify periodically that the HEPA filter housing radiation level is ≤2.0 E-03 Sv/h (≤200 mrem/h) on contact. – Replace the HEPA filters and prefilters before filter housing radiation levels exceed 2.0 E-03 Sv/h (200 mrem/h).	Reduce consequences from a possible HEPA filter failure by limiting the inventory available.	Applies to all HEPA filters, prefilters, and inlet filters in the ventilation system. Also protects accident analysis assumptions regarding HEPA filter release amounts.

Table 3.4.2.4-7. Summary of Technical Safety Requirement Controls. (2 sheets)

Control	Safety function	Comments
Transfer controls • Waste compatibility controls – Evaluate pumped and receiving tanks before waste transfers to ensure that controls for organic solvent fires are applied to the final state of the tank.	Ensure final tank states remain within analyzed topography of the organic solvent fire accident.	--

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington

HEPA = high-efficiency particulate air (filter).

Table 3.4.2.4-8. Summary of Consequences and Frequencies of Organic Solvent Fire Without Controls.

Accident	Consequences								Frequency Without controls
	Radiological Sv (rem)				Toxicological SOF				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
G, SST[a]	9.3 E-02 (9.3 E+00)	5.0 E-02 (5.0 E+00)	8.2 E-05 (8.2 E-03)	5.0 E-03 (5.0 E-01)	--	1 (ERPG-2)	--	1 (ERPG-1)	Unlikely
H, SST[a]	—	--	—	—	4.43 E+01	1 (ERPG-2)	2.8 E-01	1 (ERPG-1)	Unlikely
K, DST[a]	2.38 E-02 (2.38 E+00)	5.0 E-02 (5.0 E+00)	2.37 E-05 (2.37 E-03)	5.0 E-03 (5.0 E-01)	--	1 (ERPG-2)	--	1 (ERPG-1)	Unlikely
L, DST[a]	—	--	—	—	4.05 E+01	1 (ERPG-2)	2.93 E-01	1 (ERPG-1)	Unlikely
P, DCRT	6.46 E-04 (6.46 E-02)	5.0 E-02 (5.0 E+00)	5.43 E-07 (5.43 E-05)	5.0 E-03 (5.0 E-01)	4.68 E+00	1 (ERPG-2)	1.27 E-02	1 (ERPG-1)	Unlikely
Q, Entrained	5.62 E-02 (5.62 E+00)	5.0 E-03 (5.0 E-01)	4.92 E-05 (4.92 E-03)	1.0 E-03 (1.0 E-01)	1.05 E+01	1 (ERPG-1)	2.75 E-02	1 (PEL-TWA)	Anticipated

[a]Onsite and offsite consequences for cases G, H, K, and L are calculated in Attachment 6 of HNF-SD-WM-CN-099, 1998, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington.

DCRT = double-contained receiver tank.
DST = double-shell tank.
ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
SST = single-shell tank.
TWA = time-weighted average.

Table 3.4.2.4-9. Summary of Safety Structures, Systems, and Components for Organic Solvent Fire.

Structures, systems, and components	Safety classification	Safety function	Comments
Waste tanks	Safety-Class	The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during a tank vacuum or overpressurization event, thus decreasing the consequences of the Organic Solvent Fire accident.	Applies to SSTs, DSTs, and AWF tanks. Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.

AWF = Aging Waste Facility.
DOE = U.S. Department of Energy.
DST = double-shell tank.
ORP = Office of River Protection.
SST = single-shell tank.

Table 3.4.2.4-10. Organic Solvent Fire Topography. (6 sheets)

Tank	Organic solvent fire potential	Basis
Double-Shell Tanks		
241-AN-101	Yes	Not vapor space sampled
241-AN-102	Yes	Not vapor space sampled
241-AN-103	Yes	Not vapor space sampled
241-AN-104	Yes	Not vapor space sampled
241-AN-105	Yes	Not vapor space sampled
241-AN-106	Yes	Not vapor space sampled
241-AN-107	Yes	Not vapor space sampled
241-AP-101	Yes	Not vapor space sampled
241-AP-102	Yes	Not vapor space sampled
241-AP-103	Yes	Not vapor space sampled
241-AP-104	Yes	Not vapor space sampled
241-AP-105	Yes	Not vapor space sampled
241-AP-106	Yes	Not vapor space sampled
241-AP-107	Yes	Not vapor space sampled
241-AP-108	Yes	Not vapor space sampled
241-AW-101	Yes	Not vapor space sampled
241-AW-102	Yes	Not vapor space sampled
241-AW-103	Yes	Not vapor space sampled
241-AW-104	Yes	Not vapor space sampled
241-AW-105	Yes	Not vapor space sampled
241-AW-106	Yes	Not vapor space sampled
241-SY-101	Yes	Not vapor space sampled
241-SY-102	Yes	Not vapor space sampled
241-SY-103	Yes	Not vapor space sampled
Aging Waste Facility Tanks		
241-AY-101	Yes	Not vapor space sampled
241-AY-102	Yes	Not vapor space sampled
241-AZ-101	Yes	Not vapor space sampled
241-AZ-102	Yes	Not vapor space sampled
Single-Shell Tanks		
241-A-101	No	Vapor space sampling
241-A-102	No	Vapor space sampling
241-A-103	No	Vapor space sampling

Table 3.4.2.4-10. Organic Solvent Fire Topography. (6 sheets)

	Tank	Organic solvent fire potential	Basis
1	241-A-104	Yes	Not vapor space sampled
2	241-A-105	Yes	Not vapor space sampled
3	241-A-106	Yes	Not vapor space sampled
4	241-AX-101	No	Vapor space sampling
5	241-AX-102	No	Vapor space sampling
6	241-AX-103	No	Vapor space sampling
7	241-AX-104	Yes	Not vapor space sampled
8	241-B-101	Yes	Not vapor space sampled
9	241-B-102	No	Vapor space sampled
10	241-B-103	Yes	Vapor space sampling positive screen
11	241-B-104	Yes	Not vapor space sampled
12	241-B-105	No	Vapor space sampled
13	241-B-106	Yes	Not vapor space sampled
14	241-B-107	No	Vapor space sampled
15	241-B-108	Yes	Not vapor space sampled
16	241-B-109	Yes	Not vapor space sampled
17	241-B-110	Yes	Not vapor space sampled
18	241-B-111	Yes	Not vapor space sampled
19	241-B-112	Yes	Not vapor space sampled
20	241-B-201	Yes	Not vapor space sampled
21	241-B-202	No	Vapor space sampled
22	241-B-203	Yes	Not vapor space sampled
23	241-B-204	Yes	Not vapor space sampled
24	241-BX-101	Yes	Not vapor space sampled
25	241-BX-102	No	Vapor space sampled
26	241-BX-103	Yes	Vapor space sampling positive screen
27	241-BX-104	Yes	Vapor space sampling positive screen
28	241-BX-105	No	Vapor space sampled
29	241-BX-106	No	Vapor space sampled
30	241-BX-107	No	Vapor space sampling
31	241-BX-108	Yes	Not vapor space sampled
32	241-BX-109	Yes	Not vapor space sampled
33	241-BX-110	No	Vapor space sampled
34	241-BX-111	No	Vapor space sampled

Table 3.4.2.4-10. Organic Solvent Fire Topography. (6 sheets)

	Tank	Organic solvent fire potential	Basis
1	241-BX-112	Yes	Not vapor space sampled
2	241-BY-101	Yes	Vapor space sampling positive screen
3	241-BY-102	No	Vapor space sampling
4	241-BY-103	No	Vapor space sampling
5	241-BY-104	No	Vapor space sampling
6	241-BY-105	No	Vapor space sampling
7	241-BY-106	No	Vapor space sampling
8	241-BY-107	Yes	Vapor space sampling positive screen
9	241-BY-108	Yes	Vapor space sampling positive screen
10	241-BY-109	No	Vapor space sampling
11	241-BY-110	No	Vapor space sampling
12	241-BY-111	No	Vapor space sampling
13	241-BY-112	No	Vapor space sampling
14	241-C-101	Yes	Vapor space sampling positive screen
15	241-C-102	Yes	Vapor space sampling positive screen
16	241-C-103	Yes	Vapor space sampling organic solvent pool positive screen
17	241-C-104	Yes	Vapor space sampling inconclusive, lack of ventilation information
18	241-C-105	Yes	Vapor space sampling inconclusive, lack of ventilation information
19	241-C-106	Yes	Vapor space sampling inconclusive, lack of ventilation information
20	241-C-107	No	Vapor space sampling
21	241-C-108	No	Vapor space sampling
22	241-C-109	No	Vapor space sampling
23	241-C-110	Yes	Vapor space sampling
24	241-C-111	No	Vapor space sampling
25	241-C-112	No	Vapor space sampling
26	241-C-201	No	Vapor space sampled
27	241-C-202	No	Vapor space sampled
28	241-C-203	Yes	Vapor space sampled
29	241-C-204	Yes	Vapor space sampled positive screen
30	241-S-101	No	Vapor space sampled
31	241-S-102	No	Vapor space sampling
32	241-S-103	No	Vapor space sampled
33	241-S-104	Yes	Not vapor space sampled
34	241-S-105	No	Vapor space sampling

Table 3.4.2.4-10. Organic Solvent Fire Topography. (6 sheets)

	Tank	Organic solvent fire potential	Basis
1	241-S-106	No	Vapor space sampled
2	241-S-107	No	Vapor space sampled
3	241-S-108	No	Vapor space sampling
4	241-S-109	No	Vapor space sampled
5	241-S-110	No	Vapor space sampling
6	241-S-111	No	Vapor space sampling
7	241-S-112	No	Vapor space sampling
8	241-SX-101	Yes	Vapor space sampling inconclusive, lack of ventilation information
9	241-SX-102	Yes	Vapor space sampling inconclusive, lack of ventilation information
10	241-SX-103	Yes	Vapor space sampling inconclusive, lack of ventilation information
11	241-SX-104	Yes	Vapor space sampling inconclusive, lack of ventilation information
12	241-SX-105	Yes	Vapor space sampling inconclusive, lack of ventilation information
13	241-SX-106	Yes	Vapor space sampling inconclusive, lack of ventilation information
14	241-SX-107	Yes	Not vapor space sampled
15	241-SX-108	Yes	Not vapor space sampled
16	241-SX-109	Yes	Vapor space sampling inconclusive, lack of ventilation information
17	241-SX-110	Yes	Not vapor space sampled
18	241-SX-111	Yes	Not vapor space sampled
19	241-SX-112	Yes	Not vapor space sampled
20	241-SX-113	Yes	Not vapor space sampled
21	241-SX-114	Yes	Not vapor space sampled
22	241-SX-115	Yes	Not vapor space sampled
23	241-T-101	Yes	Not vapor space sampled
24	241-T-102	Yes	Not vapor space sampled
25	241-T-103	Yes	Not vapor space sampled
26	241-T-104	No	Vapor space sampling
27	241-T-105	Yes	Not vapor space sampled
28	241-T-106	Yes	Not vapor space sampled
29	241-T-107	No	Vapor space sampling
30	241-T-108	Yes	Not vapor space sampled
31	241-T-109	Yes	Not vapor space sampled
32	241-T-110	No	Vapor space sampling
33	241-T-111	Yes	Vapor space sampling positive screen
34	241-T-112	Yes	Not vapor space sampled

Table 3.4.2.4-10. Organic Solvent Fire Topography. (6 sheets)

	Tank	Organic solvent fire potential	Basis
1	241-T-201	Yes	Not vapor space sampled
2	241-T-202	Yes	Not vapor space sampled
3	241-T-203	Yes	Not vapor space sampled
4	241-T-204	Yes	Not vapor space sampled
5	241-TX-101	Yes	Not vapor space sampled
6	241-TX-102	Yes	Not vapor space sampled
7	241-TX-103	Yes	Not vapor space sampled
8	241-TX-104	Yes	Not vapor space sampled
9	241-TX-105	No	Vapor space sampling
10	241-TX-106	Yes	Not vapor space sampled
11	241-TX-107	Yes	Not vapor space sampled
12	241-TX-108	Yes	Not vapor space sampled
13	241-TX-109	Yes	Not vapor space sampled
14	241-TX-110	Yes	Not vapor space sampled
15	241-TX-111	No	Vapor space sampling
16	241-TX-112	Yes	Not vapor space sampled
17	241-TX-113	Yes	Not vapor space sampled
18	241-TX-114	Yes	Not vapor space sampled
19	241-TX-115	Yes	Not vapor space sampled
20	241-TX-116	Yes	Not vapor space sampled
21	241-TX-117	Yes	Not vapor space sampled
22	241-TX-118	No	Vapor space sampling
23	241-TY-101	No	Vapor space sampling
24	241-TY-102	No	Vapor space sampling
25	241-TY-103	Yes	Vapor space sampling positive screen
26	241-TY-104	No	Vapor space sampling
27	241-TY-105	Yes	Not vapor space sampled
28	241-TY-106	Yes	Not vapor space sampled
29	241-U-101	Yes	Not vapor space sampled
30	241-U-102	Yes	Not vapor space sampled
31	241-U-103	No	Vapor space sampling
32	241-U-104	Yes	Not vapor space sampled
33	241-U-105	No	Vapor space sampling
34	241-U-106	No	Vapor space sampling

Table 3.4.2.4-10. Organic Solvent Fire Topography. (6 sheets)

Tank	Organic solvent fire potential	Basis
241-U-107	No	Vapor space sampling
241-U-108	No	Vapor space sampling
241-U-109	No	Vapor space sampling
241-U-110	Yes	Not vapor space sampled
241-U-111	No	Vapor space sampling
241-U-112	No	Vapor space sampled
241-U-201	Yes	Not vapor space sampled
241-U-202	Yes	Not vapor space sampled
241-U-203	No	Vapor space sampling
241-U-204	No	Vapor space sampling
Double-Contained Receiver Tanks		
244-A	Yes	Not vapor space sampled
244-BX	Yes	Not vapor space sampled
244-CR TK-003	Yes	Not vapor space sampled
244-S	Yes	Not vapor space sampled
244-TX	Yes	Not vapor space sampled
244-U	Yes	Not vapor space sampled
Catch Tanks		
241-A-350	Yes	Not vapor space sampled
241-S-304	Yes	Not vapor space sampled
241-TX-302B	Yes	Not vapor space sampled
241-TX-302C	Yes	Not vapor space sampled
241-U-302A	Yes	Not vapor space sampled
241-UX-302A	Yes	Not vapor space sampled
241-A-417	Yes	Not vapor space sampled
241-AX-152	Yes	Not vapor space sampled
241-AZ-151	Yes	Not vapor space sampled
241-AZ-154	Yes	Not vapor space sampled
241-ER-311	Yes	Not vapor space sampled
241-EW-151	Yes	Not vapor space sampled
Miscellaneous Inactive Storage Facilities		
All	Yes	Not vapor space sampled

Table 3.4.2.4-11. Summary of Defense-in-Depth Controls for Organic Solvent Fire.

Control	Safety function	Comments
Vehicle positioning spotters	Spotters provide additional level of control in positioning cranes/ vehicles	Reduces probability of analyzed accident
HEPA filter replacement typically performed at 1.0 E-03 Sv/h (100 mrem/h)	Limits inventory available for release, limits dose rate to workers in vicinity of the filters	--
Ventilation stack CAM interlock systems	Limits release from tank headspace by stopping the ventilation exhaust fan.	Systems identified as safety SSCs for other accidents (e.g., Sections 3.3.2.4.2, and 3.4.2.9)

CAM = continuous air monitor.
HEPA = high-efficiency particulate air (filter).
SSC = structure, system, and components.

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3.4.2.5 In-Tank Fuel Fire/Deflagration. Vehicles are routinely used in the tank farms to support surveillance, sampling, maintenance, and construction activities. A vehicle accident in a tank farm could result in fuel from a ruptured vehicle tank spilling into a waste storage tank and igniting. The resulting fire from either a gasoline or diesel fuel spill has the potential to cause a fire or deflagration in the headspace of the tank and challenge the ventilation system. A deflagration may also damage the structural integrity of the tank, causing an uncontrolled release of radioactive and hazardous gases, aerosols, and particulate material from the tank headspace, ventilation system, and the tank waste.

The scope of this analysis includes DSTs, DST annuli, SSTs, DCRTs, catch tanks, and MISFs. The category of SSTs includes both 100 Series (2 million L [500,000 gal] and larger) and 200 Series (208,000 L [55,000 gal]) tanks. The category of DSTs also includes AWF tanks.

3.4.2.5.1 Scenario Development. In assessing the results of fuel spills from vehicles, two possible scenarios are considered. The first scenario is a pool fire in which the vehicle fuel burns on the surface of the waste. The second scenario is a headspace deflagration in which vaporized fuel causes the headspace volume to reach the LFL, and the headspace is then ignited. The difference between the two scenarios is the physical state of the fuel when ignition occurs.

Each of the two scenarios could occur with either of two fuels: diesel fuel or gasoline. Vehicles using either fuel are allowed in the farms. Therefore, four combinations are possible:

- Pool fires involving diesel fuel
- Pool fires involving gasoline
- Headspace deflagrations with diesel fuel
- Headspace deflagrations with gasoline.

Accident Scenarios Without Controls. Both scenarios without controls are initiated by an errant vehicle that shears off one or more tank risers and ruptures the vehicle fuel tank. The maximum amount of vehicle fuel available in an accident is 227 L (60 gal) (the capacity of the largest fuel tank on any vehicle that enters the tank farms). Spilling the maximum amount of fuel into the tank would mean that the vehicle remains over the tank opening after coming to a stop. Some spilled fuel enters the waste tank through the damaged riser, and some is vaporized or aerosolized as the fuel drains into the tank. The remaining portion of the fuel pools on the waste surface.

- **Vehicle Fuel Pool Fire in Waste Tank**—The primary assumption for this scenario is that some of the spilled vehicle fuel enters the waste tank but is not immediately ignited. Instead, the fuel pools on the surface of the waste and vaporizes. However, the fuel is ignited before the LFL is reached in the headspace, and a pool fire results.

  The pool fire can occur with either gasoline or diesel fuel. The analysis for organic solvent fires is a very close match with a potential diesel fuel fire. The diesel pool fire

is the more likely case (especially because the 60-gal maximum fuel tank size is for diesel fuel from a crane). The following sections address the similarities and present the appropriate conclusions.

Pool Fires Involving Diesel Fuel.

SSTs. For SSTs, this accident scenario involving diesel fuel would be bounded by the analysis for SSTs given in Section 3.4.2.4. The maximum amount of fuel that would burn in an SST before oxygen extinguishment would be approximately 193 L (51 gal) (WHC-SD-WM-CN-059, *Calculation Notes That Support Accident Scenario and Consequence Determination of the In-Tank Fuel Fire/Deflagration*). The energy content and release rate would be about the same for the 193 L (51 gal) as for the maximum amount of solvent that burns in an SST. Therefore, the pressures, vacuums, and release rates generated by the fire would be equivalent to those generated by the organic solvent pool fire accident. Release paths to the environment would be through the ruptured filters on the ventilation system and through the sheared-off riser opening. The tank structure would not fail.

DSTs. For DSTs, this accident scenario for diesel fuel would be bounded by the analysis for DSTs given in Section 3.4.2.4. Using the same methodology given in WHC-SD-WM-CN-059 for calculating the equivalent quantity of fuel, the maximum amount of fuel that would burn in a DST before oxygen extinguishment would be about 174 L (46 gal) (WHC-SD-WM-CN-059). The energy content and release rate would be about the same for the 174 L (46 gal) of fuel as for the maximum amount of solvent that burns in a DST. Therefore, the pressures, vacuums, and release rates generated by the fire would be equivalent to those generated by the organic solvent pool fire accident. Release paths to the environment would be through the ruptured filters on the ventilation system and through the sheared-off riser opening. The tank structure would not fail.

DST Annuli. No calculations were specifically performed for the occurrence of this accident scenario in a DST annulus. This accident scenario for diesel fuel would be bounded by the DST analysis in Section 3.4.2.4. A fire would not generate enough pressure to cause the tank to fail. None of the DSTs are known to have leaked; therefore, no waste should be present inside the annulus to contribute to a radiological or toxicological dose. Even if a leak had occurred, the waste would be the same as the waste inside the tank, which was used to calculate consequences for a DST fire. For the same reason, neither the radiological nor toxicological loading of the annulus ventilation system filters would be greater than the loadings for the main tank ventilation system. The contribution of the filters on the primary tank ventilation system is given in Section 3.4.2.4.

DCRTs. For diesel fuel in the DCRTs, this accident scenario would be bounded by the analysis for DCRTs given in Section 3.4.2.4. Using the same methodology given in WHC-SD-WM-CN-059 for calculating the equivalent quantity of fuel, the maximum amount of fuel that would burn in a DCRT before oxygen extinguishment would be about 4 L (1 gal). The energy content and release rate would be about the same for the 4 L (1 gal) of fuel as for the maximum amount of solvent that burns in a DCRT. Therefore, the pressures, vacuums, and release rates generated by the fire would be equivalent to those generated by the organic solvent pool fire. Release paths to the environment would be through the ruptured filters on the ventilation system and through the sheared-off riser opening. The tank structure would not fail.

Catch Tanks and MISFs. No calculations were specifically performed for catch tanks and MISFs. Both types of tanks are of various shapes and sizes, and information about the contents of these tanks is incomplete. The quantity of waste in these tanks is minuscule compared with the quantity in the large tanks. Most of the waste in these tanks is left over from transfers and processing of the waste in the large tanks. Therefore, it is reasonable to assume that the concentrations of material available for release are no larger than those in the large tanks. Stating on an a priori basis that this accident would always be bounded by the solvent pool fire accident described in Section 3.4.2.4 is not possible. However, because the quantity of material available for release is smaller and the concentrations of material are no larger, it is reasonable to assume that the consequences of an accident would be bounded by a deflagration as described in Section 3.4.2.2. Additionally, the size and configuration of the risers on these tanks, if even available, further reduce the possibility of a fuel fire or deflagration.

Pool Fires Involving Gasoline.

The same scenarios used in the diesel fuel fires apply to gasoline pool fires. The differences in burning gasoline and diesel fuel are small. The key parameters (except for flame spread rate) are very similar. Four cases were evaluated for gasoline to verify the similarities of pool fire scenarios discussed for diesel fuel. The variations in the key parameters of the two different fuels burning are discussed below.

The heat of combustion of gasoline (44.1 MJ/kg) is slightly higher than that for diesel fuel (41.1 MJ/kg). The flame spread rate for gasoline is significantly higher than for diesel fuel or solvent (i.e., 2 m/s for gasoline versus only 10 cm/s for diesel fuel or solvent). The oxygen extinguishment point for gasoline is 12 mol%; for diesel fuel or solvent, it is 13 mol%.

The diesel fuel (or organic solvent) pool fire scenario evaluated a burning pool area of 210 m^2. A gasoline pool fire of this size inside a waste tank could not be

postulated because (1) the amount of available fuel is limited to 227 L (60 gal) and (2) the vapor pressure of gasoline is significantly higher than that of either diesel fuel or organic solvent. The higher vapor pressure will result in much higher evaporation, transitioning the accident to a headspace deflagration which is discussed later in this section. The conservative pool size used in the gasoline pool fire is 100 m^2 based on the logic provided.

Extending the development of the accident analysis presented in Section 3.4.2.4, it was possible to select four cases that would accurately represent the bounding gasoline pool fire consequences. The four cases selected are as follows:

1. A gasoline puddle fire. This case was selected to maximize radiological consequences in an SST.

2. A large gasoline pool fire in an SST. This case was chosen to maximize the pressure created in the headspace of the SST.

3. A large gasoline pool fire in an SST. This case was chosen to maximize the toxicological consequences in an SST.

4. A large gasoline pool fire in a DST. This case was selected to maximize both radiological and toxicological consequences in a DST.

A fifth case involving a large gasoline pool fire in a sealed DST was initially evaluated. This case was run to determine the maximum pressure created by the gasoline burn in the sealed DST. All of the available fuel (i.e., 227 L [60 gal]) was consumed before failure pressure of the DST was reached. No further discussion is provided on this case. The analyses of these cases are documented in calculation note HNF-SD-WM-CN-121, *Consequences of Potential Gasoline Pool Fires*.

- **Vehicle Fuel Deflagration in the Headspace**—The primary assumption for this scenario is that some of the spilled fuel enters the waste tank but is not immediately ignited. Instead, the fuel pools on the surface of the waste and begins to vaporize. The LFL is reached and the vaporized fuel ignites in the headspace. This scenario is similar to the flammable gas deflagration scenarios (Section 3.4.2.2) in terms of the total energy available for combustion and in-tank pressures reached during the burn.

The deflagration results from evaporation of either diesel fuel or gasoline. The evaporation of gasoline to form a flammable mixture in the headspace is a more rapid, higher likelihood event. The consequences of a gasoline vapor deflagration would also be similar to those for a diesel fuel vapor deflagration. Therefore, this section addresses the gasoline vapor deflagration, which bounds the diesel fuel vapor deflagration.

The peak pressure from a gasoline (or diesel) burn is approximately equivalent to the peak pressure of a hydrogen burn. This statement is based on information about closed vessel deflagrations in NFPA (1988), *The SFPE Handbook of Fire Protection Engineering*, which relates peak pressure to flame temperatures. More details are provided in WHC-SD-WM-CN-059. The burning velocity of hydrogen is about eight times greater than that of either diesel fuel or gasoline. The AICC pressures for combustion of heavy hydrocarbon vapors (i.e., diesel fuel or gasoline) are in the range of 608 to 710 kPa (88 to 103 lb/in.^{2} gauge) which is similar to that of hydrogen.

SSTs. Because transfers to SSTs are not allowed, the existing volume of waste in each SST will not increase. The quantity of fuel required to reach the LFL was calculated for each SST. The results are given in WHC-SD-WM-CN-059. In 115 SSTs, 227 L (60 gal) are sufficient to reach the LFL in a well-mixed vapor space. The failure mechanism is described in Section 3.4.2.2.

DSTs. The volume of waste in DSTs may either increase or decrease. The LFL can be reached in a full DST (1,057 cm [416 in.] of waste) with 62 L (16.3 gal) of fuel present. A tank containing approximately 411 cm (162 in.) of waste can reach the LFL with 227 L (60 gal) of fuel present. If a tank contains less than 411 cm (162 in.) of waste, the LFL cannot be reached because of the maximum fuel assumption of 227 L (60 gal). The failure mechanism is described in Section 3.4.2.2.

DST Annuli. The LFL can be reached in the annulus of a DST with 37 L (9.9 gal) of fuel present. The annuli of DSTs are assumed to be empty; therefore, the volume of fuel needed to reach the LFL does not depend on waste volume in the annulus. Because ignition of the vapor at the LFL inside a tank can result in failure of the tank structure, a deflagration in the annulus is assumed to also cause failure of the tank structure. The failure mechanism would be similar to and bounded by that described in Section 3.4.2.2.

200-Series Tanks, DCRTs, Catch Tanks, and MISFs. A 200 Series tank is an SST with a volume of 208,000 L (55,000 gal). DCRTs, catch tanks, and MISFs all have significantly smaller volumes. The LFL could be reached in an empty 200 Series tank with approximately 14 L (3.7 gal) of fuel. On the basis of this number, it can be assumed that the LFL could be reached or exceeded in a DCRT, MISF, or catch tank with very little fuel present. No calculations were specifically performed for catch tanks and MISFs. Therefore, whether a deflagration in one of these tanks would cause failure of the tank is not definitely known.

The tanks are of various shapes and sizes. Information about the contents of the tanks is incomplete, but the quantity of waste in these tanks is minuscule

compared with the quantity in the large tanks. Most of the waste in these tanks is left over from transfers and processing of the waste in the large tanks. Therefore, it is reasonable to assume that the concentrations of material available for release are no greater than those in the large tanks. Because the quantity of material available for release is smaller and the concentrations of material are no greater, it is reasonable to assume that the consequences of an accident would be bounded by a deflagration as described in Section 3.4.2.2.

Accident Frequency Without Controls. For both accident scenarios without controls, the frequency category assigned is "unlikely" (10^{-4} to 10^{-2}). The frequencies are calculated in WHC-SD-WM-CN-037, *Frequency Analysis of Vehicle Fuel Release Resulting in Waste Tank Fire*.

Accident Scenario With Controls. The controls specified in Section 3.4.2.5.5 prevent the accident by protecting the vehicle fuel tanks from being punctured. A collision may occur; but without a punctured fuel tank, no fuel is released and the accident scenarios cannot occur. Therefore, scenarios with controls have not been developed.

Accident Frequency With Controls. The controls specified in Section 3.4.2.5.5 prevent the accident by protecting the vehicle fuel tanks from being punctured. The potential failure of these controls is addressed in Section 3.4.3.

3.4.2.5.2 Source Term Analysis.

Accident Source Term Without Controls. The source term for the vehicle fuel pool fire using diesel fuel is the same as the source term defined for the organic solvent pool fire in Section 3.4.2.4. For gasoline pool fires, the source term was modified by deleting the phosphorous pentoxide as one of the toxic chemicals evaluated in Section 3.4.2.4. No other changes were made to the source term presented in Section 3.4.2.4. The source term for the vehicle fuel fire deflagration is the same as defined for DSTs and SSTs in Section 3.4.2.2.

Accident Source Term With Controls. There is no source term for the accident with controls because the controls specified in Section 3.4.2.5.5 prevent the accident by protecting the vehicle fuel tanks from being punctured.

3.4.2.5.3 Consequence Analysis. The radiological and toxicological consequences for the vehicle diesel fuel pool fire accident scenarios, except for MISFs and catch tanks, are bounded by the cases from Section 3.4.2.4 and those listed in Table 3.4.2.4-8. The radiological and toxicological consequences for a vehicle fuel pool fire in a MISF or catch tank are bounded by the SST flammable gas deflagration accident scenario described in Section 3.4.2.2. The consequences for the vehicle fuel deflagration accident scenario are bounded by the consequences of the flammable gas deflagrations analyses given in Section 3.4.2.2.

The consequences of the four gasoline pool fire cases summarized in Section 3.4.2.5.1 are very similar to the consequences calculated for the solvent pool fire (Section 3.4.2.4) and are presented in Table 3.4.2.5-1.

Key Parameters and Assumptions. To determine the frequency of the scenarios without controls (i.e., "unlikely"), the number of vehicle entries per year was assumed to be 520/yr for DSTs and 1,040/yr for SSTs. However, because the controls identified are preventive in nature, the number of vehicle entries per year is not a critical parameter. The following key assumptions are important to the accident consequences:

- The source term for the vehicle fuel fire deflagration is bounded by that defined for both DST and SST deflagrations in Section 3.4.2.2.

- The largest amount of fuel available to flow into a tank is 227 L (60 gal). This maximum amount applies both to the vehicle fuel (diesel and gasoline) pool fire and the vehicle fuel fire deflagration.

- The ventilation model described in Section 3.4.2.4 applies to the vehicle fuel pool fire (diesel and gasoline).

- The structural criteria documented in WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*, apply to the vehicle fuel pool fire.

3.4.2.5.4 Comparison With Guidelines. For organic solvent (or diesel fuel) pool fire case "G" (from Table 3.4.2.4-8) the onsite radiological consequences exceed the risk guidelines without controls. For the gasoline pool fire, case "1" shown in Table 3.4.2.5-1, the onsite radiological consequences are exceeded also. For all diesel fuel or gasoline pool fire cases, the onsite toxicological consequences exceed the risk guidelines without controls.

Because gasoline is slightly more energetic, some of the consequences for the gasoline pool fire exceed those calculated for the organic solvent fire accident in Section 3.4.2.4. Although the numerical consequences for specific scenarios may have increased for the gasoline pool fire, substituting gasoline for solvent or diesel fuel does not change whether or not a scenario meets or exceeds the risk guidelines.

For fuel headspace deflagrations without controls, both the onsite and offsite radiological and toxicological consequences exceed guidelines as discussed in Section 3.4.2.2.

3.4.2.5.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems, and Components. No safety SSCs were selected to mitigate the risk associated with the accident.

Technical Safety Requirement Controls. The TSR controls shown in Table 3.4.2.5-2 are applicable to all the DSTs (including annuli), SSTs (100 and 200 Series), DCRTs, catch tanks, and MISFs. A vehicle fuel fire deflagration cannot occur in all SSTs. However, the vehicle fuel (diesel or gasoline) pool fire could occur in all tanks. Because the controls apply to both accident scenarios, the controls must be imposed on all tanks.

Defense-in-Depth. Controls that provide Defense-in-Depth are shown in Table 3.4.2.5-3.

References

HNF-SD-WM-CN-121, 1997, *Consequences of Potential Gasoline Pool Fires*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

NFPA, 1988, *The SFPE Handbook of Fire Protection Engineering*, First Edition, National Fire Protection Association, Quincy, Massachusetts.

WHC-SD-TWR-RPT-002, 1996, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks,* Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-037, 1996, *Frequency Analysis of Vehicle Fuel Release Resulting in Waste Tank Fire*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-059, 1996, *Calculation Notes That Support Accident Scenario and Consequence Determination of the In-Tank Fuel Fire/Deflagration*, Rev. 1-A, Westinghouse Hanford Company, Richland, Washington.

Table 3.4.2.5-1. Summary of Consequences and Frequencies of a Gasoline Pool Fire Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Case 1-Gasoline Puddle Fire in SST	6.0 E-02 (6.0 E+00)	5.0 E-02 (5.0 E+00)	5.1 E-05 (5.1 E-03)	5.0 E-03 (5.0 E-01)	2.8 E+00	1 (ERPG-2)	6.3 E-03	1 (ERPG-1)	Unlikely
Case 2-Large Gasoline Pool Fire in SST (max pressure)	9.0 E-03 (9.0 E-01)	5.0 E-02 (5.0 E+00)	7.7 E-06 (7.7 E-04)	5.0 E-03 (5.0 E-01)	2.2 E+00	1 (ERPG-2)	5.1 E-03	1 (ERPG-1)	Unlikely
Case 3-Large Gasoline Pool Fire in SST (max toxic consequences)	1.1 E-02 (1.1 E+00)	5.0 E-02 (5.0 E+00)	9.6 E-06 (9.6 E-04)	5.0 E-03 (5.0 E-01)	4.6 E+01	1 (ERPG-2)	4.9 E-01	1 (ERPG-1)	Unlikely
Case 4-Large Gasoline Pool Fire in a DST (max rad and toxic consequences)	3.4 E-02 (3.4 E+00)	5.0 E-02 (5.0 E+00)	2.9 E-05 (2.9 E-03)	5.0 E-03 (5.0 E-01)	4.6 E+01	1 (ERPG-2)	5.0 E-01	1 (ERPG-1)	Unlikely

DST = double-shell tank.
ERPG = Emergency Response Planning Guideline.
SOF = sum-of-fractions.
SST = single-shell tank.

Table 3.4.2.5-2. Summary of Technical Safety Requirement Controls for In-Tank Fuel Fire/Deflagration.

Control	Safety function	Comments
Ignition controls • Vehicle controls - Vehicle access within the tank farms shall be limited to vehicles with fuel systems protected from damage caused by potential collisions with tank structures.* - Physical barriers shall be established around tank structures outside the tank farm boundary to restrict vehicle access in the vicinity of aboveground waste tank structures. - Establish controls to limit vehicle speeds within the tank farms.	Prevent vehicle fuel system damage (i.e., fuel system leaks) in the event of collisions with tank structures within the tank farms.	Controls apply to all the SSTs (100 and 200 Series), DSTs (including annuli), DCRTs, catch tanks, and MISFs.
Emergency Preparedness Program with the following key element: • Response procedures.	Mitigate the consequences of an in-tank fuel fire/deflagration.	Controls apply to all the SSTs (100 and 200 Series), DSTs (including annuli), DCRTs, catch tanks, and MISFs.

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

*Vehicle fuel system protection may include mechanical protection such as a skid plate on the fuel tank or reservoir tanks physically located higher than risers or vehicles axles.

DCRT = double-contained receiver tank.
DST = double-shell tank.
MISF = miscellaneous inactive storage facility.
SST = single-shell tank.

Table 3.4.2.5-3. Summary of Defense-in-Depth Controls for In-Tank Fuel Fire/Deflagration.

Control	Safety function	Comments
Vehicle positioning spotters	Spotters provide additional level of control in positioning cranes/vehicles.	Reduces probability of the analyzed accident

3.4.2.6 Organic Salt-Nitrate Reaction. Sodium salts of complexants used in fuel processing and isotope separation (e.g., EDTA, HEDTA, glycolate, citrate) were deposited in waste storage tanks (first in SSTs then others) as processing waste. Additional salts developed as a product of waste degradation (aging).

3.4.2.6.1 Conditions Leading to Accidents. Two common hazards are associated with safe storage and handling of chemically reactive material: (1) spontaneous self-accelerating decomposition reactions in the material (bulk or chemical runaway) and (2) deflagration after being initiated by an ignition source (point source ignition and propagation). Both accident scenarios involving organic salt-nitrate reactions in waste tanks are discussed in the following subsections.

The scenario for bulk runaway involves (1) a loss of active cooling (on a tank with a high heat load) that causes the waste to heat up to the self-accelerating decomposition temperature; (2) chemical heating resulting from decomposition that raises the waste temperature; which in turn accelerates the chemical reaction; and (3) an accelerated bulk runaway that continues until the chemical reactants are consumed. The high temperatures and gases pressurize the tank, and large quantities of radiological and toxicological materials are released to the environment.

The scenario for point source ignition is as follows: (1) combustible waste is created by concentrating the combustible organic chemicals that were part of the waste added to the tanks; (2) a portion of the waste dries to combustible conditions; (3) an ignition source of sufficient energy and temperature contacts the combustible waste and a propagating reaction is initiated; (4) the combustion front spreads through the combustible waste, causing pressurization of the tank, and large quantities of radiological material and toxic chemicals are released to the environment; and (5) the reaction continues until all contiguous waste is consumed.

Safety Criteria. Safety criteria based on weight percent organic and weight percent water have been developed for organic salt-nitrate wastes as described in WHC-SD-WM-CN-058, *Compilation of Calculation Notes in Support of Organic Salt-Nitrate Reactions Safety Analysis*. Waste considered "safe" cannot sustain a propagating reaction even if the waste is raised to ignition temperatures. Waste considered "conditionally safe" has a low risk of being reactive but could become "unsafe" if allowed to dry (Figure 3.4.2.6-1). No Hanford Site tank wastes are considered "unsafe" at this time. Section 3.4.2.6.2 describes these safety groups in more detail.

Potential Initiators. Condensed-phase reactions of organic salt-nitrate mixtures are difficult to initiate because they require strong ignition sources with higher temperatures and available energies. Only a few ignition sources have the potential to initiate these reactions. These are discussed in Section 3.4.2.6.2.

Chemical Runaway Potential. Hanford Site tank wastes stored in SSTs have been assessed for chemical runaway using techniques from the chemical processing industry (Attachment 2 of WHC-SD-WM-CN-058). The assessment concluded that conditions leading to a chemical runaway in the passively ventilated tanks are not realistic and are assigned to be

beyond extremely unlikely in this analysis. In addition, spontaneous runaway of the wastes stored in actively ventilated SSTs is not realistic while ventilation is maintained. Ventilation is required for these tanks to address flammable gas hazards (Section 3.4.2.2). The heat up rate following a loss of ventilation in actively ventilated tanks (i.e., some SSTs, all DSTs, and all AWF tanks are actively ventilated) has been calculated and experienced for several tanks (e.g., Tank 241-C-106) and is very slow. Heatup to high temperatures is therefore prevented by maintaining cooling through active ventilation and periodic water additions to Tank 241-C-106.

Conditions for Chemical Runaway. The threshold temperature for significant chemical heating is not known exactly. The waste temperature in tanks is required to be ≤121 °C (250 °F) to prevent the tank waste from reaching a chemical runaway threshold temperature. This Safety Limit is conservatively selected based on the lowest observed chemical heating of waste surrogates occurring at 150 °C (302 °F). Further analysis and testing is being pursued to determine the actual threshold temperature for chemical runaway. Maintaining the waste at or below steam saturation temperatures will prevent both tank bumps and chemical runaways. The temperature limit set for SSTs, DSTs, and AWF tanks to prevent tanks bumps (Section 3.4.2.11) will conservatively also prevent a chemical runaway. Therefore, temperature monitoring and response actions required for these tanks to address steam bump hazards also prevent potential chemical runaway events. Therefore, temperature monitoring and response actions required for these tanks to address steam bump hazards also prevent potential chemical runaway events.

Any proposed changes to the physical configuration of the waste tanks to which this safety limit applies (Table 3.4.2.6-1) requires a safety evaluation. A safety evaluation will ensure that conditions that could lead to a chemical runaway reaction are not created as a result of the proposed change.

Preventing Tank Bump Prevents Chemical Runaway. Excessive radioactive decay heating of the tanks can first lead to solution boiling, which could result in a thermal rollover phenomenon known as a "tank bump." This accident is analyzed in Section 3.4.2.11. The safe indicated temperature limit specified to prevent tank bump in SSTs is 96 °C (205 °F). The following SSTs have sufficient decay heating in them to initiate a tank bump: 241-C-106, 241-SX-103, 241-SX-107 through -112, and 241-SX-114. Additionally, all DSTs and AWF tanks have sufficient decay heat to initiate a tank bump if not properly cooled. The temperature limit for chemical runaway is well above the solution boiling temperature. Therefore, the high heat tanks identified above for tank bump encompass all of the tanks that may be susceptible to chemical runaway. Because the safe limit is probably closer to 150 °C (302 °F) than 96 °C (205 °F), some of the tanks susceptible to tank bump contain insufficient decay heat to initiate a chemical runaway. Using the identified tanks and temperature limits of the tank bump accident is conservative to preclude chemical runaway until a chemical runaway threshold limit is established.

Controlling temperatures of waste to below 96 °C (205 °F) will prevent chemical runaway. The balance of this evaluation will focus on excluding point source ignition of the wastes.

Potential Hazard Locations. The organic salt-nitrate reaction hazard may exist in any location where dry, fuel-rich organic waste exists. Because of the lack of waste condition information (fuel and moisture) in many of the TWRS waste storage facilities, the organic salt-nitrate combustion hazard is assumed to apply to following facilities for the purposes of this analysis:

- SSTs
- DSTs
- AWF tanks
- DCRTs
- MISFs
- Catch tanks
- 244-AR Vault
- Waste transfer lines
- COBs.

The SSTs were selected for evaluation for this hazard based on the fact that the largest quantities of dried waste were known to be present in these tanks. Some of the DSTs contain sufficient fuels in their wastes that, if dried, could become an organic salt-nitrate hazard. Both the DSTs and AWF tanks are maintained at high moisture levels, which preclude organic salt-nitrate reactions. Some of the DCRTs may contain dried wastes. Little information is available on the MISFs. Some fraction of these tanks may contain potentially hazardous amounts of fuel. The catch tanks typically are used for dilute solutions (e.g., waste water) and are not expected to contain high-level wastes. The 244-AR Vault is out of service but the tanks and sumps contain some quantities of uncharacterized waste. The waste transfer lines are usually drained and flushed after use and should contain little residue. Some COBs may contain dried wastes.

Most of the tank waste fuel concentrations are too low or the wastes are too wet to support propagation. This analysis assumes that less than 10 tanks contain significant amounts of potentially combustible waste based on statistical evaluation and process history. As reported in WHC-SD-WM-CN-058, four of 67 measured tanks were determined to be "conditionally safe." Based on statistical comparisons, no more than six of the remaining 82 unmeasured ("unassigned") tanks are expected to be categorized as "conditionally safe" when their wastes are sampled. It is possible that one or more of the "unassigned" tanks may be found to contain "unsafe" waste. Evaluations of process and transfer histories and analyses of variance projections from measured tanks both indicate that the 82 "unassigned" tanks should have lower total organic carbon (TOC) values than the measured tanks. Ignition controls will be applied to tanks of all categories where the wastes are not shown to be wet. Salt well pumping of "unassigned" tanks will be prevented until it can be shown that the wastes will be safe in their post-pumped state. These controls will maintain safety until the 82 "unassigned" tanks can be measured and appropriately categorized. Categorization will allow controls to be more precisely applied to the tanks.

3.4.2.6.2 Scenario Development. The species and concentrations of organic salts that may be present in tank wastes were determined based on (1) waste samples, (2) historical Hanford Site records of organic chemicals routed to the tanks, and (3) theoretical studies and experiments of chemical degradation of those organic chemicals.

Categories for Tank Wastes. A combustion assessment (WHC-SD-WM-ER-496, *The Contact-Temperature Ignition (CTI) Criterion for Propagating Chemical Reactions Including the Effect of Moisture and Application to Hanford Waste*) focusing on the analysis of the organic complexants and their degradation products was conducted to set fuel moisture and temperature limits. Figure 3.4.2.6-1 shows the limits. These limits were used to derive the combustibility and ignition frequency of the waste. TOC is not a direct measure of combustibility; however, waste TOC measurements are the primary available data regarding the organic content of the waste, and TOC use in this analysis is conservative. The combustibility of waste and its relationship to TOC are described in WHC-SD-WM-ER-496. Because TOC measurements include both combustible and noncombustible species, gross TOC is higher than the smaller combustible TOC fraction. Tanks have been categorized and grouped according to "safe," "conditionally safe," "unsafe," and "unassigned" groups. Figure 3.4.2.6-1 shows the groups and Table 3.4.2.6-2 shows which tanks are assigned to each group.

- **Safe**—Tanks were placed in the "safe" group if
  - Waste samples were available and showed that TOC was less than 4.5 wt% on a dry basis at the 95 percentile with a 95% confidence. The moisture of the waste was not considered because, even if the wastes are dry, insufficient fuel is present to facilitate combustion.) <u>OR</u>
  - Waste process histories (LA-UR-989, *History of Organic Carbon in Hanford HLW Tanks: HDW Model*) showed minimal or no organic material in tank inventories, and differential waste sample scanning calorimetry corroborates that the waste had no exothermic energy.
- **Conditionally Safe**—Tanks were placed in the "conditionally safe" group if they were judged to pose a small risk when waste moisture was considered but judged to pose a risk if the wastes were dried out. Physical processes that have the potential to exacerbate the hazard in tanks considered "conditionally safe" or unsampled tanks (e.g., drying the wastes) were evaluated to determine if restrictions on operations were warranted until more specific information is available.
- **Unsafe**—A tank would be placed in an "unsafe" group if the tank were judged to pose a significant risk under current conditions regardless of moisture content. No tanks are considered unsafe.

- **Unassigned**—There are 82 SSTs placed in the "unassigned" group because there is insufficient sample data to categorize those tanks as "safe," "conditionally safe," or "unsafe."

Waste Process History Assessment. Assessment of the likelihood and amount of combustible waste in the TWRS facilities was made on the basis of a review of waste process history and of the evaluation of available waste sample data. LA-UR-989 concludes that waste with high complexant concentrations is expected in only a small fraction of the tanks. The tanks suspected of having high concentrations are those with unique process histories that include receipt and storage of complexant-bearing wastes that did not experience the following:

- Blending of soluble sodium and aluminum into the organic waste to limit combustible concentrations

- Chemical degradation resulting from exposures to high temperatures in the 242-T Evaporator processes

- Significant chemical degradation (aging) as the result of many years of tank storage.

The moisture in these tank wastes would need to evaporate to attain combustible concentrations and conditions. Some tanks currently considered "conditionally safe" have the potential to become "unsafe" if sufficient moisture were removed from the waste.

Of the 67 measured tanks, no tanks currently are categorized as "unsafe." However, of the four tanks currently categorized as "conditionally safe," four could become "unsafe" if waste were evaporated to dryness. Moisture can be removed by three mechanisms: evaporation, leakage of tank liquids, and salt well pumping. Because the energetic complexants that give rise to this hazard are highly soluble in typical waste liquids, most of the energetic fuel is to be found in these liquids. If these liquids are allowed to lose moisture by evaporation, the energetic complexants would deposit their fuels in the salt cake, thereby making the salt cake more reactive. Preventing excessive evaporation prevents "conditionally safe" tanks from becoming "unsafe." If the liquid is removed by leakage or by salt well pumping, both moisture and fuel are removed, and a tank could not become "unsafe."

Given that 67 tanks have been evaluated and do not pose a point source ignition hazard, no more than six of the remaining 82 tanks should be at risk.

Accident Scenario Without Controls. If enough fuel is present and the waste is sufficiently dry, an organic-nitrate propagating combustion event could be initiated by a variety of ignition sources. However, specific conditions of fuel, moisture, oxidizers, and temperature (initiators) are all required to support a propagating combustion. Figure 3.4.2.6-2 depicts the reference accident scenario based upon point source ignition. If a reaction temperature of 220 °C

(428 °F) is reached, then the reaction will start. As stated earlier, only a few tanks (e.g., Tank 241-C-106 and some 241-SX tanks) contain sufficient decay heat to be able to heat themselves to reaction temperature if their cooling were interrupted.

Chemical Heatup. The heat-up rates for high heat SSTs have been assessed (Attachment 2 of WHC-SD-WM-CN-058). Tank 241-C-106 has the highest heat load, at 32,000 W (1.1 x 10^5 Btu/h), and an average waste temperature of 68 °C (154.4 °F). If the active ventilation were turned off, and the waste allowed to dry out, it would then require at least 1 yr for the temperature of the waste to reach 200 °C (392 °F). Thus, ample time is available to detect the heatup occurring and to take actions to restore cooling.

Scenario Description. The scenario without controls assumes that a quantity of combustible waste is created (1) by concentrating the organic chemicals contained in the waste added to the tanks and (2) by drying the waste to reactive conditions. A combustion reaction is initiated when an ignition source of sufficient energy and temperature contacts the combustible waste. The resulting combustion front spreads through the combustible waste and releases significant energy and gases. The energy release liberates radionuclides and chemicals in gaseous form and overpressurizes the tank, causing the dome to crack. Overpressurization initiates a release of radiological and toxicological materials from the tank to the environment. As the accident progresses, the hot headspace gases released from the combustion heat up the salt cake surface, finally heating the as yet unburned salt cake to ignition temperature. All of the remaining unreacted salt cake then experiences general surface ignition. The resulting pressure pulse collapses the dome, causing small additional releases of radionuclides and toxic materials as the dome debris falls into the waste.

Selection of Bounding Accident. The representative calculation for the accident without controls is selected as 25 m^3 (883 ft^3) of combustible waste. The calculation is based on estimates from analysis of variance techniques, which show that Tank 241-U-105 represents the worst case with a 95% confidence that the upper bound for combustible waste (the amount of waste that exceeds the safety criteria) is 25 m^3 (883 ft^3). The 25 m^3 (883 ft^3) of waste in the tank would consist of complexants and the complexant degradation products (e.g., sodium nitrate, sodium nitrite, sodium hydroxide, water, and smaller amounts of radionuclides and other chemicals). For purposes of accident consequence calculations, the waste is modeled as a simple mixture of sodium acetate and stoichiometric amounts of sodium nitrate and nitrite in typical ratios, with the specified amount of water. For combustion purposes, the remaining materials are considered to be diluents. Heat capacity for this modeled waste is based upon the average compositions for wastes routed to the tank farms. As reaction temperatures develop, radionuclides, toxics, and corrosives are driven off from a mixture containing radionuclide and toxic chemical concentrations from SST solids (WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*, and WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*). These assumptions imply a conservatively vigorous chemical reaction to develop heat and pressure and also provide a conservative radioactive and toxic source term consistent with other accidents analyzed.

Types of Potential Ignitors Identified. The waste can be ignited from a variety of sources during normal operations (e.g., equipment failure), intrusive activities (e.g., hot lamp filaments, hot metal from modification operations, drill bit heatup during rotary mode core sampling), external activities (e.g., vehicle fuel fires caused by collisions with protrusions on top of the tank), or natural events (e.g., lightning strikes).

Threshold Energies for Ignition. Conditions for initiating propagating combustion accidents were studied theoretically and through testing of waste surrogates. Theory holds that for a dry (zero total water) stoichiometric mixture of organic fuel and oxidizer, the minimum ignition energy is 3.3 J (3.1×10^{-3} Btu). This value is about four orders of magnitude larger than the ignition energy for flammable gas mixtures. In addition, experiments with surrogate wastes show that initiation of the combustion reaction requires reactive material to be raised to the ignition temperature of about 220 °C (428 °F). Testing shows that about 5 wt% moisture can suppress ignition when the ignition source is less than 270 J (0.3 Btu) or is limited to a few seconds. The success of igniting depends upon depositing sufficient energy in the waste to achieve reaction temperatures before the heat can be conducted away.

Ignitors Review and Identification. Tank farm operations and activities were reviewed to determine which equipment and activities could lead to moderate strength ignition sources (greater than 3.3 J [3.1×10^{-3} Btu]) at the waste surface or within the waste (WHC-SD-WM-SARR-009, *Construction/Maintenance Activities and Operations Analysis Summaries*). The activities that could lead to ignitors entering the tank include modifications, maintenance, in-tank photography, vehicle accesses, and rotary mode core sampling. Natural phenomena hazards were reviewed to identify potential organic-nitrate ignitors. Lightning was determined to be the only natural phenomenon with sufficient energy and temperature to ignite combustible wastes. Seismically-induced collisions between in-tank equipment and resultant sparking of equipment were determined not to be ignition sources because these energies are well below the 3.3 J (3.1×10^{-3} Btu) threshold.

Accident Frequency Without Controls. The hazard analysis qualitatively assigns a frequency of "unlikely" to the representative organic salt-nitrate reaction accident scenario. This frequency is based on "order-of-magnitude" estimates for frequencies of initiators and considering (1) only a few tanks contain large amounts of combustible waste; (2) only a small probability exists for point source ignitors contacting the small portion of combustible waste; and (3) small ignitors are unlikely to ignite moist (but combustible) waste. If sampling and measuring of the remaining 82 unmeasured ("unassigned") tanks reveals a large number of "conditionally safe" or "unsafe" tanks, the expected frequencies of accident scenarios would increase.

Accident Scenario With Controls. The accident with controls also proceeds as shown in Figure 3.4.2.6-2. The only difference is that the frequencies of ignition have been reduced by appropriate controls.

Accident Frequency With Controls. The frequency for the accident with controls is based on controlling ignition sources and on maintaining adequate moisture in the waste through TSR Administrative Controls. If waste is found to be drying to dangerously low levels of

moisture, appropriate response actions will be taken (e.g., addition of water to compensate for evaporation losses) to maintain safety. The frequencies discussed for the accident with controls are based on the assumption that these systems and controls are in place and effectively reduce the frequency of the event from "unlikely" to "extremely unlikely." The reduction of frequency is based on estimates that each identified uncontrolled ignition source is reduced by two orders of magnitude by applying appropriate controls. Because lightning is not controlled in any special way, the frequency of lightning arcs contacting the waste is estimated at "extremely unlikely" for the accident with controls and the accident without controls.

3.4.2.6.3 Source Term Analysis. The amounts of reactive waste that might be present are based on analysis of variance of TOC and moisture of the waste sample. The sources of these measurements and the data are discussed in WHC-SD-WM-CN-058. The "composite tank" source term (WHC-SD-WM-SARR-037), which is based on highest measured values of individual radionuclides from individual tanks, agglomerated into a single fictitious tank, is used for the waste calculated to burn. The radionuclides assumed to be present in the waste were those identified for SST solids in WHC-SD-WM-SARR-037. The toxic chemicals assumed to be present in the waste were those identified for SST solids in WHC-SD-WM-SARR-011.

Combustion Release Mechanism. The waste that burns contains the organic salt-nitrate mixture as well as other chemicals and radioisotopes. WHC-SD-WM-CN-058 analyses determined which radionuclides, toxic chemicals, and corrosive materials would be vaporized and ultimately released to the environment. All 11 dominant radionuclides from the composite tank source terms have been evaluated to determine their combustion release fractions. The remaining radioisotopes were analyzed for expected releases in unusual quantities. It was determined that the same 11 dominant radioisotopes from the composite tank source term would be bounding for this combustion accident.

Combustible Waste. Only the waste that is combustible at the beginning of the accident releases radioactive and toxic materials in an accident. It is assumed for the analysis that, if ignited, all the combustible waste in a tank will be consumed; no more waste will become combustible and adjacent waste would not release radionuclides or toxics during the event.

Mechanical Entrainment as Release Mechanism. Although mechanical entrainment of radionuclides and toxics by escaping gases was evaluated as part of a confirming analysis (Lee and Plys 1996), mechanical entrainment by escaping gases is discounted in the reference analysis presented here. This confirming analysis showed that it is possible that a fraction of up to 1×10^{-4} of the heavier metals such as plutonium might be released by mechanical entrainment in such a combustion event. The exact amount would require lengthy testing to establish. If this additional amount were incorporated into the analysis, an additional dose of approximately 10% of the cesium dose reported here would be incurred. Because of these uncertainties and because 10% is within the other uncertainties in this analysis, this mechanical entrainment effect was not included.

HEPA Filter Releases. The HEPA filters are assumed to have a buildup of radioactive and toxic particles which originate from the SST solids source term (WHC-SD-WM-SARR-037 and WHC-SD-WM-SARR-011). Various types of HEPA filters that are present on SSTs are

analyzed in Section 3.3.2.4.2. As discussed in Section 3.3.2.4.2, the HEPA filter rupture pressure for HEPA filters is as low as 2.5 kPa (10 in. WG). Burning 0.1 to 0.2 m^3 (3.5 to 7.1 ft^3) of waste would create tank pressures that would rupture the HEPA filters. However, releases are very small compared with the releases from combustion and are, therefore, not included in the dose calculation.

Principal Elements Released. Volatile radionuclides and other chemicals are driven off as vapors (e.g., hydroxide compounds) at the high combustion temperatures. The principal elements released are cesium, mercury, and sodium, which condense into particulates as the exiting gases cool to respective condensation temperatures. The dynamic effects of this organic salt-nitrate combustion are studied through the use of an organic nitrate computer code discussed in WHC-SD-WM-CN-058.

Reaction Front Spread Rate and Reaction Temperature. Two assumptions were based on surrogate tests: (1) A conservatively high reaction front spreading rate of 1.2 mm/s (0.048 in./s) and (2) release rate depending on reaction temperatures of 864 °C (1587 °F) for the reactive wastes. Other assumptions include maximum leak path rates through open risers or dome cracks, maximum production of aerosols, and maximum respirable fractions (all particles are assumed to be respirable). A parametric analysis was performed to explore variations in TOC, waste moisture, headspace volume, and reactive waste quantities. Plateout and fallout of released radionuclides and toxic materials were neglected as was plume rise, for conservatism. This analysis is described in WHC-SD-WM-CN-058.

Aerosol Behavior. The response of Tank 241-U-105 to a condensed phase reaction and the corresponding fission product aerosol behavior were analyzed. This tank has a headspace volume of 1,657 m^3 (5.9×10^4 ft^3) and a total waste volume of 1,582 m^3 (5.6×10^4 ft^3). In this bounding case, 1.6% of the total waste, or 25 m^3 (883 ft^3), is assumed to combust. The average TOC and moisture content of the reactive portion of the waste were assumed to be 7.0% and 10.0%, respectively. The model assumptions and its validation are presented in WHC-SD-WM-CN-058.

Structural Failures. For the bounding 25 m^3 (883 ft^3) case, there is enough combustible waste to cause dome cracks; the tank pressure reaches the dome cracking pressure of 1.75×10^5 Pa (11 lb/in.^{2} gauge) at 1,320 s (22 min). The dome cracks, creating enough flow openings to relieve the excess pressure in the tank. Following dome cracking, the pressure is maintained constant at the dome cracking pressure until most of the reactive waste is consumed. Hot headspace gases then cause the remaining unburned salt cake to experience general surface ignition. Figure 3.4.2.6-3 contains a notation of "general surface ignition" describing this effect and labeling the resulting pressure transient that collapses the dome. The corresponding temperatures are noted in Figure 3.4.2.6-4.

Dome Collapse. When the SST dome collapses as the result of the pressure pulse which occurs near the end of the accident, tank debris would fall into the waste dispersing a portion of the waste into the atmosphere. The source term applicable to the dome collapse consequences consists of SST solids and liquids. Winds blowing across the failed tank could also entrain some

contamination. WHC-SD-WM-CN-051, *Effects of Load Drop, Uniform Load, and Concentrated Loads on Waste Tanks*, reports that for a whole dome collapse on a tank with bounding solid and liquid radioactive concentrations, the radiological dose onsite would be 2.3 Sv (2.3×10^2 rem). The toxicological doses from the combustion event are so high that the additional toxicological dose from dome collapse is trivial and was neglected.

Headspace Gas Heatup. The headspace heats up because the effluent gases enter the headspace at the reaction temperature of 864 °C (1587 °F). (See Figure 3.4.2.6-4 for plots of headspace gas, salt cake surface, and dome wall temperatures.) The hot headspace gas, in turn, transfers heat by radiation and convection to the dome and unreacted salt cake. The peak temperatures predicted for the headspace and the dome wall are 757 °C (1395 °F) and 307 °C (585 °F), respectively.

Release to the Environment. For this representative bounding transient analysis, most of the material released from the waste is also released from the tank. After the dome starts to crack, the airborne aerosol concentration remains nearly constant. (Figure 3.4.2.6-5 shows plots of aerosol distributions.) Also, fallout of airborne aerosol is minuscule compared with the amount released. Because of the high outflow, the aerosols do not have sufficient time to age and fall out. At the end of the transient, 1.1×10^{-2} kg (0.39 oz) of cesium hydroxide remains airborne in the tank, 2.2×10^{-3} kg (0.078 oz) has settled in the tank, and 2.3×10^{-1} kg (8.11 oz) has been released to the environment. Hence, the fraction of cesium hydroxide released from the tank is 0.95 of the cesium released from the combusted 25 m^3 (883 ft^3). For TOC of 7% and water content of 10%, the cesium released as the result of combustion is 0.36 of the amount contained in reacted waste.

ORNATE calculations show that for 25 m^3 (883 ft^3) of waste reacted, the maximum aerosol production rate is 7.5×10^{-4} kg/s (0.026 oz/s). This can be computed from the information presented in WHC-SD-WM-CN-058.

Note that the HEPA filter on the tank is ruptured by excessive pressure drop early in the event and its HEPA filter radioactive and toxic burden is discharged to the environment. However, the amount of this release is trivial when compared with the release from the combustion event and is, therefore, not considered in the source term.

Most of the SSTs are fitted with several risers that terminate in pits closed by cover blocks. These risers typically have loose covers of steel plate or concrete held in place by gravity. Depending on the materials used, and their thicknesses, tank internal pressures as low as 1 kPa (6.9 lb/in.^{2} gauge) would lift these covers, allowing gases to escape unfiltered to the atmosphere. If insufficient relieving capacity is provided by these pathways, the pressure would continue to rise, rupturing HEPA filters and eventually causing cracking of the SST dome (see discussions that follow).

The SST domes are comparatively light, reinforced concrete with a structural limit of 76 kPa (11 lb/in.^{2} gauge) differential pressure. At this pressure, the domes would be expected to crack in both circumferential and radial directions. These cracks would provide additional

pathways for the unfiltered release of aerosols from the tanks. Typically, only 1 to 3 m^3 (35.3 to 105.6 ft^3) of reacting waste is required to pressurize a tank to this dome cracking pressure.

3.4.2.6.4 Consequence Analysis. The release fractions for toxic and radiological species are summarized below and are detailed in WHC-SD-WM-CN-058. The release fractions shown in Table 3.4.2.6-3 are based on the total tank inventory, not on the combusted portion of the waste.

The combustion evaluations determined that ^{137}Cs highly dominates the radionuclides caused by combustion; whereas, mercury dominates the toxic releases, and sodium dominates the corrosives. Most of the combustion products are released as a hydroxide vapor that will condense into particles. The radionuclide and toxic releases from the tanks are essentially those caused by the combustion effects.

Accident Consequences Without Controls. Accident consequences without controls were determined using the methodology discussed in Section 3.4.1. The consequences are dominated by releases caused by the chemical reactions of the organic salts and nitrates. Volatile radionuclides and other chemicals are driven off as vapors at the reaction temperature of approximately 864 °C (1587 °F). The principal elements released are cesium, mercury, and sodium (usually driven off as hydroxide compounds), which condense into particulates as the exiting gas cools to respective condensation temperatures.

The consequences of the representative organic salt-nitrate combustion accident were calculated assuming conservative waste radioactive and toxic chemical concentrations. These consequences are listed in Table 3.4.2.6-4. The dose to the offsite receptor from burning 25 m^3 (883 ft^3) of waste was determined to be 7.1×10^{-2} Sv (7.1 rem). The dose resulting from dome collapse was 2.0×10^{-3} Sv (2.0×10^{-1} rem), so the combined offsite dose was 7.3×10^{-2} Sv (7.3 rem). The dose to the onsite receptor from burning the waste was 8.6×10^{1} Sv (8.6×10^{3} rem). The onsite dose resulting from dome collapse was 2.3 Sv (2.3×10^{2} rem), so the combined onsite dose was 8.8×10^{1} Sv (8.8×10^{3} rem). The toxicological sum-of-fractions resulting from burning the waste for the offsite and onsite receptors were 160 and 140,000 respectively. The toxicological exposures resulting from dome collapse were insignificant when compared with the toxicological exposures caused by burning.

The consequences from a pressurized release from a failed HEPA filter have been analyzed and reported in Section 3.3.2.4.2, Table 3.3.2.4.2-9. That section provides dose consequences for both the filter rupture releases and subsequent unfiltered releases of the tank atmosphere for 12 h (onsite receptor), 24 h (offsite receptor), and 8,760 h (12 mo) (both onsite and offsite receptors). Consult Table 3.3.2.4.2-9 for dose consequence values for releases from SSTs with active ventilation and SSTs with passive ventilation, configurations 1 and 2.

The doses from HEPA filter rupture and subsequent unfiltered releases are very small compared with the releases from combustion and are, therefore, neglected. For example, in Table 3.3.2.4.2-9, HEPA onsite radiological dose consequences for 8,760 h of release are

8.6×10^{-2} Sv (8.6 rem) (SSTs with active ventilation). The corresponding combustion/dome collapse dose in Table 3.4.2.6-3 is 8.8×10^{1} Sv (8.8×10^{3} rem), or approximately 1,000 times more. Therefore, the HEPA filter releases were not added to the combustion doses.

Accident Consequences With Controls. The consequences from the organic salt-nitrate combustion scenario with controls are the same as for the scenario without controls, except that the toxicological consequences (sum-of-fractions) are based on guidelines for an "extremely unlikely" event. Therefore, the chemical concentration guideline values are higher (ERPG-3 rather than ERPG-2 for onsite, and ERPG-2 rather than ERPG-1 for offsite) (AIHA 1988, *Emergency Response Planning Guidelines*). Consequently, the sum-of-fractions numbers for the accident with controls are lower than for the accident without controls. The radiological and toxicological consequences of the organic salt-nitrate reaction releases with controls are presented in Table 3.4.2.6-4.

Sensitivity Analysis.

- **Oxidizer is plentiful**—Sodium nitrates and nitrites exist in such large quantities in all tanks that this oxidizer is always sufficient to sustain any reactions in the tank. For the present analysis, stoichiometric amounts of oxidizer were always assumed. If less than stoichiometric amounts of oxidizer were present, not all of the fuel would be burned and consequences would decrease.

- **Ignitor strength**—Theoretical calculations have established that ignitors having as little as 3.3 J (3.1×10^{-3} Btu) of energy have the potential to ignite dry waste. Testing with small ball bearings has confirmed that as little as 10 J (9.4×10^{-3} Btu) can ignite dry waste surrogates. Testing of surrogates has also established that as little as 5 wt% moisture in the waste would require 230 J (0.216 Btu) to ignite the waste. If this effect were considered, hot filaments would be excluded as ignitors.

- **Salt cake specific heat**—A key parameter in the analysis is the value for specific heat (heat capacity) of the salt cake at 2,000 J/kg-°C (0.48 Btu/lb-°F). This value was derived from an average of all wastes disposed to the tanks at the Hanford Site. A lower specific heat value would raise reaction temperatures and increase the consequences.

- **Spreading rate of reaction**—The spreading rate of the reaction is important in the tank temperature and pressure transient response. Tests on surrogate materials concluded that the spread rate of the reaction front through the material ranged from about 0.2 to 0.6 mm/s (0.008 to 0.024 in./s), depending on material composition (sodium acetate/nitrate surrogate) (WHC-SD-WM-ER-496). A slower spread rate would cause the pressure and temperature increases to be both lower and slower. The highest experimental value for reaction spreading rate, 0.6 mm/s (0.024 in./s), was used for a downward propagation rate. Because

analysis predicted a surface spread rate about twice the rate deeper in the waste, 1.2 mm/s (0.048 in./s) was used for horizontal spread rates. The chosen spread rates result in a conservative calculation.

- **Vacuum condition effects discounted**—It is assumed that developing a vacuum condition following an organic salt-nitrate reaction is not a significant accident contributor and was therefore not a developed case. Scoping calculations were performed to determine whether a vacuum could be developed. For this case, dome cracking was not assumed to occur because these cracks would likely allow large inflows of air to equilibrate tank pressure as the reaction ends and pressures and temperatures decay. A case was assumed whereby many square meters of pit riser covers were assumed to open and vent out the reaction from a large amount of burning waste (many cubic meters). When the reactive waste was exhausted, it was assumed that the same riser covers reseated perfectly, leaving only the HEPA filter path to allow backflow into the tank. After the tank headspace cooled, a vacuum of approximately 21 kPa (3 lb/in.^{2}) developed. This is expected to be well within the structural capability of the tank (approximately 35 kPa or 5 lb/in.^{2}). (See WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*.)

- **Actual fuel content is unknown**—The fuel content of most of the sampled waste is unknown because most waste samples were analyzed for TOC rather than energetics or specific organic species. Therefore, the fuel content is conservatively assumed to be represented by the TOC. That is, all TOC is assumed to be a fuel as energetic as sodium acetate (the most energetic fuel identified during laboratory experiments). This is a conservative estimate because little of the organic chemicals included in the original waste streams is this energetic. Of the nearly 3,000 metric tons (3,308 tons) of organic chemicals sent to the tank farms, less than about 1,200 metric tons (1,324 tons) were complexants and of the complexants added, only a small fraction was acetate (LA-UR-989). Most of the other organic wastes in the tank farms (e.g., oxalate and process extractants such as TBP and NPH) do not support condensed-phase propagating combustion reactions.

- **Aging effects not included**—The chemical decomposition (aging) of organic chemicals has reduced the hazard significantly by destroying the fuel. Studies indicate that organic complexants undergo hydrolytic and radiolytic decomposition (aging) under tank waste conditions. The net effect of aging decreases the potential chemical energy of the waste. Thus, much of the original fuel such as EDTA is likely to degrade to nonfuel species such as oxalate and carbonate.

  The influence of temperature and radiation dose on the rate of aging is not sufficiently defined to quantify the effect of aging on safe storage. Therefore, no

credit for aging was assumed in this safety analysis. Kinetic data for aging is being investigated using waste simulants, and the composition of actual waste will be examined in an effort to quantify aging in the future.

- **Fuel is in solution**—A significant portion of the energetic organic fuels is probably in solution and is therefore not a combustion hazard. The solubility properties of organic complexants are being investigated. Tests with waste simulants indicate that with the important exception of sodium oxalate (oxalate is not combustible), all the other sodium carboxylate salts and their principal decomposition products are very soluble in the alkaline supernatant solutions in the tanks. Accounting for the solubility of organic complexants could reduce or eliminate reactive waste volume estimates in many tanks.

- **Reactive waste is contiguous**—For this safety analysis, it is assumed that all of the waste in a tank that exceeds the combustion criterion is contained in a single contiguous mass. If the combustible waste were contained in several noncontiguous regions, only the ignited region would burn, thereby reducing the severity of the event.

3.4.2.6.5 Comparison With Guidelines. The consequences without controls far exceed the risk guidelines, as seen in Table 3.4.2.6-4. Even for much smaller amounts of reactive waste, the risk guidelines would be exceeded. For example, 0.1 m^3 (3.5 ft^3) of reacting waste would exceed the pressure capability of the HEPA filter, causing the filter to rupture. The consequences of burning even a small amount of waste are excessive, and no practical means are available to reduce these consequences, should the accident occur. Controls on ignitors and waste moisture as described in Section 3.4.2.6.5 focus on reducing the likelihood that the accident can occur.

Because the consequences of burning even a small amount of waste will exceed the risk guidelines, discussion of continuing safety and risk assessment activities that are planned and underway is provided in the following sections.

3.4.2.6.6 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems, and Components. The waste tanks are designated as Safety-Class structures (Table 3.4.2.6-4); however, per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000. This designator is based on the structural characteristics of the tanks as related to overpressurization. Safety-Significant SSCs that have been selected to provide temperature monitoring for tank bump accident prevention in certain SSTs and all DSTs (including AWF tanks) (Section 3.4.2.11), as well as Safety-Class and Safety-Significant SSCs that have been selected to provide active ventilation to prevent flammable gas deflagrations in DSTs (including AWF tanks) and SSTs (Section 3.4.2.2), also provide protection against the postulated phenomena of organic salt-nitrate reactions initiated by bulk heat up to elevated waste temperatures. The control requirements for this temperature monitoring and cooling will be cross-referenced in Section 3.4.2.11 to ensure that necessary tank bump protection

from chemical runaway will not be omitted (perhaps because tank bump or flammable gas problems have been resolved) without first evaluating whether the controls are still necessary to prevent chemical runaway.

For safety SSCs that require electrical power (i.e., temperature monitoring systems), a supporting SSC, the tank farm electrical distribution system, is required to ensure that the chosen safety SSCs have electrical power to perform their intended safety functions.

Technical Safety Requirement Controls. Table 3.4.2.6-1 lists the TSR controls selected to prevent or mitigate the risk of organic salt-nitrate reactions accidents. For each control, the safety function is described and additional comments are provided as appropriate.

The TSRs, as delineated in Table 3.4.2.6-1, apply to the following TWRS facilities:

- SSTs
- DSTs
- AWF tanks
- DCRTs
- IMUSTs
- Catch tanks
- 244-AR Vault
- Waste transfer lines.

Limiting the waste temperature to ≤121 °C (≤250 °F) for high decay heat SSTs has been established to ensure that waste does not reach chemical runaway temperature thresholds. TSR controls that have been selected to provide temperature monitoring for tank bump accident prevention in certain SSTs and DSTs (including AWF tanks) (see Section 3.4.2.11), as well as TSR controls that have been selected to provide active ventilation to prevent flammable gas deflagrations in DSTs (including AWF tanks) and SSTs (see Section 3.4.2.2), also provide protection against the postulated phenomena of organic salt-nitrate reactions initiated by bulk heat up to elevated waste temperatures.

Other controls that protect against organic salt-nitrate reactions are also listed in Table 3.4.2.6-1 and include the maintenance of process instrumentation and measuring and testing equipment, ignition controls, moisture controls, transfer controls, HEPA filter controls, and emergency preparedness actions.

Defense-in-Depth. Defense-in-Depth protective measures for organic salt-nitrate reaction accidents are shown in Table 3.4.2.6-6.

Planned Safety and Risk Assessment. The safety SSCs and TSR controls developed for this accident acceptably provide a means to manage the interim risk associated with the organic salt-nitrate hazard even though the risk guidelines are exceeded. However, additional safety and risk assessment is required to close the organic complexant issue and to reduce the risk to within the established guidelines. The organic complexant hazard is part of the existing safety issue on

organics and is the subject of an open USQ. WHC-EP-0914, *Project Plan for Resolution of the Organic Waste Tank Safety Issues at the Hanford Site*, outlines the steps that will be taken to resolve this safety issue. Also see Section 3.4.2.4 for a discussion of activities that will address and resolve the safety issues associated with the organic complexant hazard. Both hazards (i.e., organic solvent and organic complexant) are addressed by WHC-EP-0914.

WHC-EP-0914 provides the logic and description of the associated actions that are necessary to resolve and ultimately close the organic waste tank safety issue and related USQ. Substantial efforts are currently underway to complete specific project activities outlined in the WHC-EP-0914 that include identification of organic waste tanks, assessment of fuel content and waste energetics, quantification of ignition source requirements, development and implementation of methods for monitoring and mitigation, and completion of safety analyses leading to closure of the organic complexant USQ. In concert with the analysis presented in this section, controls have been imposed on many of the waste tanks as a conservative measure while analysis continues. It is expected that the completion of work described in WHC-EP-0914 will show that very few, if any, tanks have this potential hazard, and those with the potential risk of an organic salt-nitrate reaction can be managed satisfactorily by the identified controls. Consult the latest revision of WHC-EP-0914 for details regarding these actions and their scheduled completion dates.

Evaluation of Temperature and Pressure Monitoring/Alarms as a Means to Initiate Emergency Response Actions. In response to direction received in Kinzer (1997), the effectiveness of tank farm evacuation based on temperature and pressure monitoring/alarms in relation to the organic salt-nitrate reactions accident has been investigated. Because this accident is not a continuous release of waste material over an extended period (hours) but rather a very short-term release (less than about 50 min), early detection of the accident is important to reduce consequences to the onsite receptor. Discussion of the evaluation that was performed is provided here.

The evaluation process involved assessing the topography of the organic salt-nitrate reactions. The topography assessment discussed previously was completed and is detailed in Table 3.4.2.6-2. Table 3.4.2.6-2 shows that, of the tanks that have been categorized, the tanks that pose the highest hazard (based on the discussion and criteria provided in this section) are the "conditionally safe" tanks. The tanks listed as "conditionally safe" are all SSTs and specifically include 241-AX-102, 241-C-201, 241-C-202, and 241-U-105. Applicability of the discussion in this section is limited to these SSTs. No tanks have been classified as "unsafe" according to criteria summarized in this section.

The evaluation process determined the availability of either temperature or pressure monitoring in the SSTs. According to the WHC-EP-0914, temperature monitoring sensor trees are currently installed and data is being collected for the 20 organic watch list tanks categorized as "conditionally safe." An organic complexant combustion event would result in an increase in tank temperature and pressure; therefore, the strategy is to have either continuous temperature or pressure monitoring. Temperature reading indications may be monitored/alarmed locally or through the Tank Monitoring and Control System or the Computerized-Automated Surveillance System operated for tank farms.

The availability of vapor space pressure monitoring instrumentation was also determined for the tanks categorized as "conditionally safe." Vapor space pressure monitoring is currently only available in the following 12 SSTs: 200 East (241-A-101, 241-AX-101, 241-AX-103, and 241-C-106); 200 West (241-U-103, 241-U-105, 241-U-108, 241-U-109, 241-U-110, 241-T-110, 241-S-102, and 241-S-109.) With the exception of 241-C-106, all vapor space pressure monitoring indications (e.g., level, alarm) are displayed/read locally (i.e., at the tank or tank farm). Of the tanks listed that have available instrumentation, only one SST, 241-U-105 in the 200 West Area, is equipped with instrumentation that could be credited in this evaluation.

The vapor space pressure monitoring available on the tanks listed has a sensitivity of ±2.5 kPa (±10 in. WG), and would likely be able to detect an organic salt-nitrate reaction from the onset of the accident. Figure 3.4.2.6-3 shows that the pressure increases nearly exponentially until the dome starts to crack at about 1.8×10^5 Pa (26 lb/in.^{2}).

Vapor space pressure monitoring, although currently available with only local monitoring and alarm capability in one of the tanks listed as "conditionally safe" (see Table 3.4.2.6-1), is hypothetically considered as the method in this evaluation to detect an organic salt-nitrate reaction and initiate emergency response actions. A similar evaluation could also be performed using temperature monitoring (using different set points).

The next step in the effectiveness evaluation is to determine whether monitoring the vapor space pressure in an SST with the potential for an organic salt-nitrate reaction has the potential to reduce the consequences to the onsite receptor. Several calculations have been performed. Figure 3.4.2.6-5 provides a graphical relationship of the mass release versus time for a 25 m^3 (883 ft^3) organic salt-nitrate combustion. If the vapor space pressure monitor were set to alarm when the pressure in the tank reaches 1.1×10^5 Pa (1.25 lb/in.^{2} gauge), just below the pressure expected to unseat and fail the HEPA filter according to Figure 3.4.2.6-3, this would be about 10 min into the organic salt-nitrate reaction. TWRS emergency preparedness personnel estimate that approximately 20 min would be required to direct facility workers and onsite personnel to take cover in nearby buildings/structures after notification of the event is received by the building emergency director. Therefore, the total maximum exposure time to onsite personnel would be approximately 30 min if emergency response actions occur as planned.

At 30 min into the organic salt-nitrate reaction, 2.7×10^{-2} kg of CsOH has been released from the tank headspace out of a maximum total amount assumed for the event of 2.3×10^{-1} kg. Thus, less than 12% of the total Cs has been released at 30 min. into the reaction. Because the dose consequences are dominated by Cs and are directly related to the amount of Cs released, less than 12% of the total organic salt-nitrate reaction dose consequences to the onsite receptors would be received before taking cover in the nearby buildings and structures. Therefore, with notification by vapor space pressure monitoring early in the organic salt-nitrate reaction and a 20-min emergency response action time, the onsite consequences could be reduced by as much as 88%. This means that onsite radiological dose consequences could be reduced to approximately 1.1×10^1 Sv (1.1×10^3 rem) from those presented in Table 3.4.2.6-4.

The consequences are shown to be very sensitive to the amount of time that the receptor is exposed to the material that is released from the tank. Therefore, it is worth investigating other possible ways of notifying facility workers and onsite receptors early in the progression of an organic salt-nitrate reaction.

Another case considered was the use of sirens or other communications equipment in conjunction with the vapor space pressure monitoring instrumentation. This way, with adequate training of facility workers and onsite personnel to take appropriate actions, the emergency response action time could be reduced. In the scenario investigated here, the vapor space pressure monitor is set to alarm at a level based on operational experience that will not create spurious trips or the same level that was considered in the previous case. Because wide swings of the vapor space pressure in SSTs should not occur under nonaccident conditions, the set point could be set just above the highest expected barometric pressure difference. If barometric pressure rises above the set point, sirens will be activated and surrounding facility workers and onsite personnel will take cover and shut down building ventilation systems. Because specific evacuation routes to be used are highly dependent on wind direction, the sirens may need to be used in concert with other audible communication to advise personnel which direction to go. It is also possible that if the accident occurs during daylight hours, facility workers and onsite personnel would not enter (or remain in) the acrid smoke plume emanating from the burning tank. If these actions (organic salt-nitrate reaction indication, siren activation, and take cover) all occur within 10 min., the consequences can be reduced to below the risk guidelines defined in Table 3.4.2.6-3.

Figure 3.4.2.6-5 shows that at 10 min into the reaction only approximately 7.5×10^{-5} kg of waste is released. This means that only about 0.0326% of the waste has left the tank; thereby, the facility workers and onsite receptors would only be exposed to 0.0326% of the total maximum expected from the reaction. The onsite radiological dose consequences could therefore be reduced by approximately 3,066 times to only approximately 2.9×10^{-2} Sv (2.9 rem). Consequences such as these would be below the risk guidelines of 1.0×10^{-1} Sv (1.0×10^{1} rem) for the organic salt-nitrate reactions accident with a frequency (with controls) of "extremely unlikely." Although improved (i.e., faster) emergency response actions could reduce the exposure to the onsite and facility worker, the offsite consequences (which exceed the risk guidelines) would not be reduced because the duration of the accident is very short.

The effectiveness of using vapor space temperature/pressure monitoring (in conjunction with emergency response actions) should be the subject of further cost/benefit analysis. Specific items to be determined are the associated capital improvement costs with outfitting the necessary tanks (on a per tank basis) with vapor space temperature/pressure monitoring and outfitting the necessary tank farms (on a per tank farm basis) with sirens and communication gear. Additional costs may be incurred in training contractor and subcontractor personnel in the proper emergency response actions to be taken after recognizing the organic salt-nitrate reaction alarm.

Actions related to the characterization of tank waste with respect to the organic salt-nitrate hazard are still underway. Before a commitment is made to install vapor space temperature/pressure monitoring or other related equipment (e.g., sirens, communication

equipment, alarms), it is important to have solid technical information upon which decisions can be based. The results of the safety issue resolution (discussed above) are expected to provide this information.

Mitigation alternatives, including increased monitoring and improved emergency response, are being evaluated as part of resolution of the organic complexant safety issue discussed above (WHC-EP-0914).

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WHC-SD-WM-SARR-037, 1996, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations,* Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Figure 3.4.2.6-1. Safety Criteria Showing Conditions for "Unsafe," "Conditionally Safe," and "Safe" Waste Categories.

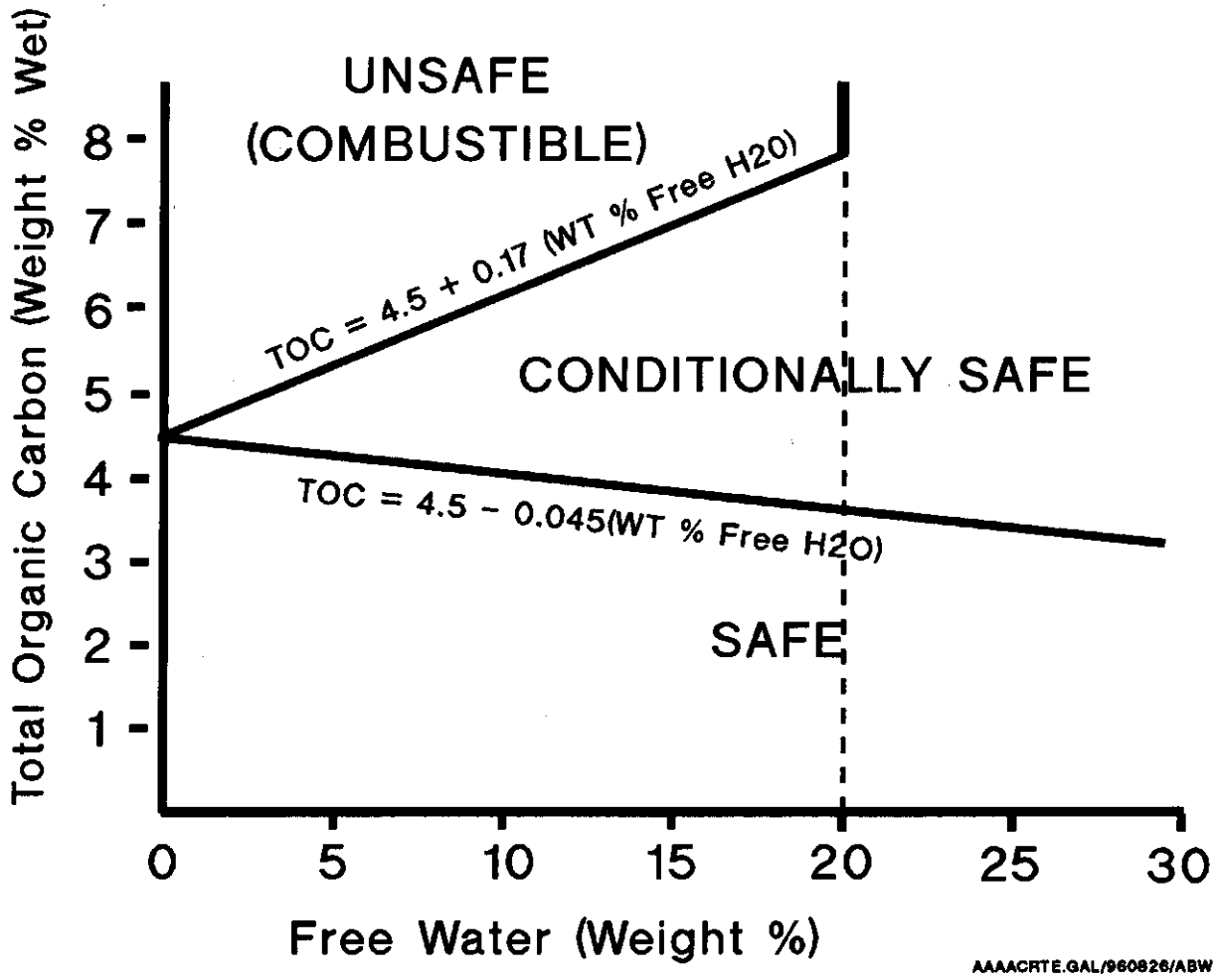
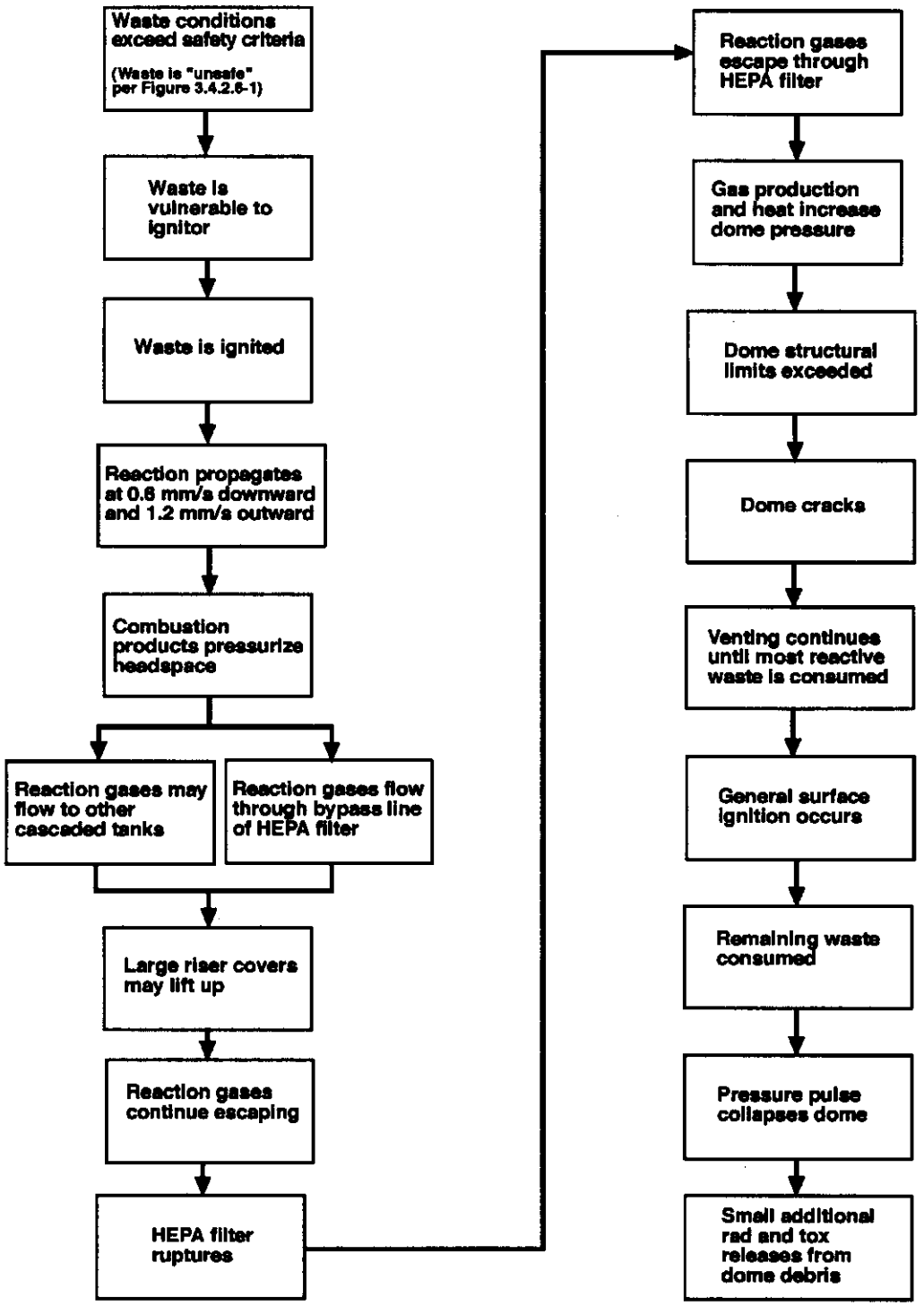


Figure 3.4.2.6-2. Accident Scenario for Organic Salt-Nitrate Reaction.



HEPA = high-efficiency particulate air (filter)

7G96100087.10B
R4 SRP-3

Figure 3.4.2.6-3. Headspace Pressure in Tank 241-U-105 as a Result of Burning 25 m^3 (883 ft^3) of Waste.

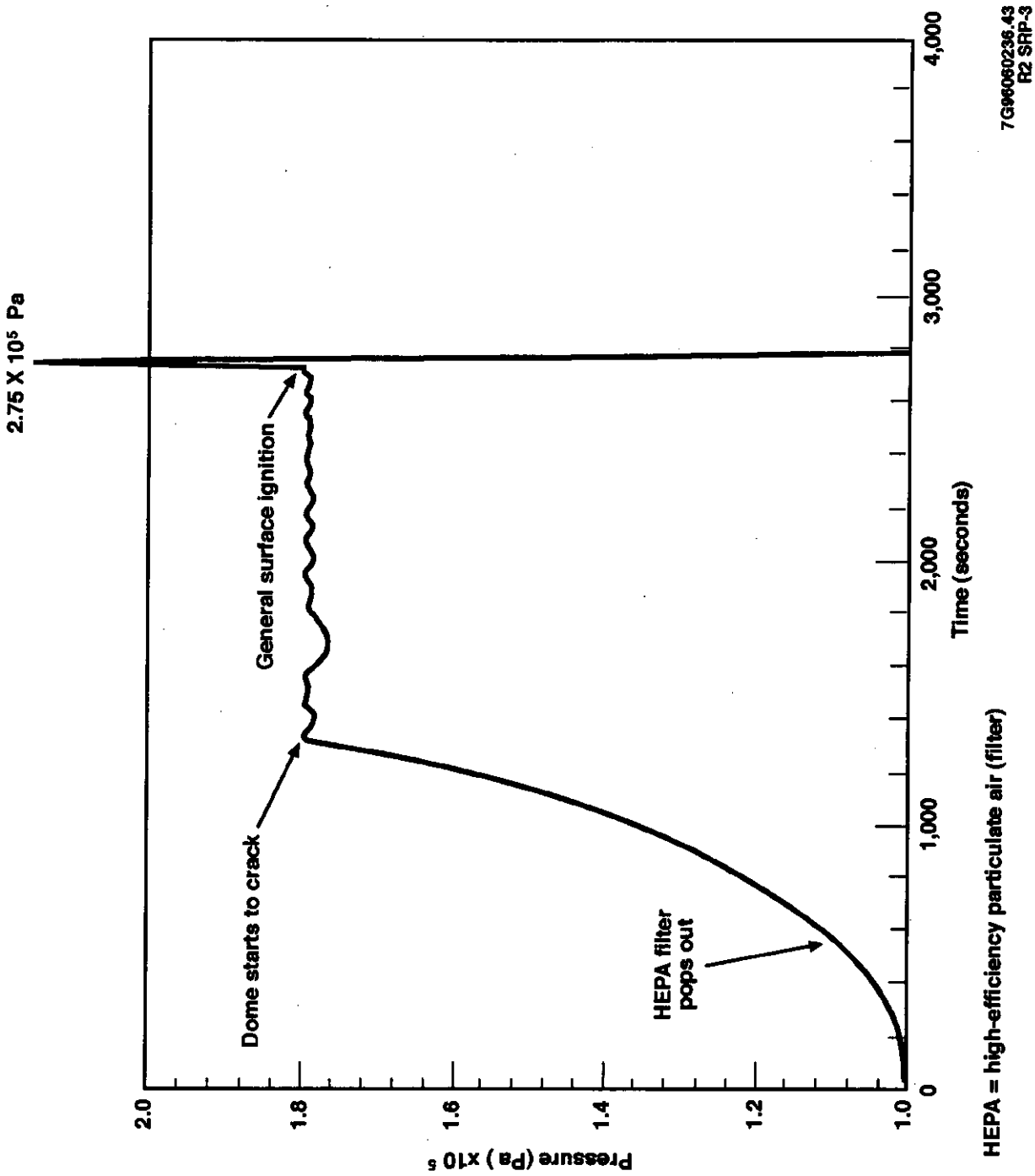


Figure 3.4.2.6-4. Headspace Gas, Salt Cake Surface, and Dome Wall Temperature in Tank 241-U-105 as a Result of Burning 25 m^3 (883 ft^3) of Waste.

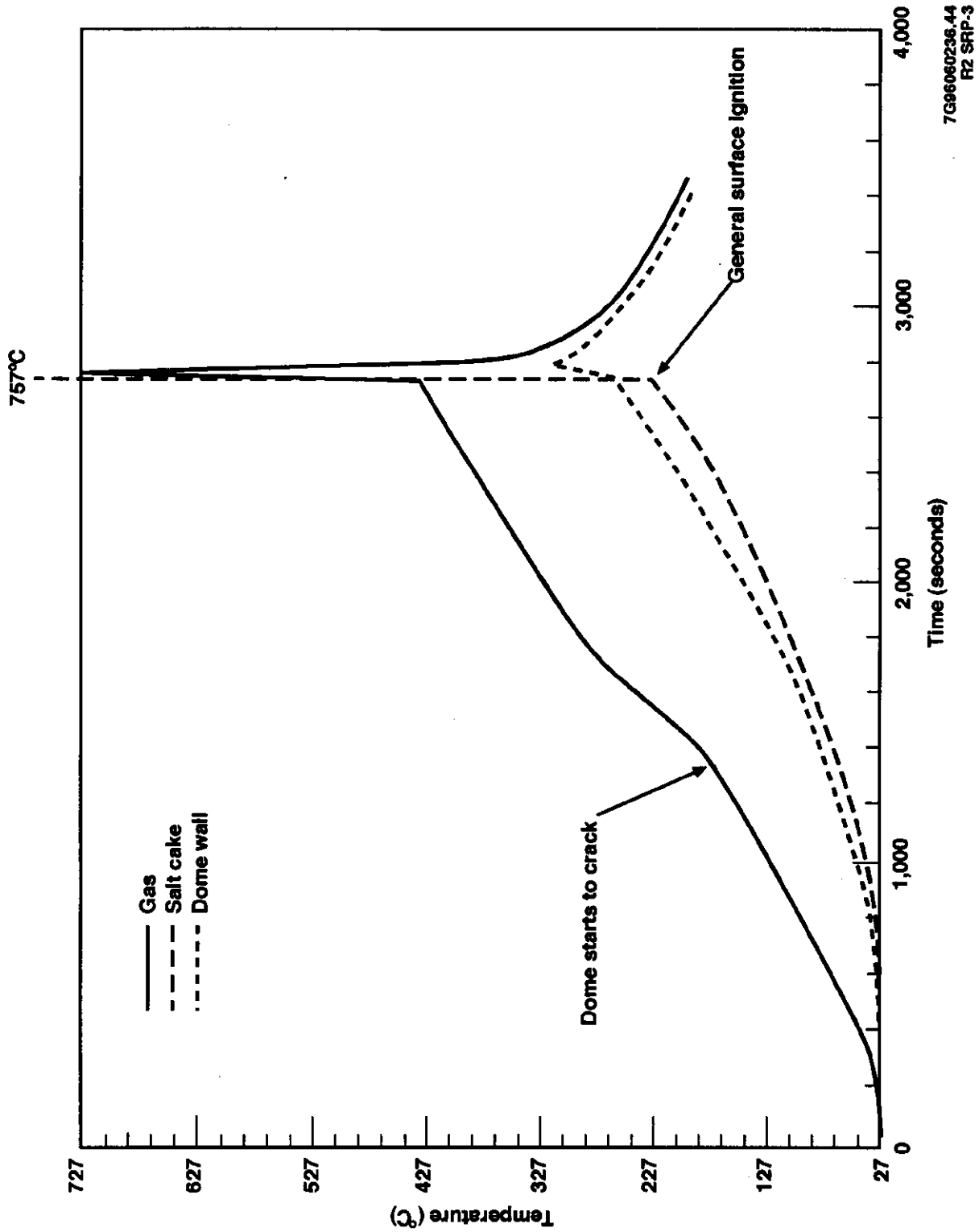


Figure 3.4.2.6-5. Aerosol Distribution for Tank 241-U-105 as a Result of Burning 25 m^3 (883 ft^3) of Waste.

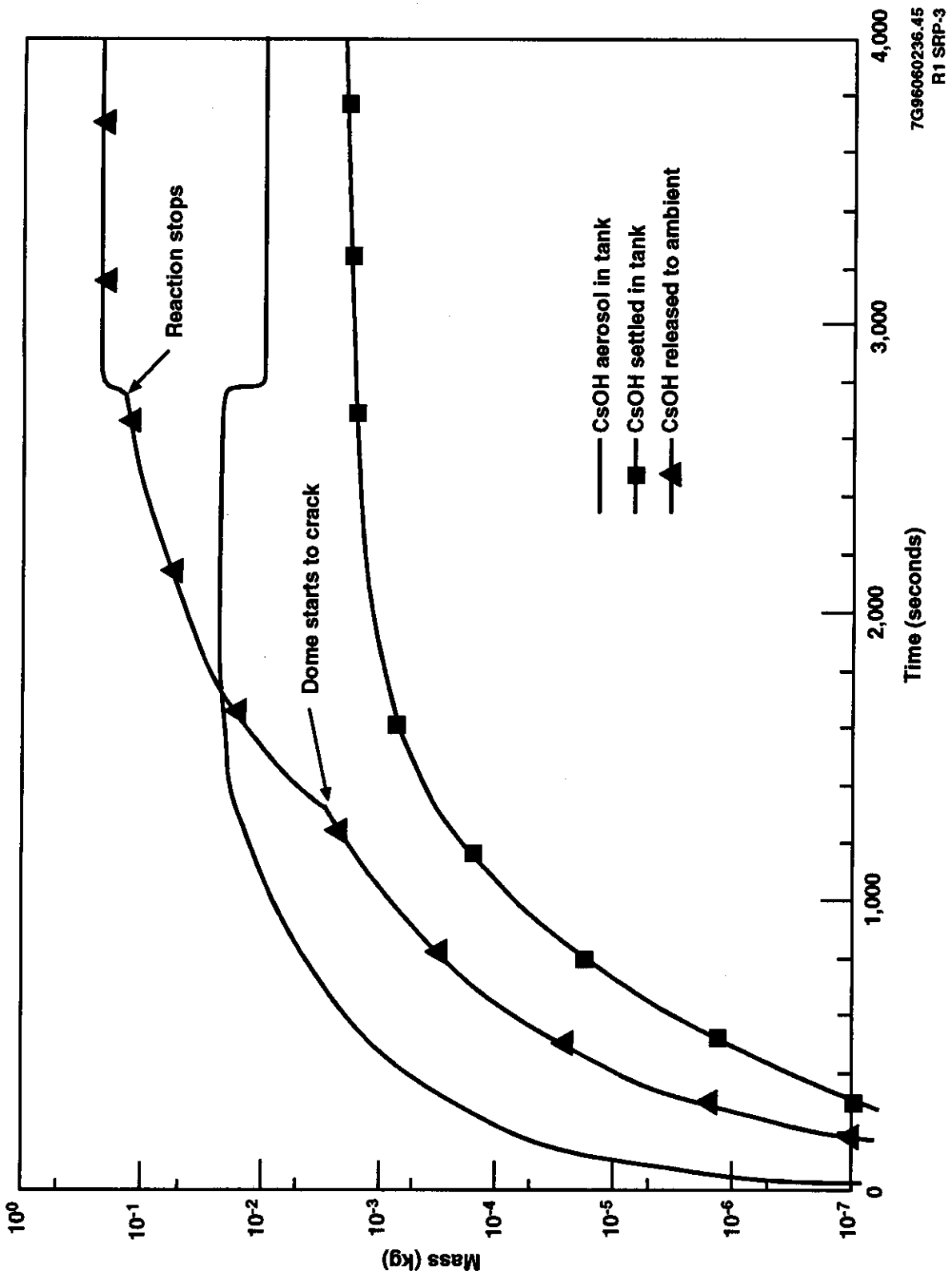


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Table 3.4.2.6-1. Summary of Technical Safety Requirement Controls for Organic Salt-Nitrate Reaction. (4 sheets)

Control	Safety function	Comments
Waste temperature A temperature limit of ≤121 °C (250 °F) is applicable to the following: 241-C-106, 241-SX-103, 241-SX-107, 241-SX-108, 241-SX-109, 241-SX-110, 241-SX-111, 241-SX-112, 241-SX-114, DSTs, and AWF tanks	Prevents tank waste from reaching a chemical runaway threshold temperature	Temperature monitoring required to prevent a tank bump is conservatively used to ensure that this chemical runaway threshold is not reached.
SST waste temperature controls[a] • The waste temperature shall be ≤ 205 °F (96 °C). DST and AWF Tank Temperature Controls[b] • The waste temperature shall be either: ≤ 195 °F (91 °C) in all levels of the waste. OR ≤ 195 °F (91 °C) in the top 4.6 m (15 ft) of the waste AND ≤ 215 °F (102 °C) in the waste below 4.6 m (15 ft).	Ensure that tank waste temperature monitoring system (and, if required, tank waste level monitoring system) is operable and that temperatures at which a "chemical runaway" accident could occur are not reached.	The specific waste temperature limits for SSTs and DSTs/AWF tanks were established during the development of the TSR controls by the accident analysts and operations personnel. Control also provides protection against postulated tank bumps or steam releases (Section 3.4.2.11).
Process instrumentation and measuring and testing equipment • Identification and traceability of TSR-related instrumentation and equipment shall be maintained. • Instrumentation and equipment shall have a functional test or calibration as applicable at appropriate intervals to verify required performance. • Records shall be maintained to provide evidence that the instrumentation and equipment are within the functional test or calibration when used.	Ensures instrumentation used to monitor temperature is maintained.	Control also provides protection against postulated tank bumps or steam releases (Section 3.4.2.11).

Table 3.4.2.6-1. Summary of Technical Safety Requirement Controls for Organic Salt-Nitrate Reaction. (4 sheets)

Control	Safety function	Comments
Ignition controls		Ignition source controls are applicable to "unsafe," "safe," "conditionally safe," and "unassigned" waste groups of Table 3.4.2.6-2 unless waste solids are verified to be covered by liquids
• Intrusive controls		
- Stop intrusive activities in tanks with a potential organic salt-nitrate hazard when lightning is identified within a 48-km (30-mi) radius of the tank farm.	Reduces likelihood of lightning as an initiator of organic salt-nitrate reactions.	--
- If flame cutting is performed where debris could fall onto the waste surface in a tank with a potential organic salt-nitrate hazard, a barrier or device is required to prevent hot metal from falling on the waste surface.	Reduces frequency of flame cutting as an initiator of organic salt-nitrate reactions.	--
- If welding is performed where debris could fall onto the waste surface in a tank with a potential organic salt-nitrate hazard, a barrier or device is required to prevent hot slag from falling on the waste surface.	Reduces frequency of welding as an initiator of organic salt-nitrate reactions.	--
- When installing equipment (e.g., still/video cameras, videos, lights, etc.) with hot filaments, in a tank with a potential organic salt-nitrate hazard, a method shall be used to prevent these hot sources from falling and contacting the waste.	Reduces frequency of installed equipment as an initiator of organic salt-nitrate reactions.	The temperature limit for contact by hot equipment is set to 160 °C (320 °F) to account for the possibility of localized organic-nitrate chemical self heating in the heated portion of the waste which could raise the waste temperature to the ignition temperature of 230 °C (446 °F).
• Vehicle controls		--
- Vehicle access within the tank farms shall be limited to vehicles whose fuel systems are protected from damage caused by potential collisions with tank structures.	Prevent vehicle fuel system damage (i.e., fuel system leaks) in the event of collisions with tank structures within the tank farms.	
- Physical barriers shall be established around tank structures outside the tank farm boundary to restrict vehicle access in the vicinity of aboveground waste tank structures.		
- Speed limit controls within tank farms.	Eliminates ignition sources from tanks that could pose an organic-nitrate hazard by preventing moderate or high energy ignition sources from contacting combustible waste	A flammable gas deflagration may also be an ignition source for an organic salt-nitrate combustion event. Therefore, where potential hazards include both flammable gas and an organic salt-nitrate hazard, the controls for flammable gas described in Section 3.4.2.2 also prevent or reduce the potential for organic salt-nitrate reactions.
• Flammable gas ignition controls All flammable gas ignition controls must be applied in respective facility when and where they are required to prevent flammable gas deflagrations. Specific flammable gas ignition controls are listed in Section 3.4.2.2 and are not repeated here.		

Table 3.4.2.6-1. Summary of Technical Safety Requirement Controls for Organic Salt-Nitrate Reaction. (4 sheets)

Control	Safety function	Comments
Moisture controls		
• Interim stabilization		
- Pumping of excess liquid above the solid waste surfaces is acceptable. Salt well pumping of liquids below the solid waste surfaces of "safe," "conditionally safe," "unsafe," or "unassigned" tanks is prohibited unless sampling and analysis have shown that the post salt well pumped condition of the remaining waste meets the following safety criteria:	Prevents removal of tank moisture which protects wastes from potential organic-nitrate combustion events.	Control applies to all SSTs.
• Wt% free $H_2O \geq 20\%$		
OR		
• TOC (wt%) < 4.5 + 0.17 (wt% free H_2O) when wt% free H_2O < 20%,		
where wt% TOC is the wet basis TOC concentration and wt% free H_2O is the moisture content of the waste.		
• Emergency pumping		
Emergency pumping of "safe," "conditionally safe," "unsafe," or "unassigned" tanks in response to tank leaks shall be limited to supernatant pumping of the excess liquid above the solid waste surfaces unless the safety criteria listed above is met or until DOE approval of a waiver to this requirement is received by Fluor Daniel Hanford, Inc.	Prevents removal of tank moisture that protects wastes from potential organic-nitrate combustion events.	Control applies to all SSTs.
• Moisture monitoring		
Periodic verifications by liquid level monitors, visual observation, or other available means shall be performed to ensure that tanks are classified as "safe" or "conditionally safe," respectively. If moisture cannot be verified, control of potential ignition sources in the waste is required in accordance with the ignition controls for organic salt-nitrate reactions outlined above.	Ensures that "conditionally safe" waste does not dry out to the point where it would be "unsafe."	Control applies to all SSTs that are classified as "safe" or "conditionally safe."

Table 3.4.2.6-1. Summary of Technical Safety Requirement Controls for Organic Salt-Nitrate Reaction. (4 sheets)

Control	Safety function	Comments
Moisture controls (continued) • Ventilation system changes - SST ventilation system design or operating changes that could cause increased waste moisture loss shall be evaluated for the effect on the organic salt-nitrate reaction risk and controls.	Ensures that ventilation system design or operating changes are not made without consideration of the impacts on the tank waste moisture content that prevents organic-nitrate combustion in the tanks.	Control applies to all SSTs.
Transfer controls • Waste compatibility controls - Evaluate pumped and received tank prior to waste transfers to ensure that controls for tank bumps are applied to the final state of the tank.	Ensure final tank states remain within analyzed topography of the organic salt-nitrate reactions accident.	Control also provides protection against postulated tank bumps or steam releases (Section 3.4.2.11).
HEPA filter controls • HEPA filter source term - Verify periodically that the HEPA filter housing radiation level is ≤2.0 E-03 Sv/h (200 mrem/h) on contact - Replace the HEPA filters and prefilters before filter housing radiation levels exceed 2.0 E-03 Sv/h (200 mrem/h).	Reduce consequences from a possible HEPA filter failure by limiting the inventory available.	Applies to all HEPA filters, prefilters, and inlet filters in the ventilation system. Also protects accident analysis assumptions regarding HEPA filter release amounts.
Emergency Preparedness Program with the following key element: • Response procedures	Mitigate the consequences of organic salt-nitrate reactions.	–

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

[a]Controls apply to 241-C-106, 241-SX-103, 241-SX-107, 241-SX-108, 241-SX-109, 241-SX-110, 241-SX-111, 241-SX-112, and 241-SX-114.

[b]Controls apply to all DSTs and AWF tanks.

AWF = Aging Waste Facility.
DOE = U.S. Department of Energy.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.
TOC = total organic carbon.
TSR = Technical Safety Requirement.

Table 3.4.2.6-2. Organic Salt-Nitrate Waste Grouping.

Organic-nitrate waste group	Applicable facilities	Comments
Pose no hazard because of supernate above the waste solids level	DSTs, AWF tanks, DCRTs 244-AR TK 001, TK-002, TK-003, TK-004	Salt well pumping of these tanks is not performed. Dry waste solids would only occur if waste heels are left in the tank following pumping and the heel is allowed to dry because of evaporation
"Safe"	SSTs: 241-A-101, 241-A-102, 241-A-103, 241-A-106, 241-B-103, 241-B-104, 241-B-106, 241-B-110, 241-B-111, 241-B-201, 241-B-204 241-BX-101, 241-BX-104, 241-BX-105, 241-BX-106, 241-BX-107, 241-BX-108, 241-BX-109, 241-BX-110, 241-BX-111, 241-BX-112, 241-BY-106 241-C-101, 241-C-103, 241-C-104, 241-C-105, 241-C-106, 241-C-108, 241-C-109, 241-C-110, 241-C-111, 241-C-112, 241-C-204, 241-S-104, 241-S-109, 241-S-111 241-SX-102, 241-SX-108, 241-SX-113 241-T-102, 241-T-104, 241-T-105, 241-T-106, 241-T-107, 241-T-108, 241-T-109, 241-T-111, 241-TX-102, 241-TX-107, 241-TX-118, 241-TY-101, 241-TY-102, 241-TY-103, 241-TY-104, 241-TY-105, 241-TY-106 241-U-103, 241-U-110, 241-U-111, 241-U-201, 241-U-202, 241-U-203, 241-U-204	Tanks were placed in the "safe" group if its waste has a low organic fuel content and is thus judged to be noncombustible without consideration of waste moisture. That is, even if these wastes were dried out, the waste would not be combustible
"Conditionally Safe"	SSTs: 241-AX-102, 241-C-201, 241-C-202, 241-U-105	Tanks were placed in the "conditionally safe" group if they were judged to pose a small risk when waste moisture was considered, but could pose a risk if the waste were dried out
"Unsafe"	None	Tanks would be placed into the "unsafe" group if they were judged to pose a significant risk even considering moisture present, or lack there of, under current conditions
Unassigned because of a lack of information and analysis (unsampled)	SSTs: all not listed under "safe," "conditionally safe," or "unsafe" above Catch tanks: all Miscellaneous inactive storage facilities: all Waste transfer lines that contain waste solids	

AWF = Aging Waste Facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
SST = single-shell tank.

Table 3.4.2.6-3. Release Fractions for Tank 241-U-105.

Analyte	Release Fraction for total waste inventory (25 m^3 [883 ft^3] burned)
^{137}Cs	5.5 E-03
^{90}Sr	2.3 E-10
^{90}Y	7.5 E-12
^{60}Co	2.4 E-10
^{99}Tc	8.4 E-10
^{125}Sb	5.3 E-04
^{154}Eu	5.9 E-05
^{239}Pu	8.5 E-12
Cd	1.9 E-06
Hg	1.5 E-02
NaOH	1.9 E-06

Table 3.4.2.6-4. Summary of Radiological and Toxicological Consequences for 25 m^3 (883 ft^3) Organic Salt-Nitrate Reaction With and Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				With and Without Controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Organic salt-nitrate reaction without controls	8.8 E+01 (8.8 E+03)	5.0 E-02 (5.0 E+00)	7.3 E-02 (7.3 E+00)	5.0 E-03 (5.0 E-01)	1.4 E+05	1 (ERPG-2)	1.6 E+02	1 (ERPG-1)	Unlikely
Organic salt-nitrate reaction with controls	8.8 E+01 (8.8 E+03)	1.0 E-01 (1.0 E+01)	7.3 E-02 (7.3 E+00)	4.0 E-02 (4.0 E+00)	1.0 E+03	1 (ERPG-3)	1.2 E+02	1 (ERPG-2)	Extremely unlikely

ERPG = Emergency Response Planning Guideline.
SOF = sum-of-fractions.

Table 3.4.2.6-5. Summary of Safety Structures, Systems, and Components for Organic Salt-Nitrate Reaction.

Structures, systems, and components	Safety classification	Safety function	Comments
Waste tanks	Safety-Class	The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during a tank vacuum or overpressurization event, thus reducing the consequences of the Organic Salt-Nitrate Reaction accident.	Applies to SSTs, DSTs, and AWF tanks. Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.
Temperature monitoring systems	Safety-Class	The safety function of the temperature monitoring systems is to provide tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding waste temperatures at which organic salt-nitrate reactions could proceed, thus decreasing the frequency of the Organic Salt-Nitrate Reaction accident.	There is an Authorization Basis amendment pending DOE approval that will eliminate the need to designate the Temperature Monitoring Systems as Safety-Class. Therefore, these systems are identified as Safety-Significant.

AWF = Aging Waste Facility.
DST = double-shell tank.
SSC = structure, system, and component.
SST = single-shell tank.

Table 3.4.2.6-6. Summary of Defense-in-Depth Controls for Organic Salt-Nitrate Reaction.

Control	Safety function	Comment
Vehicle positioning spotters	Spotters provide additional level of control in positioning cranes/vehicles	Reduces probability of analyzed accident
HEPA filter replacement typically performed at 1.0 E-03 Sv/h (100 mrem/h)	Limits inventory available for release, limits dose rate to workers in vicinity of the filters	--
SST and DST/AWF tank primary ventilation systems	Provide means to reduce flammable gas concentrations in the tank headspace.	Systems identified as safety SSCs for other accidents (e.g., Section 3.4.2.2)

AWF = Aging Waste Facility.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

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3.4.2.7 Surface Leak Resulting in Pool. Accidents that form surface pools of waste are of safety concern because a fraction of the waste can be resuspended (entrained) in wind blowing over the surface of the pool, or over the surface of contaminated soil after the pool soaks into the soil. Resuspended waste can lead to significant inhalation doses to onsite and offsite receptors. In addition, waste surface pools and contaminated soil can produce significant shine dose (direct gamma radiation dose) and skyshine dose (dose due to scattering of gamma rays off the atmosphere) to onsite receptors.

The specific hazardous conditions that can result in waste leaks directly to the soil surface are identified in the hazards analysis. The hazardous conditions can be categorized as follows:

- Overflows of various waste transfer pits (i.e., process pits, diversion boxes, valve pits, and the vent station nozzle pit) caused by to leaks from internal transfer equipment during transfers. Leaks can be caused by several mechanisms, including: misaligned jumpers, failed jumper gaskets, failed valve packing, failed pump seal, failed piping welds, etc.

- Overflows of various waste transfer pits caused by misroutes of waste through compromised transfer paths, especially misroutes through open nozzles.

- Overflows of underground storage tanks (e.g., DSTs, DCRTs, catch tanks) caused by leaving transfer pumps running too long. Tanks will overflow through process pits and risers located on top of the tanks.

- Overflows of underground waste storage tanks caused by service water leaks. Waste storage tanks are connected to process pits with the potential to receive service water via open drain lines or risers.

- Overflows of slurry line COBs caused by leaks from cleanout lines during transfers.

- Surface pools caused by leaks from SST temporary overground transfer lines during transfers.

- Overflows through transfer line encasement risers. This scenario requires failure of the primary pipe concurrent with closed or plugged encasement drains.

- Surface pool leaks caused by backflows of waste into service water supply systems. In backflow scenarios, waste can overflow flush pits or service pits should containment barriers be breached, or waste can be spilled onto the ground because of leaks from abovegrade service water system components.

- Pool leaks inside various interfacing facilities (e.g., 242-A Evaporator) caused by misroutes of waste from tank farms.

- Surface pool caused by excavation accident that uncovers and damages a buried or bermed transfer line during a transfer.

An overflow of DST valve pit 241-A-A caused by a misroute of AWF tank waste through an open nozzle originally was selected as the bounding representative accident for both the scenario without controls and the scenario with controls. Subsequent analysis using pit volumes smaller than valve pit 241-A-A (15 m^3 [530 ft^3]) indicated that higher consequences might be produced because of the combination of smaller pit volumes and potentially inadequate transfer system covers on the smaller pits. The accident scenario assuming no controls is not affected by the size of the pit because the entire liquid volume available is assumed to result in a surface pool (HNF-2296, *Justification for Continued Operation of Transfer Lines Having Structures with Less Volume than 241-A- Valve Pit*). Therefore, the accident scenario without controls is based on the 241-A-A valve pit, whereas the accident scenario with controls is based on a cleanout box with an interior volume of 0.2 m^3 (7.1 ft^3).

The analyses performed for the valve pit overflow case are summarized in Sections 3.4.2.7.1 through 3.4.2.7.4. The detailed calculations for the accident analysis are documented in WHC-SD-WM-CN-049, *Calculation Notes for Surface Leak Resulting in Pool, TWRS FSAR Accident Analysis*. The controls developed based on the valve pit overflow case, for all represented surface pool leak sites, are summarized in Section 3.4.2.7.5.

Surface pools of waste caused by subsurface leaks from buried portions of transfer lines are covered in Section 3.4.2.8.

Supplemental safety analysis regarding a bounding leak of waste (i.e., 27,000 gal) from the 242-A Evaporator has been performed and is documented in TWR-3738, *Mitigated Transfer Line Leaks that Result in Surface Pool*. The results of the analysis demonstrate that the entire volume can be released to the environment with resulting consequences that are within the consequences presented in this section. No additional controls for this scenario, beyond those presented in this section, were considered necessary.

Supplemental safety analysis and controls required for Tank 241-SY-101 remediation activities and operations are documented in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

3.4.2.7.1 Scenario Development. This section comprises discussions of four variations of the scenario development: (1) accident scenario without controls, (2) accident frequency without controls, (3) accident scenario with controls, and (4) accident frequency with controls.

Accident Scenario Without Controls. The waste is postulated to be misrouted through an open nozzle into a process pit where the cover blocks have been removed and the pit drain is closed. Misroutes can be caused by improperly aligning valves before waste transfers or by installing jumpers across the wrong nozzles before waste transfers. The misroute is postulated to involve AWF tank waste because this type of waste has the highest inhalation dose potential of

the three tank waste types. The accident analysis assumes the waste is misrouted into the 241-A-A valve pit. As noted previously, analysis has shown that leaks in pits with volumes smaller than valve pit 241-A-A (15 m^3 [530 ft^3]) may produce higher consequences because of the combined effect of smaller pit volumes and the potential for inadequate transfer system covers on the smaller pits. However, the accident scenario assuming no controls is not affected by the size of the pit because the entire liquid volume available is assumed to result in a surface pool (HNF-2296).

While the pit is filling with waste and before the nozzle becomes submerged, aerosols are generated by splatter and splashing. After the nozzle becomes submerged, aerosols will continue to be resuspended off the surface of the liquid in the pit as the pit fills. The aerosols are generated by welling and wave action. The aerosols are suspended by eddy and convection currents. The waste fills the pit, overflows to the ground surface, and spreads out on the soil surface. The surface pool continues to grow until the transfer pump runs out of waste or until the transfer pump is shut off. For the purposes of this analysis, the transfer pump is assumed to pump for 12 h. It is assumed that the large surface pool will be visually detected and the transfer pump shut off within this time frame.

While the surface pool is growing, liquid aerosols are resuspended in wind blowing over the surface of the pool. After the transfer pump is shut off, the pool is postulated to soak into the ground. The ambient temperature at the time of the leak is likely to be well below the saturation temperature of the waste. Dissolved salts are therefore postulated to crystallize out of solution while the pool soaks in, leaving a surface layer of contamination. Entrained sludge particulates in the waste are also postulated to be filtered out and left on the surface of the soil. In an accident without controls, the surface contamination would dry out and be subject to resuspension for an indefinite time. For the purpose of this analysis, it is assumed that the offsite receptor is exposed for 24 h after the transfer pump is shut off. The model used in this analysis to estimate the resuspension release fraction predicts that the majority of the resuspension release will occur within 24 h of the waste soaking in, so the 24-h resuspension assumption is sufficiently conservative.

The onsite receptor is assumed to be exposed for the first 12 h of the accident (approximately one work shift, as defined in Section 3.4.1). This receptor is assumed to be evacuated upon detection of the surface pool at 12 h. The onsite receptor is exposed to aerosols generated by splatter, splashing, and resuspension while the pit is filling, and to aerosols resuspended from the surface pool as it is forming during the first 12 h of the accident. The onsite receptor is also exposed to shine and skyshine dose for the 12-h exposure period.

The offsite receptor is assumed to be exposed for a total of 36 h. This duration was selected because it accounts for the majority of the contamination that can be expected to be resuspended from the soil surface over an indefinite time. The offsite receptor is exposed to the same aerosol releases as the onsite receptor plus an additional 24 h of resuspension of waste particulates from the contaminated soil surface and resuspension of aerosols from the liquid waste inside the valve pit.

Accident Frequency Without Controls. In the absence of controls to prevent mistransfers or leaks of waste into transfer structures such as valve pits, a spill of waste to the soil surface is considered to be an anticipated event (with annual frequency greater than 1×10^{-2}). Three general types of initiating events are postulated to result in overflows of transfer enclosures (e.g., overflows of valve pits, pump pits, sluice pits) as follows: (1) misroutes through open nozzles; (2) leaks from transfer equipment inside pits (e.g., leaks caused by gasket failures; misaligned jumpers, valve packing failures, pump seal failures) during transfers; and (3) leaks from buried portions of concrete or pipe encased transfer lines during transfers, where the leak drains back into the pit through the encasement drain.

All three initiators are considered to be anticipated events, based on Hanford Site experience. The occurrence reporting database contains three events between 1975 and 1977 where waste was misrouted through compromised paths and was spilled into pits. These events led to more stringent controls to prevent misroutes. In addition, the occurrence reporting database contains nine accounts between 1972 and 1995 where waste or flush water was found to have spilled into pits because of leaks from jumpers, valves, or pump seals. Seven events are included in the database between 1972 and 1995 where waste leaked from primary transfer lines and drained back into pits or diversion boxes through concrete or pipe encasements.

Accident Scenario With Controls. A set of controls was selected to prevent misrouting through open nozzles into pits and to prevent jumpers from becoming disconnected during transfers. These controls include configuration management of transfer routings, administrative procedures to require independent verification of valve lineups before transfers, and administrative procedures that require leak tests of jumpers following jumper changes. In addition, a TSR exists to blank off all open nozzles in pits where waste could be misrouted.

The scenario with controls takes credit for the previously described controls to prevent high flow rate leaks into process pits. Given the preventive controls, a maximum transfer equipment leak rate of 1.3 L/s (20 gal/min) was assumed. The leak rate corresponds to 20% of the nominal transfer flow rate of 379 L/min (100 gal/min) and is judged to conservatively represent leaks that might emanate from failed gaskets, valve packing, or cracks in transfer equipment. In the accident analysis with controls, the process pit leak detectors and their alarms are credited with providing early indication of the equipment leak. Operator action is also credited to ensure operators shut off the appropriate transfer pump following activation of the pit leak detector. The abovegrade portions of the pit and the pit cover is also credited with impeding the release of aerosols (generated in the accident caused by splatter) from the pit, and with limiting the shine and skyshine exposure to the onsite receptor.

The sequence of the accident with controls is as follows:

- An equipment leak (e.g., gasket failure) inside a COB with an interior volume of 0.2 m^3 (7.1 ft^3) causes a low volume leak (maximum leak rate assumed to be 1.3 L/s [20 gal/min]).

- The COB drain is assumed to be plugged at the time of the leak.

- The COB cover is installed at the time of the leak.
- The COB leak detector is assumed to alarm after 51 mm (2 in.) of waste have built up in the bottom of the COB.
- Flow is assumed to continue for 30 min after the leak detector alarms, allowing time for operators to respond to the alarm and to shut off the appropriate transfer pump.
- After the pump is shut off, 2,915 L (770 gal) of waste is assumed to drain back through the leakage path.
- As waste flows into the COB, aerosols are generated by splatter and splashing.
- Convection currents in the COB are assumed to keep some aerosols in suspension after the transfer pump is shut off.
- Aerosols are expelled through gaps in the COB cover caused by liquid displacement, the heat load in the COB, wind effects, and atmospheric pressure and temperature fluctuations.

Accident Frequency With Controls. The frequency category of the accident scenario with controls is anticipated. Leaks from transfer equipment inside pits are anticipated on the basis of Site experience. See discussion under "Accident Frequency Without Controls."

3.4.2.7.2 Source Term Analysis. The methodology and detailed calculations used to determine the airborne release quantities in the accident analyses, both without and with controls, are documented in WHC-SD-WM-CN-049. To maximize the inhalation dose estimates for the onsite and offsite receptors in the scenarios without and with controls, the waste leak is assumed to occur during a transfer of aging waste. The aging waste is assumed to contain 33 vol% entrained solids, the maximum expected during transfers. This assumed solids content is considered to be very conservative because it is above the upper operating limit (30 vol% solids) for the 242-A Evaporator, which produces the most concentrated transfer solution in the tank farms.

The quantities of waste material estimated to be spilled in the accident scenarios, without and with controls, and the quantities of respirable aerosol estimated to be dispersed downwind in each case are summarized in the following subsections.

Accident Source Term Without Controls. A bounding flow rate through the open nozzle of 1,140 L/min (300 gal/min) was established based on DST and AWF tank pump performance curves. At this flow rate, the total volume of waste spilled during the 12-h pumping period is 8.18×10^5 L (216,000 gal). The holding capacity of the 241-A-A valve pit was calculated to be 15,100 L (4,000 gal), based on the inside dimensions of the pit with the cover blocks on. At the maximum pump flow rate of 1,140 L/min (300 gal/min), the pit was calculated to overflow in the first 13 min of the accident. The 8.03×10^5 L (212,000 gal) of waste spilled to

the soil surface was estimated to ultimately spread and cover a surface area of 2.33×10^4 m^2 (2.51×10^5 ft^2), based on the surface area to volume ratio for a 32,600-L (8,600-gal) waste leak that occurred in the 241-S Tank Farm in 1973. The estimated respirable aerosol releases over the course of the accident, in equivalent liters of aging waste slurry, are summarized as follows:

- Splatter/splashing release during filling of the pit: 0.30 L (7.9×10^{-2} gal). Occurs in first 6.5 min of the accident, assuming the nozzle becomes submerged when the pit is half full.

- Resuspension release from liquid surface during filling of pit: 1.21×10^{-6} L (3.2×10^{-7} gal). Occurs during the first 13 min of the accident.

- Resuspension release from liquid pool overflowing pit: 7.1×10^{-2} L (1.9×10^{-2} gal). Applies during the 13-min to 12-h timeframe.

- Resuspension releases from contaminated soil after soaking in: 67.5 L (18 gal). Applies during the 12- to 36-h timeframe.

- Resuspension release from the surface of the waste in the pit after the pump has been shut off: 1.34×10^{-4} L (3.5×10^{-5} gal). Applies during the 12- to 36-h timeframe.

The splatter/splashing source term during filling of the pit was estimated using a splatter release fraction of 4×10^{-5}. This release fraction is the conservative value recommended in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, for spills of slurry from heights up to 3 m (10 ft). Splatter continues until the nozzle becomes submerged under the accumulating waste in the pit. The nozzle was assumed to become submerged when the waste level reached the midpoint of the pit. The splatter source term was thus determined by multiplying the splatter release fraction by a volume of 7,570 L (2,000 gal), half the holding capacity of the A-A valve pit.

A resuspension release flux of 2×10^{-10} kg/m^2-s was used to determine the respirable release volumes from the liquid surface during filling of the pit, from the pool during its growth phase on the soil surface, and from the surface of the waste in the pit after the transfer pump has been shut off. The mass resuspension release flux was taken from Figure 4 in WHC-SA-1378-FP, *Determining Wind Spray Release from Effluent Disposal Ponds Using AIRSOURC Model*, and corresponds to estimated sea spray releases for ponds with a 200-m (660-ft) fetch in winds up to 2 m/s (6.6 ft/s). This release rate is conservative for the size of pool considered here under worst-case (stable, low wind speed) atmospheric dispersion conditions. The mass resuspension flux was converted to a volumetric basis using an estimated slurry waste density of 1.4 g/cm^3 (11.7 lb/gal). To estimate the resuspension source term during filling of the pit, the volumetric resuspension flux was multiplied by the pit cross-sectional area (11.1 m^2) and the time period required to fill the pit (13 min). The resuspension release from the waste in the pit after the pump has been shut off was estimated similarly using a timeframe of 24 h instead of 13 min. The resuspension source term for the growing surface pool was determined by multiplying the

resuspension flux by the average pool surface area over its growing phase of 1.17×10^4 m^2 (1.26×10^5 ft^2) and the appropriate timeframe of 707 min.

A resuspension release fraction of 8.4×10^{-5} over 24 h was used to estimate the particulate release after waste soak in. This resuspension release fraction is taken from Section 3.2.4.4 of DOE-HDBK-3010-94 and is based on experiments with uranyl nitrate hexahydrate (UNH) solutions spilled on soil and dried under low wind speed conditions (<4.0 km/h [<2.5 mi/h]). Based on the original experiments, 50% of the total release was assumed to occur in the first 2 h after the waste had soaked into the ground, 80% in the first 12 h after soaking in, and 99% in the first 16 h after soaking in (BNWL-1732, *Some Experimental Measurements of Airborne Uranium [Representing Plutonium] in Transportation Accidents*).

The dose to the offsite receptor was determined on the basis of the total release volume over the 36-h duration of the accident. The onsite receptor dose was estimated on the basis of the aerosols released over the first 12 h of the accident. As stated previously, this receptor is assumed to be evacuated upon detection of the surface pool at 12 h.

For determining toxicological exposures, the maximum release rate for the onsite receptor is different than the maximum release rate for the offsite receptor. For the onsite receptor, the maximum release rate occurs in the first 13 min of the accident (while the pit is filling) because of splatter and resuspension. Dividing the splatter and resuspension release quantities during filling of the pit by 13 min gave a maximum release rate for the onsite receptor of 3.85×10^{-4} L/s (6.10×10^{-3} gal/min).

For the offsite receptor, the maximum waste release rate occurs in 12 to 14 h (after the waste has soaked into the soil, assuming instantaneous soak after the pump is shut off). Based on the resuspension experiment results reported in BNWL-1732, 50% of the total resuspended material was assumed to be resuspended in the initial 12 to 14 h. This results in a maximum release rate for the offsite receptor of 4.69×10^{-3} L/s (7.43×10^{-2} gal/min).

Accident Source Term With Controls. The analysis with controls previously assumed that valve pit 241-A-A was the smallest pit where a mistransfer or leak could occur and potentially result in a surface pool. Upon further evaluation, it was determined that leaks within COBs represent the bounding scenario. For the accident scenario with controls, the total volume of waste spilled includes the volume of waste necessary to activate the leak detector, the volume of waste that continues to spill during the 30 min required for operator action, and the volume of waste that drains back through the transfer line after the pump is shut off because of the slope and length of the transfer line. Because of the controls stipulated to prevent high flow rate leaks, the maximum leak rate in the analysis with controls was assumed to be 76 L/min (20 gal/min). Because the smallest COB has an interior volume of 0.2 m^3 (7.1 ft^3), which is equivalent to about 189 L (50 gal), the COB will overflow in 2.5 min. Therefore, activation of the leak detector (typically assumed to occur at a 5-cm [2-in] depth) is assumed to be instantaneous. Based on a flow of 76 L/min (20 gal/min), the volume of waste spilled in the COB before the pump is shut off is estimated to be 2,300 L (600 gal). After the pump is shut off, 20% of the waste contained in a 3,048-m (10,000-ft), 77-mm- (3-in.-) diameter transfer line (equivalent to 2,915 L [770 gal]) is assumed to drain back through the leakage path. Thus, the total volume of waste spilled to the

COB is 5,186 L (1,370 gal), which was conservatively rounded to 5,300 L (1,400 gal). It is conservatively estimated that this 5,300 L (1,400 gal) spreads and covers a surface area of 1.51×10^2 m^2 (1.63×10^3 ft^2) based on the measured surface area to volume ratio for a 32,600-L (8,600-gal) waste leak that occurred in the 241-S Tank Farm in 1973.

For the accident scenario involving the COB, aerosols are generated by four mechanisms. These mechanisms include splatter and splashing while the COB is filling with waste, spray release through a supplemental cover during active transfer pumping as the COB overflows, splatter and splashing during drainback, and resuspension release from the surface pool after the COB overflows.

To estimate the aerosol release generated while the COB is filling with waste, a simplistic model was used that assumed that one COB volume was expelled with a quasi-stable aerosol loading limit of 100 mg/m^3 (Section 2.4.14 of PNL-4154, *Accident Generated Particulate Materials and their Characteristics - A Review of Background Information*). The analysis assumes a 91 cm (36-in.) slit in the supplemental cover, which allows a total leak rate of 7.8×10^{-4} m^3/sec. Using the 2.5 min duration that it takes to fill the COB, the 100 mg/m^3 aerosol loading limit and the leak rate of 7.8×10^{-4} m^3/sec, the aerosol released when the COB is filling was determined to be 8.3×10^{-6} L.

After the COB has filled, a spray out of the COB through the supplemental cover is assumed to generate an aerosol with a quasi-stable loading limit of 100 mg/m^3. Because the COB requires 2.5 min to overflow, the spray would occur for 27.5 min (30 min - 2.5 min). Applying the total leak rate through the supplemental cover discussed in the preceding paragraph (7.8×10^{-4} m^3/sec), the aerosol released by the spray outside the COB is 9.2×10^{-5} L.

As noted previously, a drainback volume of 2,915 L (770 gal) is assumed to flow to the COB after the pump is shut off. The COBs are about 61 cm (2 ft) above ground level and the waste is a slurry with a density of 1.4 g/cm^3 (11.7 lb/gal). Assuming the waste is best represented by UNH solution, and using DOE-HDBK-3010-94, Section 3.2.3.1, a bounding respirable release fraction (5×10^{-7}) representing a fall of 1 m (3.3 ft) was selected. The entire 2,915 L (770 gal) is assumed to pass through the supplemental cover, which when multiplied by the respirable release fraction of 5×10^{-7} produces an aerosol release of 1.5×10^{-3} L.

The final factor to be considered is the expanding surface pool that forms after the COB overflows. The same resuspension flux used in the accident scenario without controls (i.e., 2×10^{-10} kg/m^2-s) was converted to a volumetric resuspension flux based on a waste density of 1.4 g/cm^3 (11.7 lb/gal) and then used to determine the aerosol release rate from the surface pool with an area of 1.51×10^2 m^2 (1.63×10^3 ft^2). Using these values, the aerosol release was determined to be 7.6×10^{-5} L (2.0×10^{-5} gal).

To determine the total release, the releases produced by the four mechanisms were summed. The total aerosol release from the COB was 1.7×10^{-3} L (4.5×10^{-4} gal).

For estimating toxicological exposures, the maximum release rate occurs while the transfer pump is running and the COB is filling with waste. Over the first 2.5 min required to fill the

COB, the release volume caused by splatter and splashing is 1.7×10^{-3} L (4.5×10^{-3} gal). This release volume was divided by the time (150 sec) to yield a maximum aerosol release rate of 1.1×10^{-5} L/s.

3.4.2.7.3 Consequence Analysis. The detailed consequence calculations are documented in WHC-SD-WM-CN-049. Table 3.4.2.7-1 summarizes the estimated doses for the scenarios without and with controls. The doses are broken down by mechanism. For the onsite receptor, the inhalation, direct shine, and skyshine doses are reported individually. For the offsite receptor, the inhalation and 24-h ingestion doses are reported separately. The total dose to the onsite receptor, in the accident without controls, was found to be 3.3 Sv (3.3×10^{2} rem). The total dose to the offsite receptor in the accident without controls was found to be 3.6×10^{-1} Sv (3.6×10^{1} rem). For the accident scenario with controls, the total onsite and offsite doses were found to be 5.1×10^{-3} Sv and 6.6×10^{-6} Sv (5.1×10^{-1} rem and 6.6×10^{-4} rem), respectively.

The toxicological sum-of-fraction estimates for the onsite and offsite receptors in the accident without controls were found to be 5.0 and 3.2×10^{-1}, respectively (Table 3.4.2.7-2). The toxicological sum-of-fraction values for the onsite and offsite receptors in the accident with controls were found to be 1.4×10^{-1} and 7.5×10^{-4}, respectively (Table-3.4.2.7-3).

The onsite and offsite inhalation doses, the offsite 24-h ingestion dose, and the toxicological exposures for the accident scenarios without and with controls were calculated using the methodologies outlined in Section 3.4.1 and the source terms discussed in the previous section.

The direct shine and skyshine dose estimates to the onsite receptor in the accident without controls were estimated using the *MICROSHIELD* (Grove 1992) and *MICROSKYSHINE* (Grove 1987) computer codes. These computer codes were also used to estimate the direct shine and skyshine doses in the accident with controls.

The surface pool, in the accident without controls, was modeled for the purposes of estimating shine and skyshine dose as a disk 86 m (282 ft) in radius and 3.5 cm (1.38 in.) in depth, based on the total estimated leakage volume and surface area discussed in Section 3.4.2.7.2. To account for the self shielding and scattering properties of the waste pool, the pool was modeled as water, with bulk density equivalent to that of the waste slurry, which is 1.4 g/cm^3. For the direct shine dose estimates, the soil between the edge of the pool and the receptor was modeled as a concentric shield consisting of concrete with an average density equivalent to that of Hanford Site soil, which is 1.6 g/cm^3. For the skyshine models, a hypothetical shielding wall was added between the valve pit and the receptor to preclude line of sight dose. The aging waste solids and liquids concentrations from Table 3.4.1-4 were used to define the source volume radionuclide concentrations. Photons produced indirectly by beta emitters in the waste because of the brehmsstrahlung effect were included in the shine and skyshine calculations. The shine and skyshine doses were calculated for a 12-h exposure duration, based on the exposure rate for the fully formed pool.

In the accident with controls the shine and skyshine dose were estimated in the same fashion as described above for the accident without controls except that the pool radius is 6.9 m (22.8 ft) and a 1-h exposure duration is used.

Key Parameters and Assumptions—Accident Analysis Without Controls. The level of conservatism in key parameters used in the accident analysis without controls and the sensitivity of the consequence estimates to variations in those parameters are addressed in the following subsections:

- **Waste Inventory**—The onsite and offsite inhalation dose estimates depend on the radiological inventory of the waste, which in turn is a function of the waste type released and the solids content of the waste. The waste released in the representative accident is assumed to be AWF tank waste. The waste was assumed to contain 33 vol% entrained solids. The majority of the dose comes from the solids constituents in the waste. The 33 vol% solids value is conservative. The solids content during most transfers is expected to range from trace amounts to 5 vol% solids, based on grab sample results and measured solids level increases in receipt tanks during transfers. A more likely accident would involve DST waste with a solids content of less than 5 vol%. The ULD for DST waste containing 5 vol% solids is a factor of 18 times smaller than the ULD for AWF tank waste containing 33 vol% solids. Based on this, the inhalation dose consequences for DST waste containing 5 vol% solids could be expected to be approximately 18 times smaller than the dose estimates for the representative case analyzed.

  The gamma emitter concentrations in the waste pool determine the shine and skyshine doses to the onsite receptor. Skyshine constitutes a large fraction of the total onsite dose estimate. Most of the shine and skyshine dose comes from the ^{137}Cs daughter ^{137m}Ba. The ^{137m}Ba concentration in DST waste containing 5 vol% solids is approximately 67% of the ^{137m}Ba concentration in AWF tank waste containing 33 vol% solids. For a given size pool, the effect of ^{137m}Ba concentration on shine and skyshine dose can be expected to be approximately linear. The skyshine dose in the representative accident was estimated to be 9.1×10^{-1} Sv (9.1×10^{1} rem). Changing the waste inventory to DST waste containing 5 vol% solids would reduce the skyshine contribution to about 5.0×10^{-1} Sv (5.0×10^{1} rem).

- **Waste Flow Rate and Pumping Duration**—The waste flow rate and pumping duration affect the inhalation dose estimates by affecting the total volume of waste released in the accident. In the accident analysis, the waste is assumed to be released at a flow rate of 1,136 L/min (300 gal/min). This is a conservative flow rate and would only occur if waste were misrouted through an open nozzle in a pit very close to the transfer pump. The pump was assumed to continue to run for a conservative period of 12 h before the pool was noticed and the pump was shut off. This maximizes the size of the pool and the offsite inhalation dose. The total volume of waste spilled in the accident analysis without controls was 8.18×10^{5} L

(216,000 gal). Of this, 1.51×10^4 L (4,000 gal) were contained within the valve pit. It is likely the surface pool would be visually observed by tank farm workers well before 8.03×10^5 L (212,000 gal) of waste were spilled to the soil surface. The onsite inhalation dose comes from resuspension of aerosols off the pool surface for 12 h. The resuspension rate off the pool is a function of the surface area of the pool (see discussion below). If it is assumed that the average depth of the pool does not change with total surface pool volume, changing the surface pool volume by changing the waste flow rate or pumping duration assumptions will have an approximately linear effect on the onsite inhalation dose estimate. The contaminated soil resuspension fraction is a function only of total spill volume (see the following discussion). Therefore, changing the total surface spill volume, by changing the waste flow rate or pumping duration, will also have a linear effect on offsite inhalation dose. Based on this, changing the total surface spill volume to 1.36×10^5 L (36,000 gal), similar to the size of a recent service water spill in the tank farm, would reduce the onsite inhalation dose estimate by a factor of 5.9, from 2.3 Sv (2.3×10^2 rem) to approximately 3.9×10^{-1} Sv (3.9×10^1 rem). The offsite inhalation dose would be reduced from 3.6×10^{-1} Sv (3.6×10^1 rem) to approximately 6.1×10^{-3} Sv (6.1×10^{-1} rem).

An inherent assumption in the onsite dose estimate is that the spilled waste remains as a liquid pool for the entire onsite receptors exposure period. Pumping durations less than 12 h could result in the spill soaking into the soil within the first 12 h of the accident. The resuspension rate of particulate contamination off a dried soil surface after the waste has soaked in could be expected to be much higher than off the surface of a liquid pool covering a similar surface of soil. The onsite dose estimates are therefore nonconservative for small to moderate spills. The 12-h pump duration was selected to maximize the size of the pool and to maximize the offsite dose estimate.

In the accident analysis without controls, the onsite receptor is located 100 m (330 ft) from the leading edge of the pool. The onsite shine and skyshine doses are very conservatively estimated based on the maximum exposure rates for the fully formed pool. Reducing the volume of material spilled, by changing flow rate or pump duration, would be expected to reduce the shine and skyshine dose estimates by reducing the total gamma emitter concentrations in the source volume. However, for very large pools, such as the one postulated in the accident analysis without controls, most of the dose comes from the portion of the pool nearest the receptor. Shrinking the dimensions of the very large pool estimated in this analysis will not have much effect on the maximum shine and skyshine exposures rates, assuming the distance between the edge of the pool and the receptor is held constant at 100 m (330 ft).

- **Pool Resuspension Flux**—The resuspension flux used in the analysis is based on measurements of ocean sprays. The mass resuspension flux used in the analysis was 2×10^{-10} kg/m^2-s, which corresponds to the resuspension flux for a pond with

a fetch of 200 m (660 ft) at a wind speed of 2 m/s (6.6 ft/s). The low wind speed value is used to correspond to 99.5 percentile meteorological conditions.

The offsite dose estimate is not sensitive to the liquid resuspension flux because the majority of the offsite dose is caused by resuspension of contamination off the soil surface after the waste has soaked in. The resuspension rate for the contaminated soil is much higher than the resuspension rate predicted from the liquid resuspension flux value. The onsite receptor is evacuated before the waste has a chance to soak into the soil, so the onsite receptor inhalation dose is sensitive to the resuspension flux value used. A degree of conservatism and the sensitivity of the onsite dose estimates to variations in this variable were not estimated because of a lack of data on resuspension rates from large outdoor pools.

- **Surface Pool Geometry**—It is assumed in the analysis without controls that the pool spreads to an average depth of 3.5 cm (1.37 in.) based on the surface area to volume ratio estimated for a large waste spill in the tank farms in 1973. The assumed pool depth is conservative for modeling pool spread because of the unevenness of the terrain and the expectation that some of the waste would penetrate the soil. The assumed pool depth and shape do not effect the offsite inhalation dose estimate because that dose primarily depends on the contaminated soil resuspension release fraction, which only depends on total pool volume. The assumed pool depth does, however, affect the onsite inhalation dose. The onsite inhalation dose comes from resuspension of aerosols off the growing pool surface. The aerosol resuspension rate is proportional to pool surface area. The surface area is inversely proportional to assumed waste depth, so the estimated dose would be expected to also vary in an inversely proportional manner. Doubling the assumed pool depth would cut the onsite dose estimate by approximately a factor of 2. The shape of the pool does not affect the resuspension rate or the inhalation dose estimate.

  The integrated shine and skyshine doses to the onsite receptor over the 12-h exposure period were conservatively estimated based on the maximum exposure rate estimated for the fully formed pool. The onsite receptor was assumed to be located 100 m (328 ft) from the edge of the pool. For large pools, altering the shape or depth of the surface pool would not be expected to strongly affect the shine and skyshine estimates, provided the onsite receptor remains 100 m (328 ft) from the edge of the pool.

- **Contaminated Soil Resuspension Fraction**—The majority of the dose to the offsite receptor comes from inhalation of particulate contamination resuspended off the soil surface after the waste soaks into the ground. The contaminated soil resuspension fraction does not affect the onsite dose estimate because the onsite receptor is exposed only to resuspension of aerosols off a liquid surface.

  The contaminated soil resuspension release fraction is based on experiments where relatively small quantities (<100 mL) of UNH solution were poured over soil and

dried out under low wind speed conditions. The release fraction used, 8.4×10^{-5} over 24 h, is likely very conservative for large pooling releases, for the following reasons:

- Large pooling releases will leave a smaller fraction of the solids and salts in solution subject to resuspension. The filtering effect of the soil on large pooling releases will pile up the solids and salts as a much deeper surface layer than in the UNH experiments. Only the top few millimeters of the surface contamination are subject to release under 99.5 percentile meteorological conditions. Large pooling releases will also soak into the ground farther than the small volumes spilled in the UNH experiments. This may allow a larger fraction of the dissolved salts to migrate deeper in the soil where the salts will not be subject to resuspension.
- Large pooling releases will keep the soil damp longer. The resuspension rate off a pool or a damp soil surface is much smaller than off a dry soil surface. Over a given recovery period, the release will be reduced if the contaminated soil surface remains damp longer.

Quantitatively estimating the conservatism in using the UNH resuspension fractions for large pooling releases of tank waste (given the different physical and chemical considerations) is beyond the scope of the analysis. The UNH resuspension fraction, however, can be compared with resuspension fractions measured for powders spilled on soil. BNWL-2000, "Resuspension Rates from a Circular Field Source," measured resuspension rates of a powder deposited on a soil surface and deduced that a reasonable value for resuspension rate ranged from 4×10^{-5}/h to 4×10^{-7}/h. This range compares very well with the resuspension rate of 4×10^{-6}/h measured in the UNH experiments (see Section 3.2.4.4 of DOE-HDBK-3010-94). It is assumed in the accident analysis without controls that the waste spreads out thinly before soaking in, simulating the UNH experiments. The resuspension release fraction is independent of surface area affected and is, therefore, only a function of total surface spill volume (total spill volume - volume contained in the pit). The relationship between offsite inhalation dose and surface spill volume is approximately linear.

As discussed above, the total spill volume in the accident without controls is conservative. Reducing the surface spill volume from 8.03×10^5 L (212,000 gal) to 1.36×10^5 L (36,000 gal), similar to a recent service water spill in the tank farms, would be expected to reduce the offsite dose estimate by approximately a factor of 5.9, from 3.6×10^{-1} to 6.1×10^{-2} Sv (3.6×10^1 to 6.1 rem).

The contaminated soil resuspension rate also affects the offsite receptor toxicological exposure estimate for the accident scenario without controls. The toxicological exposure estimate is based on a maximum release rate. The maximum release rate was set in the accident analysis without controls, based on a 2-h resuspension rate. The experiments on which the soil resuspension fraction is based indicate that the release rate decreases with time. However, no experimental

data was found for resuspension durations less than 2 h. The toxicological exposure limits are based on 1-h exposure durations. If the 2-h resuspension release occurs over a 1-h timeframe, the toxicological sum-of-fractions value for the offsite receptor in the accident without controls doubles to 6.4×10^{-1}.

Key Parameters and Assumptions—Accident Analysis With Controls. The accident analysis with controls uses a simple model that assumes that the COB fills to capacity so rapidly (2.5 min) that the leak detector can be assumed to respond instantaneously. One COB volume of air at the quasi-stable loading limit of 100 mg/m^3 is assumed to be released in this 2.5-min period. In the ensuing 27.5 min, aerosols are generated from the spray release through the supplemental cover during active transfer pumping as the COB overflows. Aerosols are also generated by splatter and splashing during drainback and by the resuspension release from the surface pool after the COB overflows. In the accident analysis with controls, several assumptions are made based on the controls that serve to limit the dose to the onsite and offsite receptors. These assumptions relate to the leak flow rate, the operator response time required to shut off the transfer pump after the leak detector alarms, and the line drainback after the transfer pump is shut off. The conservatisms in the key parameters and assumptions used in the analysis and the sensitivity of the analysis to variations in these key parameters and assumptions are discussed below.

- **Aerosol Loading**—In the first 2.5 min after initiation of the accident the aerosol content in the pit air is assumed to reach the quasi-stable loading limit of 100 mg/m^3. This aerosol loading limit is comparable to a dense fog. This value is very conservative because it is unlikely that a volume the size of a valve pit could reach such an aerosol loading only by splatter and splashing. Based on splatter release fractions reported in DOE-HDBK-3010-94, enough aerosol could in theory be released by splatter to load the pit air volume (assuming perfect mixing) to the quasi-stable limit, assuming low air exchange rates through the pit. In reality, aerosol depletion mechanisms would be expected to keep the average aerosol loading in the pit well below the 100 mg/m^3 value. In addition, in the 27.5 min period after the COB has filled but the transfer pump continues to run, it is assumed that waste will spray out of the COB with an aerosol loading of 100 mg/m^3. This is based on an assumed slit in the supplemental cover that is 36-in. and 5×10^{-3} in. wide. These slit dimensions were selected to optimize the aerosol loading and increasing or decreasing either dimension would serve to reduce the aerosol loading. Thus the 100 mg/m^3 provides an upper bound for the release expelled by displacement in the first 2.5 min and the subsequent spray release that occurs for 27.5 min. The dose is proportional to the aerosol loading. PNL-4154, Section 4.1, suggests a metastable aerosol concentration of 10 mg/m^3 for aerosols mixed vigorously in air. Using this aerosol loading would give doses a factor of 10 times lower than reported for the representative analysis.

- **Breathing Volume**—The COB covers and supplemental covers limit the air exchange rate through the COB. The accident analysis with controls estimates the total aerosol release from the COB during the first 2.5 min of the accident by assuming that one pit volume of air is expelled at the 100 mg/m^3 aerosol loading limit. The model postulates that the splatter-generated aerosols rapidly load the pit

volume with aerosols and that all of the contaminated pit air is expelled because of liquid displacement. Using the simple consequence model, the dose consequences from this initial displacement are a function of the pit volume. The largest valve pit is 241-AP. Section 3.4.2.9 evaluates a spray leak inside the 241-AP pit. The accident presented above and the spray leak accident presented in Section 3.4.2.9 both are caused by postulated equipment leaks releasing waste at 76 L/min (20 gal/min). The equipment leak can produce aerosol from both direct spraying and splatter. The primary difference in the two accident analyses is that the pit leak detectors are credited in this section to mitigate equipment leaks that might cause pit overflows; whereas pit leak detectors were not considered in the spray leak accident (without controls). Crediting pit leak detectors, the dose consequences of an equipment leak inside a very large pit, such as 241-AP, would be expected to be between the doses estimated in this section and the doses estimated for the covered valve pit spray leak accidents analyzed in Section 3.4.2.9. The pit leak detectors will reduce the doses over those estimated in the mitigated spray leak analysis because the leak detector will limit the duration of the spray when it is assumed that the pit drains are either plugged or closed.

- **Leak Flow Rate**—Because of the controls defined to prevent misroutes through open nozzles, and to prevent jumpers from falling off during transfers, it is assumed in the accident analysis with controls that the maximum leak rate inside the COB is limited to 76 L/min (20 gal/min). The primary effect of leak flow rate is to determine the size of the surface pool that forms, which in turn affects the inhalation and onsite shine and skyshine doses. The offsite inhalation dose varies linearly with the leak flow rate because this dose is a function of the total spill volume only. Similarly, the onsite inhalation dose has a linear relationship to the leak flow rate because this dose is approximately a linear function of surface area, which in turn has a linear relationship to pool volume (assuming the spreading depth is independent of flow rate).

  The effect of leak rate on the shine and skyshine doses is more complicated. Lower flow rates will limit the spread of the surface pool toward the receptor and will reduce the total gamma emitter inventory accumulated in the pool. Shine and skyshine doses fall off rapidly with increasing distance between the source volume and receptor location. However, the sensitivity of shine and skyshine results to variations in leak flow rates was not quantitatively evaluated.

  It is important to note that the leak flow rate also has an effect on the toxicological exposure estimates. Higher flow rates will displace contaminated air from the COB at a faster rate thereby increasing the toxicological exposure estimates in a linear fashion.

- **Operator Response Time**—The accident analysis with controls assumes a 30-min operator response time to shut off the transfer pump after the pit leak detector alarms. As noted previously, aerosols are generated by four mechanisms including splatter and splashing while the COB is filling with waste, spray release through a

supplemental cover during active transfer pumping as the COB overflows, splatter and splashing during drainback, and resuspension release from the surface pool after the COB overflows. Because it occurs in the first 2.5 min, the aerosol release from splatter and splashing while the COB is filling with waste is not affected by the operator response time. The dose contribution from drainback is also unaffected by the operator response time, because this dose is dependent on the volume of the drainback, which is determined by the dimensions and configuration of the transfer route. The inhalation dose consequences from the spray release after the COB has filled is linearly dependent on the duration of continued pumping, which is determined by operator response time. In addition, the operator response time is one of the factors that determines the size of the surface pool which affects the inhalation and onsite shine and skyshine doses in the manner described in the preceding paragraph.

- **Line Drainback**—In the accident analysis with controls, it is assumed that 2,915 L (770 gal) of waste drains back through the leakage path after pumping stops. This drainback is equivalent to 20% of the waste retained in a 76 mm (3 in.) dia transfer line that is 3,048-m (10,000 ft) long. For equipment leaks (e.g., gasket failures, valve packing failures, misaligned jumpers), the majority of the line holdup would be expected to flow back into the receipt or source tank, with only a small fraction (assumed to be 20%) branch flowing through the leakage path. In addition, the point of overflow for the COB is approximately 1.22-1.83 m (4-6 ft) above the transfer line which further serves to make the 2,915 L (770 gal) drainback a conservative assumption. Drainback contributes to dose through two mechanisms. The first mechanism involves the aerosol created by splatter and splashing as the waste overflows from the COB, which contributes to the inhalation dose. This inhalation dose is proportional to the drainback volume and therefore is directly affected by the length of the transfer route and the amount of waste assumed to flow back to the COB. After overflowing from the COB, the waste produced by drainback collects in the surface pool, thereby making a second contribution to dose consequences. As noted previously, the size of the surface pool affects the inhalation and onsite shine and skyshine doses. These effects are described in the preceding section discussing leak flow rates.

3.4.2.7.4 Comparison With Guidelines. The radiological and toxicological consequences of the accidents without and with controls are compared with the risk guidelines in Tables 3.4.2.7-2 and 3.4.2.7-3, respectively. Table 3.4.2.7-2 shows that the accident where no controls are credited produces onsite and offsite dose consequences in excess of the risk guidelines for the anticipated frequency category. The onsite toxicological exposure for the accident without controls is also shown to be above the risk guidelines for the anticipated frequency category. The offsite toxicological consequences for the accident without controls are shown to be below the risk guidelines for the anticipated frequency category.

Table 3.4.2.7-3 shows that the controls selected to mitigate the consequences of the accident are sufficient to keep offsite radiological and onsite and offsite toxicological exposures

below the risk guidelines for the anticipated frequency category. The onsite radiological consequences are essentially equal to the risk guidelines, but have been accepted by DOE.

3.4.2.7.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. Before discussing the safety SSCs and controls it is important to note the following. Waste transfer structures with volumes equal to or greater than 15 m^3 (530 ft^3) will not overflow when the full set of controls are applied. Conversely, COBs which have volumes less than 15 m^3 (530 ft^3) will overflow even after the full suite of controls is applied. Therefore, discussions in this section that refer to preventing the overflow of waste transfer structures are only valid for those structures with volumes equal to or greater than 15 m^3 (530 ft^3). The COBs will be specifically mentioned in any discussions of controls that are related to mitigating the effects of waste transfer structure overflow.

Tables 3.4.2.7-4 and 3.4.2.7-5 summarize the safety SSCs and TSR controls, respectively, selected to prevent or mitigate surface pool leaks throughout the TWRS. For each safety SSC and TSR control, the safety function required is described and additional comments are provided as appropriate. The safety SSCs and TSR controls are identified for the representative accident analyzed above and for the other accident scenarios identified in the hazards analysis to result in surface pools. In addition to this analyzed accident scenario, misrouting of waste transfers is a potential cause for the following postulated accidents analyzed in the following subsections of this document:

- Subsurface Leak Remaining Subsurface (Section 3.3.2.4.7)
- Subsurface Leak Resulting in Pool (Section 3.4.2.8)
- Spray Leak in Structure or From Waste Transfer Lines (Section 3.4.2.9)
- Spray Leak from Underground Waste Transfer Lines (Section 3.4.2.10).

Therefore, before discussing the specific safety SSCs and TSR controls chosen for this accident scenario it is important to discuss the control strategy developed to either prevent or mitigate the potential misrouting of waste transfers.

Control Strategy for Potential Misrouting of Waste Transfers. The selected safety SSC and TSR controls provide three levels of defense to prevent or mitigate the risk of these accidents caused by waste transfer misrouting.

The first level of defense requires that the controls selected to prevent or mitigate leaks from waste transfer systems (e.g., transfer system covers, transfer leak detection systems, periodic ground-level radiation surveys of single-walled, direct-buried/bermed lines) are operable or implemented for the "physically connected" topography of the waste transfer. The physically connected topography refers to piping, structures, and tanks and their associated instrumentation as follows:

1. Physically connected piping is any piping that is part of or connected to the transfer route. Piping need not be considered connected to the transfer route if it is physically disconnected by a removal of piping (i.e., air gap) or isolated with a

blind flange/process blank. (Note: Closed valves do not physically disconnect piping.)

The replacement cross-site transfer line is considered physically connected piping only when cross-site waste transfers are in progress. The replacement cross-site transfer line is described in Addendum 2.

An operable service water pressure detection system is considered to physically disconnect piping on either side of the detection system.

2. Physically connected structures are those structures through which physically connected piping runs, or structures that could be subject to leakage from physically connected piping.

3. Physically connected tanks are those tanks connected to the transfer route, those tanks connected to the physically connected piping, and those tanks designed to receive leakage from physically connected piping through a drain path.

This first level of defense ensures that, should a mistransfer occur because of a leaking or misaligned isolation valve, controls are operable and implemented where the waste could be misrouted to detect and/or mitigate the consequences of a potential waste leak (i.e., spray, pool, underground plume). For example, the transfer leak detection systems must be operable in all physically connected structures (i.e., process pits, diversion boxes, valve pits, and COBs) during the waste transfer.

The second level of defense is the selection of additional controls for identifying waste transfer leaks or misroutings. These controls are the TSRs for periodic material balances and periodic monitoring of interconnected tanks during waste transfers. Upon indication of a significant material balance discrepancy or unexpected tank level rise, the waste transfer would be shut down to limit the potential quantity of waste leaked or misrouted.

The third level of defense is controls that prevent waste transfer misrouting. These TSR controls include the following:

- Wherever practical, isolation of piping connected to the planned waste transfer path with two closed valves in series.
- Independent verification of the planned waste transfer route.
- Waste transfer system and jumper configuration control.
- Waste transfer system operations by approved procedures.

These controls reduce the likelihood of misrouting during planned waste transfers.

In summary, the selected safety SSCs and TSR controls and their required application during waste transfers provide diversity and multiple levels of defense. The controls minimize the likelihood of a waste transfer misrouting and ensure that, should a waste leak occur as a result of a misrouting, mitigative safety SSCs or TSR controls are in place to reduce the accident consequences.

Safety Structures, Systems, and Components. To prevent waste transfer-associated structures from overflowing because of equipment leaks, the leak detection systems were designated Safety-Class. High flow rate leaks, such as misroutes through open nozzles, are prevented with TSR controls discussed in the following paragraphs. The previously discussed representative accident analysis shows that the leak detection systems are required, along with operator response, to prevent offsite dose consequences in excess of the evaluation guidelines. In addition, SST, DST, AWF tank, and DCRT level detection systems and SST salt well flow totalizers were designated Safety-Significant to support the performance of periodic material balances during transfers. The periodic material balances provide an alternate means to detect large volume leaks that could overflow transfer structures.

Transfer system covers were designated Safety-Significant to protect the onsite receptor. The transfer system covers limit the aerosol release from the waste transfer-associated structure by splatter and splashing and limit the shine dose to nearby workers should a leak develop in a waste transfer-associated structure during a transfer. Without the transfer system covers, calculations indicate that the splatter/splashing source term could produce onsite consequences in excess of the evaluation guidelines. Taking credit for the Safety-Class transfer system leak detection system and operator response to shut off the transfer pump within 30 min, the aerosol release from the pit was not great enough to produce offsite consequences in excess of the evaluation guidelines. Note that although the transfer system covers are designated as Safety-Significant for liquid leaks within waste transfer-associated structures, the covers have been designated Safety-Class to mitigate spray leaks within the waste transfer-associated structures (see Section 3.4.2.9).

The abovegrade portions (i.e., walls) of process pits, diversion boxes, and valve pits serve two separate safety functions: (1) Safety-Class—to maintain the physical integrity of the abovegrade portions of the process pits, diversion boxes, and valve pits such that they will contain a waste leak; and (2) Safety-Significant—to limit the aerosol release from the waste transfer-associated structure caused by splatter and splashing and limit the shine dose to nearby workers should a leak develop in a waste transfer-associated structure during a transfer. Per agreement with DOE-ORP, both safety designations of the SSC are not effective until March 30, 2000.

TSR Administrative Controls are primarily relied on to prevent waste transfer-associated structure overflows because of misroutes of waste during transfers (see the discussion of TSR controls). The SSCs identified for transfer equipment leaks provide backup mitigation in the event of a misroute. The primary tank leak detection systems were also designated Safety-Class to provide backup mitigation in the event of a misroute of waste to the annulus of a DST or an AWF tank.

It is possible for receipt tanks (DSTs, AWF tanks, or DCRTs) to overflow to the ground surface if overfilled in a transfer. SSTs and catch tanks do not receive waste except in misroute scenarios, which are addressed in separate TSR controls. Receipt tanks will overflow to the ground surface through process pits and risers on top of the tanks. Leak detectors in pump pits and sluice pits located on top of DSTs and AWF tanks, and pump pits located on top of DCRTs were designated Safety-Class to prevent surface pools caused by overfilling. To limit aerosol release to the atmosphere caused by displacement of contaminated air through the pit drains, the pit cover blocks were designated Safety-Significant. Tank level detection systems (in DSTs, AWF tanks, DCRTs, and catch tanks) were designated Safety-Significant to support material balances during transfers. The material balances provide backup detection to the pit leak detectors to prevent tank overflows to the ground.

To prevent overflows of waste storage tanks (e.g., DSTs, AWF tanks, SSTs, DCRTs, and catch tanks) because of service water leaks, the service water flow totalizers and tank level detection systems were designated Safety-Significant. The flow totalizers and tank level detection systems will be monitored periodically for water intrusion in the tanks (see TSR Controls).

To limit overflows of waste from slurry line COBs, the transfer leak detection systems were designated Safety-Class. To limit the release of aerosols generated by spray (following the initial surface leak), the transfer system supplemental covers were designated as Safety-Class for COBs and waste transfer-associated structures with volumes less than 15 m^3 (530 ft^3). The transfer system covers (i.e., COB covers) and the abovegrade portions of the COBs were designated Safety-Significant to limit the aerosol release generated by splatter, splashing, and spray in the COB and to ensure the onsite evaluation guidelines are not exceeded. Per agreement with DOE-ORP, this Safety-Significant designation for aboveground portions of COBs is not effective until March 30, 2000.

For the SST overground transfer lines, the encasement pipe and connections were designated Safety-Class. The encasement pipe and connections are needed to provide secondary confinement in case the primary pipe leaks. The encasement pipe and connections provide the Safety-Class function of channeling the leak back to the interfacing process pits where the leak can be detected by the Safety-Class leak detection systems and where the waste can safely drain back to an SST or DCRT. The overground transfer line concrete shielding system was designated as Safety-Class so it could be used to protect overground transfer lines from damage caused by vehicle impacts. The concrete shielding system is required when Administrative Controls are not used to preclude vehicle traffic around overground transfer lines during transfers.

No safety SSCs were designated as Safety-Class or Safety-Significant to preclude overflows through transfer line encasement risers. See the TSR controls discussion for controls to prevent potential surface leak via encasement risers.

To prevent backflows of waste into service water or flush water supply systems where additional leaks could result in surface pools, the service water system pressure switches and their interlocks with the waste transfer pumps were designated Safety-Class. The backflow prevention devices located in the raw water and other service system connections to the waste transfer system in the 204-AR Waste Unloading Facility (waste unloading room) leading to the

Mechanical Equipment Room were also designated as Safety-Class. Backflow prevention devices, other than those in the 204-AR Waste Unloading Facility, were designated as Safety-Significant to prevent general contamination of the service water supply systems, which could adversely impact many Site employees.

The controls to prevent misroutes of substantial quantities of tank farm waste material back into interfacing facilities are mainly administrative (see TSR Controls). However, the 204-AR Waste Unloading Facility structure was designated as Safety-Significant with the safety function of limiting the aerosol release from inside the 204-AR Waste Unloading Facility by splatter and splashing and to limit the shine dose to nearby workers should a leak develop during a transfer.

See the TSR Controls discussion for controls to preclude excavation accidents that might uncover and damage buried transfer lines during transfers. No Safety-Class or Safety-Significant SSCs were identified for the excavation initiator.

For safety SSCs that require electrical power (i.e., transfer leak detection systems, tank level detection systems, primary tank leak detection systems, and pressure switch interlock or alarm systems [service water lines]), a supporting SSC, the tank farm electrical distribution system, is required to ensure that the chosen safety SSCs have electrical power to perform their intended safety functions.

Technical Safety Requirement Controls. Several of the controls listed in Table 3.4.2.7-5 were selected to ensure the operability of Safety-Class and Safety-Significant SSCs. Specifically, TSR controls were determined to be necessary to ensure that the following SSCs are operable during transfers:

- Leak detection systems in all waste transfer-associated structures physically connected to the transfer route
- Covers on all waste transfer-associated structures physically connected to the transfer route
- Pressure switch interlock or alarm systems on service water lines physically connected to the transfer route
- Service water backflow prevention devices
- Primary tank leak detection systems on all DSTs or AWF tanks physically connected to the transfer route.

Several other controls listed in the table can be logically combined into an administrative transfer control program. The key elements in this program include the following:

- Configuration management of waste transfer routes

- Independent route verification during transfer route setup
- Double valve isolation on interconnected transfer lines
- Periodic material balances during waste transfers
- Periodic monitoring of interconnected tanks for level increase during waste transfers
- Jumper leak testing following jumper changes
- Caps/blanks on nozzles when not in use
- Pit drains associated with the cross-site transfer have an open flow path to allow drainage before cross-site transfer is initiated
- Physically connected catch tanks that are not in the direct transfer route are <50% full before waste transfer
- Use of concrete shielding system or vehicle restrictions around overground transfer lines.

Configuration management of transfer routes, independent verification of transfer routes before initiating transfers, and double-valve isolation on interconnecting transfer lines minimize the potential for misroutes into transfer structures, waste storage tanks, service water systems, or interfacing facilities where waste could overflow to the ground surface. Material balances provide alternate indication to the pit leak detectors of an equipment leak inside a transfer structure, an overflow of an underground tank, or a misrouting that could be forming a surface pool (should the misroute preventive controls fail). Monitoring of interconnected tanks provides indication of waste misroutes into tanks or waste leaks into transfer structures that drain to those tanks. Ensuring that nozzles are capped when not in use is necessary to prevent potential high flow rate leaks through open nozzles. High flow rate leaks can result in pit overflows in less than the 30-min operator response time assumed in the analysis to manually shut off the transfer pump after the pit leak detector alarm activates. Ensuring that drains in pits connected to the cross-site transfer line are open during cross-site transfers is necessary because the line holdup in the cross-site transfer line is high enough to potentially overflow several of the pits even if the transfer pump is shut off shortly after the pit leak detectors are activated. Also, catch tanks that are physically connected but not in the direct transfer route must be less than 50% full before a waste transfer to provide a place for line holdup to drain. Ensuring that the overground transfer line concrete shielding system is in place or vehicle restrictions around overground transfer lines are implemented is necessary to protect the lines from damage caused by vehicle impacts. The overground transfer line concrete shielding system must withstand credible vehicle impacts.

To prevent overflows through transfer line encasement risers, a TSR control (i.e., encasement seal loop controls) was determined to be necessary to ensure that at least one encasement drain valve is not closed during transfers. This control ensures that waste leaked from

the primary transfer line will drain back properly to a transfer enclosure where the leak can be detected by the transfer leak detection system. For the overground transfer system, a similar control is used to ensure that leaks from the primary overground transfer line drain properly back to interfacing pump pits.

To prevent storage tank overflows from service water leaks, a service water intrusion monitoring program was determined to be necessary. This program requires periodic visual surveillances for service water leaks, surveillance of tank levels, or surveillance of service water flow totalizers to detect service water leaks.

The key elements of the transfer control program are relied on to prevent misroutes and to prevent pool leaks inside interfacing facilities because of inadvertent transfers from the tank farms. Periodic material balances are also required to limit the consequences should a misroute occur because of failure of the preventive controls.

To prevent and mitigate pool leaks caused by excavation accidents, an excavation control program was determined to be necessary. Excavation controls require that (1) excavation permits be used in areas where waste transfer lines exist (key requirements of the permitting process are delineated in Table 3.4.2.7-5); (2) waste transfer lines outside tank farm fences be identified with aboveground labeling; (3) compensatory controls be established when transfer lines are uncovered to repair, replace, or install other underground utilities to protect the exposed transfer line and to provide shielding for facility workers before transfers are initiated; (4) transfers not be conducted through transfer lines located within approximately 4.5 m (15 ft) of ongoing excavation activities; and (5) communication links be established between the excavation site and tank farm operations before digging.

Three other general controls were determined to be necessary: emergency preparedness controls, transfer pump administrative lock controls, and transfer system cover removal controls. In the event a leak occurs, emergency response procedures are needed to provide direction to minimize the consequences of the leak and to implement recovery activities. Placing an administrative lock on an active transfer pump that is physically connected to a waste transfer system minimizes the potential for an inadvertent pump start that could result in the unplanned transfer of waste. The transfer system cover removal controls provide compensatory measures for cover removal during waste transfers.

Defense-in-Depth. In addition to the above identified safety SSCs and TSR controls, which are discussed further in Chapters 4.0 and 5.0, respectively, other engineering and administrative controls provide Defense-in-Depth protection for the public and workers against the risk of pool leaks within the TWRS. The Defense-in-Depth controls are identified in Table 3.4.2.7-6. The controls are organized based on the accident scenarios they prevent or mitigate.

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Table 3.4.2.7-1. Summary of Dose Consequences of Valve Pit Overflow, by Pathway Without and With Controls.

Scenario	Onsite doses Sv (rem)			Offsite doses Sv (rem)	
	Inhalation	Direct shine	Skyshine	Inhalation	Ingestion
Without controls	2.3 E+00 (2.3 E+02)	8.4 E-02 (8.4 E+00)	9.1 E-01 (9.1 E+01)	3.6 E-01 (3.6 E+01)	5.2 E-03 (5.2 E-01)
With controls	3.5 E-03 (3.5 E-01)	2.4 E-04	1.4 E-03	6.6 E-06 (6.6 E-04)	9.7 E-08 (9.7 E-06)

Table 3.4.2.7-2. Summary of Consequences and Frequencies for Surface Leak Resulting in Pool Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Surface Leak Resulting in Pool	3.3 E+00 (3.3 E+02)	5.0 E-03 (5.0 E-01)	3.6 E-01 (3.6 E+01)	1.0 E-03 (1.0 E-01)	5.0 E+00	1 (ERPG-1)	3.2 E-01	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
TWA = time-weighted average.
SOF = sum-of-fractions.

Table 3.4.2.7-3. Summary of Consequences and Frequencies for Surface Leak Resulting in Pool With Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				With controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Surface Leak Resulting in Pool	5.1 E-03 (5.1 E-01)	5.0 E-03 (5.0 E-01)	6.6 E-06 (6.6 E-04)	1.0 E-03 (1.0 E-01)	1.4 E-01	1 (ERPG-1)	7.5 E-04	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
TWA = time-weighted average.
SOF = sum-of-fractions.

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
1.0 Overflows of Waste Transfer Pits[a] Caused by Transfer Equipment Leaks (All Internal Mechanisms)			
1.1 Transfer Leak Detection Systems	Safety-Class	The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures, and to either provide an alarm to alert operators to take mitigative action, or provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
1.2 Abovegrade Portions of Process Pits, Diversion Boxes, and Valve Pits	Safety-Class[b]	The Safety-Class safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes are to provide an intact boundary for the leaked waste, and when leak detector alarms and appropriate operator response times to shut off the transfer pump are credited, to prevent premature waste transfer structure overflow and the formation of a surface pool. This decreases the consequences of the Surface Leak Resulting in Pool accident. The Safety-Significant safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes as safety SSCs ensures that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function. Designation of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes as safety SSCs ensures that any modifications do not impede the ability of the waste transfer-associated structure in a way that prevents the waste transfer-associated structure from meeting the intended safety function. Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
1.3 Transfer System Covers	Safety-Significant	The safety functions of the transfer system covers are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the transfer system covers as safety SSCs ensures that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function.
1.4 Tank Level Detection Systems	Safety-Significant	The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Surface Leak Resulting in Pool accident. An additional safety function of the tank level detection systems is to detect a service water leak into a waste tank, enabling the operators to terminate the service water leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
1.5 Salt Well Flow Totalizers	Safety-Significant	The safety function of the salt well flow totalizers is to provide the total salt well flow parameter used in periodic material balance calculations during waste transfer operations. These calculations enable operators to terminate the waste transfer operation if waste leaks or mistransfers are detected, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
2.0 Overflows of Waste Transfer Pits Caused by Misroutes Through Compromised Transfer Paths			
2.1 Transfer Leak Detection Systems	Safety-Class	The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures, and to either provide an alarm to alert operators to take mitigative action, or to provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
2.2 Abovegrade Portions of Process Pits, Diversion Boxes, and Valve Pits	Safety-Class[b]	The Safety-Class safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes are to provide an intact boundary for the leaked waste, and when leak detector alarms and appropriate operator response times to shut off the transfer pump are credited, to prevent premature waste transfer structure overflow and the formation of a surface pool. This reduces the consequences of the Surface Leak Resulting in Pool accident. The Safety-Significant safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes as safety SSCs ensures that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function. Designation of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes as safety SSCs ensures that any modifications do not impede the ability of the waste transfer-associated structure in a way that prevents the waste transfer-associated structure from meeting the intended safety function. Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
2.3 Transfer System Covers	Safety-Significant	The safety functions of the transfer system covers are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the transfer system covers as safety SSCs ensures that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function.
2.4 Tank Level Detection Systems	Safety-Significant	The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Surface Leak Resulting in Pool accident. An additional safety function of the tank level detection systems is to detect a service water leak into a waste tank, enabling the operators to terminate the service water leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
2.5 Salt Well Flow Totalizers	Safety-Significant	The safety function of the salt well flow totalizers is to provide the total salt well flow parameter used in periodic material balance calculations during waste transfer operations. These calculations enable operators to terminate the waste transfer operation if waste leaks or mistransfers are detected, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
2.6 Primary Tank Leak Detection Systems	Safety-Class	The safety function of the primary tank leak detection systems is to provide an alarm of misrouted tank waste into the tank annulus to alert operators to take action to stop the transfer of waste into the DST or AWF tank annulus, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
3.0 Overflows of Process Pits Caused by Overfilling of Underlying Tanks[c] with Waste			
3.1 Transfer Leak Detection Systems	Safety-Class	The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures and to either provide an alarm to alert operators to take mitigative action or to provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
3.2 Transfer System Covers	Safety-Significant	The safety functions of the transfer system covers are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the transfer system covers as safety SSCs ensures that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function.

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
3.3 Tank Level Detection Systems	Safety-Significant	The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Surface Leak Resulting in Pool accident. An additional safety function of the tank level detection systems is to detect a service water leak into a waste tank, enabling the operators to terminate the service water leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
3.4 Salt Well Flow Totalizers	Safety-Significant	The safety function of the salt well flow totalizers is to provide the total salt well flow parameter used in periodic material balance calculations during waste transfer operations. These calculations enable operators to terminate the waste transfer operation if waste leaks or mistransfers are detected, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
4.0 Overflows of Process Pits Due to Service Water Leaks that Overflow Connected Waste Storage Tanks			
4.1 Service Water Flow Totalizers	Safety-Significant	The safety function of the service water flow totalizers is to alert operators that an excessive service water flow and a potential water intrusion into a waste tank exists. This information enables operators to terminate the service water flow if water intrusion is confirmed, thus preventing a waste tank overflow and decreasing the frequency of the Surface Leak Resulting in Pool accident.	--

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
4.2 Tank Level Detection Systems	Safety-Significant	The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Surface Leak Resulting in Pool accident. An additional safety function of the tank level detection systems is to detect a service water leak into a waste tank, enabling the operators to terminate the service water leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
5.0 Overflows of Slurry Line Cleanout Boxes During Transfers			
5.1 Transfer Leak Detection Systems	Safety-Class	The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures, and to either provide an alarm to alert operators to take mitigative action, or to provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Surface Leak Resulting in Pool accident.	Cleanout box drains to encasement and then to process pit
5.2 Transfer System Supplemental Covers	Safety-Class	The safety function of the transfer system supplemental covers is to limit release of aerosols generated by spray (following the initial surface leak) in the COB/pit by providing an impaction surface that prevents a waste leak from jetting directly into the atmosphere, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the transfer system supplemental covers as safety SSCs ensures that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function.

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
5.3 Transfer System Covers	Safety-Significant	The safety functions of the transfer system covers are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the transfer system covers as safety SSCs ensures that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function.
5.4 Above Grade Portions of Cleanout Boxes	Safety-Significant	The safety functions of the abovegrade portions of cleanout boxes are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Designation of the abovegrade portions of cleanout boxes as safety SSCs ensures that any modifications do not impede the ability of the waste transfer-associated structure in such a way that prevents the waste transfer-associated structure from meeting the intended safety function. Per agreement with DOE-ORP, this Safety-Significant designation is not effective until March 30, 2000.
6.0 Surface Pools Caused by Leaks from Temporary SST OGT Lines			
6.1 Overground Transfer System - Encasement and Connections	Safety-Class	The safety function of the OGT system encasement and connections is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	The OGT pipe encasement shall be designed to withstand the design basis earthquake and high wind.
6.2 Overground Transfer System - Concrete Shielding System	Safety-Class	The safety function of the OGT concrete shielding system is to protect the primary line from external events (e.g., vehicle impacts), thus decreasing the frequency of the Surface Leak Resulting in Pool accident.	Although not part of the safety function, the system provides radiation shielding protection for facility workers.

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
6.3 Transfer Leak Detection Systems	Safety-Class	The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures, and to either provide an alarm to alert operators to take mitigative action, or to provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Surface Leak Resulting in Pool accident.	--
7.0 Overflows Through Transfer Line Encasement Risers			
No safety SSCs identified	--	--	See Table 3.4.2.7-5 for Technical Safety Requirement controls.
8.0 Surface Pools of Waste Caused by Backflows of Waste into Service Water/Flush Water Supply Systems			
8.1 Pressure Switch Interlock or Alarm Systems (Service Water Lines)	Safety-Class	The safety function of the pressure switch interlock or alarm systems is to limit the volume of tank waste which could backflow into and leak from the service water piping system, thus decreasing the consequences of the Surface Leak Resulting in Pool accidents.	The pressure switch in the service water lines connected to the waste transfer system are not automatically interlocked to some waste transfer pumps (e.g., waste transfer pumps in interfacing facilities that transfer waste to tank farms). An acceptable alternative is isolation of the service water line by two closed valves and a pressure switch with an alarm in a continuously monitored area. Pressure switch alarm procedures would require the immediate shutdown of the transfer pump on alarm. This control also prevents backflow should valves leak or should a transfer pump be inadvertently turned on during flushing operations.

Table 3.4.2.7-4. Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool. (10 sheets)

Structures, systems and components	Safety classification	Safety function	Comments
8.2 Backflow prevention devices (204-AR Waste Unloading Facility (waste unloading room only)	Safety-Class	The safety function of the backflow prevention devices located in the 204-AR Waste Unloading Facility (waste unloading room) is to prevent a backflow of waste into the raw water or other service systems leading to the Mechanical Equipment Room where a leak could form a surface pool, thus decreasing the frequency of the Surface Leak resulting in a Pool accident.	Prevents backflow should the isolation valves leak.
8.3 Backflow Prevention Devices (other than 204-AR Waste Unloading Facility)	Safety-Significant	The safety function of the backflow prevention devices is to is to prevent a backflow leak of tank waste from the waste transfer system into the service water piping system, thus decreasing the frequency of the Surface Leak Resulting in Pool accident.	The hazardous condition of concern is contamination of the service water system and not specifically a waste leak resulting in a surface pool.
9.0 Pool Leaks Inside Interfacing Facilities due to Misroutes of Waste from Tank Farms			
9.1 204-AR Waste Unloading Facility Structure	Safety-Significant	The safety functions of the 204-AR Waste Unloading Facility structure are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	Structure provides confinement function similar to the abovegrade portions of process pits, diversion boxes, valve pits and cleanout boxes.
10. Surface Pools of Waste Caused by Excavation Accidents Uncovering and Damaging Buried Transfer Lines During Transfers			
No safety SSCs identified	--	--	See Table 3.4.2.7-5 for Technical Safety Requirement controls.

[a]Includes valve pits, central and feed pump pits, sluice pits, leak detection pits, annulus pump pits, flush pits, catch tank pump pits, diversion boxes, valve pits, and vent station nozzle pits.

[b]Because the safety SSC serves two safety functions, the higher classification is listed in this column.

[c]Waste storage tanks include SSTs, DSTs, DCRTs, and catch tanks.

AWF = Aging Waste Facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
OGT = overground transfer.
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
General Applicability		
Emergency Preparedness Program with the following key element: • Response procedures	Mitigate the consequences of a waste overflow from a waste transfer-associated structure	--
Transfer pump administrative lock controls	Eliminates motive force for unplanned transfers	--
Transfer system cover removal controls • Obtain management approval before removing a transfer system cover • Provide continuous monitoring for waste leaks while covers are removed • Establish procedures that identify required operator responses to the detection of a waste leak	Provides compensatory measures for cover removal during transfers and minimizes risk from unplanned transfers.	--
1.0 Overflows of Waste Transfer Pits[a] Caused by Transfer Equipment Leaks (All Internal Mechanisms)		
1.1 Transfer system covers	Ensure structures physically connected to the transfer route are covered during transfers	--
1.2 Transfer leak detection systems	Ensure operability of the transfer leak detection system in physically connected transfer-associated structures during waste transfers.	--
1.3 Transfer Controls • Transfer System Configuration Management - Newly installed jumpers are leak tested before use.	Prevents jumpers from being grossly misaligned or from falling off during transfers.	Repositioned jumpers are leak tested with pressurized water (where available) before initiating waste transfers. Cameras lowered through penetrations in the cover block are used to verify initial jumper integrity during the leak test. Where water is not readily available, the jumper leak test is performed during the initial stages of the transfer.
• Operating Requirements - Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	--
- Verify all pit drains associated with the cross-site transfer route have an open flowpath to allow drainage before a cross-site waste transfer	Ensure pit floor drains in pits used for cross-site transfers are open during transfers.	Potential drainback in cross-site transfer line is high enough to overflow pits even if the transfer pump is shutdown immediately after detection of a leak.

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
1.4 Primary tank leak detection systems	Ensure primary tank leak detection systems on tanks physically connected to the transfer route are operable to detect misroutes of waste into the annuli of double-shell (including AWF) tanks.	--
2.0 Overflows of Waste Transfer Pits Caused by Misroutes Through Compromised Transfer Paths		
2.1 Transfer system covers	Ensure structures physically connected to the transfer route are covered during transfers	--
2.2 Transfer leak detection systems	Ensure operability of the transfer leak detection system in physically connected transfer-associated structures during waste transfers.	--
2.3 Transfer Controls		
• Transfer System Configuration Management		
- Establish and maintain controlled status of waste transfer systems as-built and jumper configuration	Prevents mistransfers into waste transfer-associated structures.	--
- Perform waste transfer operations by approved procedures	Prevents mistransfers into waste transfer-associated structures.	--
- Perform independent route verification during transfer setup (includes items such as verification of correct pump and correct valve alignment)	Prevents mistransfers into waste transfer-associated structures.	--
- Perform double valve isolation on interconnected lines	Supports radiation surveillance activity.	--
- Open nozzles physically connected to waste transfer lines shall be sealed with caps, process blanks, or equivalent	Prevents mistransfers through open nozzles in waste transfer-associated structures.	High flow rate leak through open nozzle could overflow pit in less than the assumed 30-min operator response time to a leak detector alarm.
• Operating Requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	--
- Monitor for increasing level in all tanks (including catch tanks) physically connected to the waste transfer route, during a waste transfer through a waste transfer system	Monitoring interconnected tanks for level increases provides a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	--
3.0 Overflows of Process Pits Caused by Overfilling of Underlying Tanks with Waste[b]		
3.1 Transfer leak detection systems	Ensure operability of the transfer leak detection system in physically connected transfer-associated structures during waste transfers.	--

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
3.2 Transfer Controls • Operating Requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	--
- Monitor for increasing level in all tanks (including catch tanks) physically connected to the waste transfer route, during a waste transfer through a waste transfer system	Monitoring interconnected tanks for level increases provides a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	--
- Verify physically connected catch tanks which are not in the direct transfer route are < 50% full before waste transfer	Ensures space is available in catch tanks to contain potential waste leaks, misroutes, and line drainback.	--
4.0 Overflows of Process Pits Caused by Service Water Leaks that Overflow Connected Waste Storage Tanks[b]		
4.1 Tank Service Water Intrusion Monitoring Program • Monitor service water usage or tank levels every 24 h to detect leaks • Procedures shall identify required operator responses to the detection of a service water leak	Prevent waste transfer-associated structure overflow from service water leaks.	Includes visual surveillance and surveillance of service water flow totalizers or tank level systems
5.0 Overflows of Slurry Line Cleanout Boxes During Transfers		
5.1 Transfer leak detection systems	Ensure operability of the transfer leak detection system in physically connected transfer-associated structures during waste transfers.	--
5.2 Transfer system covers	Ensure structures physically connected to the transfer route are covered during transfers	--
5.3 Transfer system supplemental covers	Ensure COBs physically connected to transfer routes have supplemental covers installed during transfers	Transfer system supplemental covers are required for waste transfer-associated structures with volumes less than 15 m^3 (530 ft^3)
6.0 Surface Pools Caused by Leaks from Temporary SST OGT Lines		
6.1 Transfer leak detection systems	Ensure operability of the transfer leak detection system in physically connected transfer-associated structures during waste transfers.	--
6.2 Encasement seal loop controls (i.e., isolation valves are not in the closed position)	Ensure that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure	--

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
6.3 Transfer Controls		
• Operating Requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	–
• Transfer System Configuration Management		
- Before waste transfer through overground waste transfer piping, verify either vehicle restrictions (i.e., vehicle access limitations to the tank farm) or concrete shielding systems surrounding the overground transfer line portion of the transfer route are in place	Ensure the OGT line is protected from vehicle collisions that could result in a loss of integrity of the primary and encasement pipes.	Concrete shielding also provides radiation shielding protection for facility workers.
7.0 Overflows Through Transfer Line Encasement Risers		
7.1 Encasement seal loop controls (i.e., isolation valves are not in the closed position)	Ensure that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure	–
7.2 Transfer Controls		
• Transfer System Configuration Management		
- Establish and maintain controlled status of waste transfer systems as-built and jumper configuration	Prevents mistransfers into waste transfer-associated structures, which could result in the overflow of waste through an encasement riser.	–
- Perform waste transfer operations by approved procedures	Prevents mistransfers into waste transfer-associated structures, which could result in the overflow of waste through an encasement riser.	–
- Perform independent route verification during transfer setup (includes items such as verification of correct pump and correct valve alignment)	Prevents mistransfers into waste transfer-associated structures, which could result in the overflow of waste through an encasement riser.	–
- Perform double-valve isolation on interconnected lines	Prevents mistransfers into waste transfer-associated structures, which could result in the overflow of waste through an encasement riser.	–
• Operating Requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	–

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
8.0 Surface Pools of Waste Caused by Backflows of Waste into Service Water/Flush Water Supply Systems		
8.1 Service water pressure detection systems	Ensure operability of pressure switch interlock or alarm systems. This ensures pressure switch interlock or alarm systems are operable during waste transfers, transfer line flushing, pump priming, and transfer line pressure testing	Includes the pressure switch/waste transfer pump interlock systems used for connections to the permanent service water system and for pressure switch interlock systems used for connections to temporary, abovegrade service water systems. Temporary abovegrade water lines are used for flushing and priming of SST salt well systems Note: Pressure switch/waste transfer pump interlocks or alarm shall be operable during waste transfers to prevent backflow of waste into service water lines. To address backflow of waste during inadvertent waste transfer pump starts, either the pressure switch/waste transfer pump interlock shall be operable or the waste transfer pump(s) physically connected to the service water line shall be locked out
8.2 Backflow prevention devices (204-AR Waste Unloading Facility [waste unloading room]) only	Prevents contamination of the raw water system via backflow of waste and prevents surface pools caused by overflow out of the building.	Backflow prevention system is required when raw water and other service systems are physically connected.

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
8.3 Transfer Controls		
• Transfer System Configuration Management		
- Establish and maintain controlled status of waste transfer systems as-built and jumper configuration	Prevents mistransfers into waste transfer-associated structures into service water supply systems.	–
- Perform waste transfer operations by approved procedures	Prevents mistransfers into waste transfer-associated structures into service water supply systems.	–
- Perform independent route verification during transfer setup (includes items such as verification of correct pump and correct valve alignment)	Prevents mistransfers into waste transfer-associated structures into service water supply systems.	–
- Perform double valve isolation on interconnected lines	Prevents mistransfers into waste transfer-associated structures into service water supply systems.	–
• Operating Requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and to detect losses of waste into service water supply systems.	–

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
9.0 Pool Leaks Inside Interfacing Facilities Caused by Misroutes of Waste from Tank Farms		
9.1 Transfer Controls		
• Transfer System Configuration Management		
- Establish and maintain controlled status of waste transfer systems as-built and jumper configuration	Prevents mistransfers into waste transfer-associated structures into interfacing facilities.	--
- Perform waste transfer operations by approved procedures	Prevents mistransfers into waste transfer-associated structures into interfacing facilities.	--
- Perform independent route verification during transfer setup (includes items such as verification of correct pump and correct valve alignment)	Prevents mistransfers into waste transfer-associated structures into interfacing facilities.	--
- Perform double-valve isolation on interconnected lines	Prevents mistransfers into waste transfer-associated structures into interfacing facilities.	--
• Operating Requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and to limit the quantity of material spilled inside an interfacing facility should the preventive controls fail.	--

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
10.0 Surface Pools of Waste Caused by Excavation Accidents Uncovering and Damaging Buried Transfer Lines During Transfers		
10.1 Excavation Controls • Obtain an excavation permit before excavating in areas where underground waste transfer lines exist.[c] The excavation permitting process shall provide for the following: - Composite map for the planned excavation site indicating approximate horizontal and vertical locations of waste transfer piping, piping encasements, and transfer structures. - Radiological evaluation for the planned excavation activity, including the issuance of a radiological work permit as required. - Physical marking of the ground surface to identify waste transfer lines based on the composite map and a documented subsurface scan. - Approval of the proposed excavation activity by TWRS cognizant facility engineer and facility manager or delegate. - All excavations within 4.5 m (15 ft) of an ongoing waste transfer are prohibited. - Hand-digging only is allowed within approximately 1.5 m (5 ft) of a waste transfer line.	Prevents leaks in waste transfer lines caused by excavation activities by ensuring: • Excavation activities are not inadvertently performed near waste transfer lines during waste transfers • Excavation activities are carefully controlled when required near waste transfer lines	–
• Encased pipe (concrete encased and pipe-in-pipe encased) outside of the tank farm boundaries shall be identified with permanent aboveground labels.	Prevents leaks in waste transfer lines caused by excavation activities by ensuring that excavation activities are not inadvertently performed near waste transfer lines outside of tank farms	–
• Waste transfers are prohibited through lines uncovered by excavation activities unless compensatory controls are established (e.g., vehicle access limitations, concrete shielding system installed).	Prevents transfers through waste transfer lines that are uncovered by excavation activities that could cause worker radiation doses exceeding limits established by the radiation protection program	–
• Waste transfers are prohibited through lines within approximately 4.5 m (15 ft) of an ongoing excavation activity.	Prevents leaks in waste transfer lines caused by excavation activities by ensuring that excavation activities are not performed near waste transfer lines during waste transfers	–

Table 3.4.2.7-5. Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool. (9 sheets)

Control	Safety function	Comments
• Before initiation of an excavation activity, identify emergency response actions and establish communications between the excavation site and operations personnel to ensure immediate shutdown of waste transfers when leakage is indicated.	Mitigates waste transfer leaks caused by excavation activities by prompt shutdown of the waste transfer pump	–

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington .

[a]Includes valve pits, central and feed pump pits, sluice pits, leak detection pits, annulus pump pits, flush pits, catch tank pump pits, diversion boxes, valve pits, vent station nozzle pit.

[b]Waste storage tanks include DSTs, SSTs, DCRTs, and catch tanks.

[c]Excavation activities include: (1) movement of earth by mechanical means below existing grade, or (2) any hand-digging to a depth greater than approximately 1 ft (only within 1.5 m [5 ft] of a waste transfer line).

AWF = Aging Waste Facility.
DCRT = double-contained receiver tank.
DST = double-shell tank.
OGT = overground transfer.
SST = single-shell tank.

Table 3.4.2.7-6. Summary of Defense-in-Depth Controls for Surface Leak Resulting in Pool.

Control	Safety function	Comments
General Applicability		
Drains in waste transfer-associated structures	Allow leak to drain back to storage or catch tank; prevents overflow of pit to soil surface	--
DCRT/catch tank vault leak detection systems	Detect overflow of DCRT or catch tank	DCRT will overflow into the vault through the vent line and drains/penetrations in DCRT pump pit floor
Encasement leak detection systems	Detect leak of waste from primary transfer line.	--
Specific to Overflows of Process Pits Caused by Service Water Leaks that Overflow Connected Waste Storage Tanks[a]		
Waste tank high level alarms	Alarms provide indication of a tank overflow.	--
Service water freeze protection	Minimize likelihood of service water line breaks caused by freezing	--
Service pit leak detection systems (where installed)	Detect service water line breach	Mitigates leaks inside service pits that may overflow tank through drain lines
Specific to Surface Pools Caused by Leaks from Temporary SST OGT Lines		
Heat tracing and insulation (where provided)	Heat tracing and insulation prevents freezing and potential rupture of primary line.	--
Specific to Surface Pools of Waste Caused by Backflows of Waste into Service Water/Flush Water Supply Systems		
Service pit leak detection systems (where installed)	Detect leaks of waste/service water in service pits	--
Valve position limit switches/ interlocks (where installed and maintained)	Prevent backflow of waste into service water supply by stopping transfer pump	Allows waste transfer pump to operate only when the hydrostatic test valves are closed
Check valves (salt well systems)	Prevent backflow of waste into the service water supply	--

[a]Waste storage tanks include SSTs, DSTs, DCRTs, and catch tanks.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air.
OGT = overground transfer.
SST = single-shell tank.

3.4.2.8 Subsurface Leak Resulting in Pool. This accident analysis covers leaks from buried and bermed transfer lines as potential initiators of surface pools of waste. High flow rate leaks from buried transfer lines can result in surface pools if the leak rate exceeds the natural infiltration rate of the soil. This is because the soil beneath the leak can become supersaturated with liquid, resulting in an upward expansion of the waste plume. Capillary action and hydraulic forces (if the leak occurs at high pressure on the top of the direct-buried line) can contribute to the formation of surface pools. Leaks from unencased, bermed transfer lines can result in surface pools of waste caused by "piping" phenomena, which can result in washout of the berm. Section 3.3.2.4.7 includes analysis of waste leaks that remain subsurface and do not create surface pools.

Accidents that result in surface pools of waste are of safety concern because radioactive aerosols and particulates can be resuspended in wind flowing over the pool surface or by wind flowing over a contaminated soil surface, should the waste pool soak into the soil. Resuspended aerosols and particulates can be inhaled by downwind receptors. Large pools of waste or contaminated areas of soil also can present a significant shine and skyshine hazard to onsite receptors.

Waste is transferred in the tank farms using three basic kinds of buried transfer lines: unencased direct-buried or bermed lines, concrete-encased lines, or pipe-in-pipe transfer lines. For a description of each type of transfer line, see Chapter 2.0. In general, unencased, direct-buried, or bermed lines are used for transfers between SSTs and DCRTs (i.e., used for interim stabilization of SSTs). Pipe-in-pipe transfer lines are generally used for transfers within the newer DST farms and for transfers to and from the 242-A Evaporator. The cross-site transfer line is concrete encased, as are some transfer lines to DSTs from interfacing facilities and transfer lines between DST farms.

Lines of all three types have been found to have leaked. Leaks from transfer lines are considered to be one of the more likely accidents within TWRS. Mechanisms postulated to result in leaks from transfer lines include aging, corrosion, erosion, thermal stress, water hammer, undermining due to leaks from nearby pipes, and excavation accidents (see Section 3.3). Leaks induced by seismic events are covered in Section 3.4.2.12.3.

A leak from an unencased, bermed line was selected as the representative case for detailed analysis. This case was selected for the following reasons:

- The unencased lines are older, in direct contact with the soil, and are more prone to failure than the encased lines.

- Berms can be washed out because of "piping" phenomena, resulting in larger surface pools than are possible from buried lines.

- Leaks into concrete or pipe encasements will tend to flow back to process pits. Should the encasements leak, the volume of waste leaked to the soil will be smaller than from unencased lines.

- Leaks from concrete and pipe encasements will be under low pressure and oriented down, making surface pools far less likely than in the bermed, unencased pipe scenario.

Sections 3.4.2.8.1 through 3.4.2.8.4 summarize the accident analysis performed for the representative case. The detailed calculations for the accident analysis are documented in WHC-SD-WM-CN-057, *Calculation Notes for Subsurface Leak Resulting in Pool, TWRS FSAR Accident Analysis*. The controls developed to prevent or mitigate subsurface leaks for all the represented cases are summarized in Section 3.4.2.8.5.

3.4.2.8.1 Scenario Development. Approximately 80% of the unencased transfer lines being used for interim stabilization of the SSTs were installed at ground level and covered with dirt (i.e., bermed). Waste is transferred from the SSTs using either salt well jet pumps or submersible pumps. Salt well jet pumps are used to remove residual liquor from salt cake remaining in tanks where supernatant liquid has been removed. Submersible pumps are used when substantial quantities of supernatant liquids remain in tanks. The submersible pumps transfer waste at higher flow rates than the salt well jet pumps. The maximum flow rate using salt well jet pumps is 15 L/min (4 gal/min). The maximum flow rate using submersible pumps is 189 L/min (50 gal/min).

Recent analysis (WHC-SD-WM-RPT-048, *Safety Study of Interim Stabilization of Non-Watchlist Single-Shell Tanks*) indicates that waste transfer line leaks from bermed pipelines could result in almost all of the leaked waste reaching the soil surface. This is because of the possible development of quicksand or "piping" phenomena, especially if the embankment material is primarily made of cohesionless fine sand. If seepage from the embankment overlying the piping were to break out on the downstream slope, leading to a local instability, a process of gradual soil erosion and undermining of the embankment may begin. This type of failure has caused earthen dams to fail.

Occurrence report RL-WHC-TANKFARM-1992-009, *Failed Hydrostatic Pressure Test of Slurry Line SL-119*, describes a case where a leak from a bermed line eroded the berm away and formed a large surface pool. This leak occurred during filling of the pipe with water for pressure testing, and it illustrates the potential for surface pools of waste to be formed during transfers of waste through unencased bermed lines.

Accident Scenario Without Controls. A catastrophic leak from an unencased bermed line is assumed to occur during a submersible pump transfer from an SST. This results in the highest potential flow rate from the leak. Liquid waste is assumed to seep out the downslope of the berm, undermining the berm, and causing erosion that results in a large quantity of waste running off on the surface outside the berm, forming a large pool. It is postulated that the leak occurs when the ambient temperature is significantly below the saturation temperature of the waste. The dissolved salts in the waste crystallize out of solution as the pool spreads, limiting the penetration of waste into the soil. While the pump is running it is assumed the surface of the pool remains liquid.

After the leak is detected and the transfer pump is shut off, it is postulated the remaining liquid waste soaks into the soil. Because of the filtering effect of the soil, the salts crystallizing out of solution, and the entrained solid precipitates carried in the waste stream are postulated to be deposited in the top few centimeters of soil. While the pump is running and the pool is growing, aerosols are resuspended by wind blowing over the liquid surface. After the pump is shutoff and the waste soaks in, particulate surface contamination is resuspended as the soil dries. Resuspension occurs until the leak site is remediated (e.g., sprayed with water to limit resuspension, covered with gravel).

For the purposes of this analysis, the onsite receptor is assumed to be exposed to resuspended aerosols and particulates from the liquid pool and contaminated soil for an exposure period of 12 h. Similarly, the offsite receptor is assumed to be exposed for 24 h after pump shutdown or a total of 36 h. The onsite receptor is also exposed to significant shine and skyshine dose from the surface pool for a period of 12 h. Shine and skyshine dose to the offsite receptor will be negligible because of the distance to that receptor.

Accident Frequency Without Controls. Leaks from unencased, direct-buried and bermed transfer lines are "anticipated" events, based on Site experience. All the unencased transfer lines to be used for interim stabilization of SSTs are beyond their intended 5-yr design life (WHC-SD-WM-SAR-034, *Safety Analysis Report, Stabilization of Single-Shell Waste Storage Tanks by Salt Well Jet Pumping*). Because these lines are in contact with the soil, they are prone to corrosion failures.

The occurrence reporting database contains eight accounts, between 1972 and 1996, where unencased direct-buried or bermed lines were found to have leaked during transfers of waste or during pressure testing before initiating transfers. Most of the leaks were detected early and resulted in small plumes of waste to the soil column that remained subsurface. Two of the cases, however, resulted in substantial surface pooling. As previously discussed, occurrence report RL-WHC-TANKFARM-1992-009 describes an incident where a large surface pool of raw water was formed when a berm was washed out during pressure testing of an unencased line. In an earlier incident, a subsurface direct-buried line at the 242-S Evaporator failed because of galvanic corrosion, and leaked a total of 7,571 L (2,000 gal) of waste to the soil. An amount of 760 L (200 gal) of the waste was discovered pooled on the soil surface.

Accident Scenario With Controls. In the accident scenario with controls, operators are credited with detecting the release, limiting the quantity of waste spilled, and evacuating nearby onsite personnel to minimize exposures.

It was decided that operator surveillance of SST transfer routes using unencased lines would be required every 30 min during submersible pump transfers. The operator will visually check for leaks and check for elevated radiation readings indicative of a leak. It is postulated that a leak occurs and erodes through the berm shortly after the operator passes on a surveillance. Flow is postulated to continue until the washout is discovered at the next surveillance interval. Thirty minutes of continued flow after detection is assumed to allow for operator response to turn off the appropriate transfer pump. It is also assumed that emergency response procedures will also

be implemented within 30 min of detection of the leak to evacuate workers in the vicinity of the leak to upwind staging areas. It is assumed that radiation surveys will be performed to establish a safe distance around the leak site and that access controls will be implemented to minimize onsite worker exposures.

The leak is postulated to occur at the maximum submersible pump flow rate. The leak is also assumed to occur at a low point of the line so that the waste held up in the line drains out the leakage path after the transfer pump is shut off. During the first hour, while the pump is running, aerosols are released from the growing liquid pool. After the pump is shut off, it is conservatively assumed, for modeling purposes, that the waste instantaneously soaks into the ground. The onsite receptor is exposed to resuspended aerosols from the growing liquid pool for 1 h before being evacuated to an upwind staging area. In addition, the onsite receptor is exposed to direct shine and skyshine radiation from the growing pool for 1 h. The offsite receptor is exposed to resuspended aerosols from the growing liquid pool for 1 h and to resuspended particulates from the contaminated ground for an additional 24 h. No credit is taken for emergency response actions to cover the leak to minimize resuspension within 24-h.

Accident Frequency With Controls. The control selected is mitigative. No credit is taken for controls to reduce the likelihood of the accident. The frequency category for the accident scenario with controls is therefore the same as in the scenario without controls, or "anticipated."

3.4.2.8.2 Source Term Analysis. The methodology and detailed calculations used to determine the airborne release quantities in the accident analyses with and without controls are documented in WHC-SD-WM-CN-057. The waste inventory is common to both accident scenarios. Unencased bermed transfer lines will only be used for transfers out of SSTs. The SST radionuclide concentrations summarized in Table 3.4.1-4 were therefore used to estimate the dose consequences. It was assumed that the waste being transported through the bermed line contained one-third (by volume) entrained solids. This is the maximum solids loading expected during waste transfers.

Accident Source Term Without Controls. From WHC-SD-WM-CN-057, the surface pool formed in the accident without controls was assumed to contain 142,000 L (37,500 gal) of waste covering a surface area of 2,510 m^2 (27,000 ft^2). This pool size was set based on the dimensions of a raw water spill experienced in the tank farms in 1979. It was assumed that the pool forms in a circular shape with an estimated radius of 28 m (92 ft). At the maximum submersible pump flow rate of 189 L/min (50 gal/min), the 142,000 L (37,500 gal) surface pool is estimated to be formed in 12.5 h. It was assumed that the surface pool is visually detected and the transfer pump is shut off at 12.5 h.

During the first 12.5 h of the accident, aerosols are resuspended off the surface of the growing pool. A resuspension flux of 2.0×10^{-10} kg/m^2-s was used to estimate the respirable release during this time. This resuspension flux was estimated from Figure 4 in WHC-SA-1378-FP, *Determining Wind Spray Release from Effluent Disposal Ponds Using AIRSOURC Model*, corresponding to the mass release flux for a pond with a 200-m (660-ft) fetch at wind speeds less than 2 m/s (6.6 ft/s). Converting the resuspension flux to a volumetric basis,

using an estimated slurry waste density of 1.4 kg/L (11.7 lb/gal), and using an average pool surface area of 1,255 m^2 (13,509 ft^2), the total aerosol release for 0 to 12.5 h was estimated to be

$Q(0 - 12.5\ h) = 8.1 \times 10^{-3}$ L (2.1×10^{-3} gal) of equivalent waste.

After the pump is shut off at 12.5 h, the waste is postulated to soak into the ground, leaving crystallized salts and entrained solids behind as surface contamination. A resuspension release fraction of 8.4×10^{-5} over 24 h was used to estimate the particulate release after waste soak in. This resuspension release fraction comes from Section 3.2.4.4 of DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, and is based on experiments with UNH solutions spilled on soil and dried under low wind speed conditions (<4 km/h [<2.5 mph]). Based on the original experiments reported in BNWL-1732, *Some Experimental Measurements of Airborne Uranium (Representing Plutonium) in Transportation Accidents*, 50% of the total release was estimated to come off in the first 2 h after the waste has soaked into the ground, 80% in the first 12 h after soaking in, and 99% in the first 16 h after soaking in. Using these time varying release fractions, the particulate releases over the timeframes of interest were estimated to be as follows:

$Q(12.5 - 14.5\ h) = 6$ L of equivalent waste

$Q(14.5 - 24.5\ h) = 3.6$ L of equivalent waste

$Q(24.5 - 28.5\ h) = 2.4$ L of equivalent waste.

Resuspension after 28.5 h was neglected because of the diminishing release rate with time. The dose to the offsite receptor was estimated based on the total release volume over the 28.5-h duration of the accident. The onsite receptor dose was estimated based on the particulate release in the 12.5-h to 24.5-h timeframe. The maximum release rate of 8.3×10^{-4} L/s (2.2×10^{-4} gal/s) from the 12.5-h to 14.5-h timeframe is used to determine the toxicological exposures in the accident.

Accident Source Term With Controls. The leak was assumed to occur at a flow rate of 189 L/min (50 gal/min). This is the maximum flow rate expected in SST transfer lines, based on a review of pump performance curves for submersible pumps and accounting for lift out of the tank and frictional losses through the pipe into the SST pump pit and the velocity head loss on exit through the leakage path. The leak was assumed to be catastrophic, with 100% of the flow leaking onto the soil surface. At 189 L/min (50 gal/min), the total flow over the 1-h pumping duration was determined to be 11,300 L (3,000 gal). The pool was postulated to spread to an average depth of 2.54 cm (1 in.). This was judged to be conservative for a pool spread out over a large area of Hanford Site terrain. The waste was postulated to remain as a liquid pool during the pumping period. The leak was conservatively assumed to occur at the low point of the pipe. Waste held up in the pipe was therefore postulated to drain back through the leakage path. Assuming a 305-m- (1,000-ft-) long, 3-in.-dia waste transfer pipe, the waste holdup was estimated to be approximately 1,500 L (400 gal). The pool was estimated to ultimately cover a circular surface area of 506 m^2 (5,447 ft^2) with a radius of 12.7 m (41.7 ft), assuming a circular

shaped pool. After the waste transfer pump is shut off (at 1 h) and liquid waste no longer resupplies the pool, the waste is postulated to soak into the ground.

Over the first hour of the accident a resuspension release flux of 2.0×10^{-10} kg/m^2-s was used to estimate the aerosol release of the liquid pool. This resuspension flux comes from WHC-SA-1378-FP, Figure 4, and is based on estimated sea spray releases for ponds under wind speeds less than 2 m/s (6.6 ft/s). This resuspension flux is conservative because it is based on release estimates for ponds with a 200-m (660-ft) fetch. The release rate over the first hour of the accident was estimated using the above resuspension flux and the average surface area (125 m^2 [1,345 ft^2]) of the growing pool over 1 h. This produced a release, in equivalent liters of waste of 4.2×10^{-4} L (1.1×10^{-4} gal), using an estimated waste density of 1.4 g/cm^3 (11.7 lb/gal). For estimating toxicological exposures to the onsite receptor, the release rate was 1.2×10^{-7} L/s.

The release over the final 23 h of the accident was estimated using the contaminated soil resuspension release fraction of 8.4×10^{-5}, as in the accident analysis without controls. This gave a total release over the 1- to 24-h timeframe of 1.1 L. Based on half of the resuspended material coming off in 1 to 3 h, the maximum release rate for the purposes of estimating toxicological exposures was estimated to be 1.5×10^{-4} L/s.

3.4.2.8.3 Consequence Analysis. The onsite receptor receives dose from inhalation of respirable particles, from direct shine, and from skyshine. Inhalation and a 24-h uptake ingestion dose were determined for the offsite receptor. The shine and skyshine doses to the offsite receptor are negligible.

In the accident analysis without controls, the onsite and offsite receptors are exposed for 12 and 24 h, respectively. In the accident analysis with controls, the onsite receptor is exposed to resuspension off a liquid surface for 1 h, and to shine and skyshine from a surface pool for 1 h. The offsite receptor is exposed to resuspended particles from the liquid pool for 1 h and resuspension from contaminated soil, because of the waste soaking in, for an additional 23 h. The dose estimates for the onsite and offsite receptors for the accident analyses, both with and without controls, are summarized, by pathway, in Table 3.4.2.8-1. The total radiological doses and toxicological exposure estimates are summarized in Tables 3.4.2.8-2 and 3.4.2.8-3. The detailed consequence calculations are documented in WHC-SD-WM-CN-057.

The inhalation doses, 24-h offsite ingestion doses, and toxicological sum-of-fractions were calculated using the methodologies discussed in Section 3.4.1 and the resuspension releases and maximum release rates summarized in the previous section.

The shine and skyshine doses to the onsite receptor were estimated with the *MICROSHIELD* and *MICROSKYSHINE* codes. For a description of these codes see Grove (1992) and Grove (1987), respectively. The shine and skyshine doses were estimated for a receptor assumed to be located 100 m (328 ft) laterally from the point of the release. Doses were estimated for a point 1.5 m (5 ft) off the ground, the approximate height of the trunk of the receptor.

In the accident analysis without controls, the onsite receptor was assumed to be exposed for 12 h after the waste had soaked into the soil (this maximizes the inhalation dose). For the shine and skyshine calculations, the contaminated soil was modeled as a disk, consisting of soil with SST waste evenly dispersed in the void spaces of the soil. The radius of the disk was set at 28 m (92 ft), based on a circular surface area of 2,510 m^2 (27,017 ft^2). Using an estimated soil void fraction of 0.4, the disk depth used in the model was 14 cm (5.5 in.). The disk was assumed to consist of water (40 vol%) with a density of 1.4 g/cm^3 to simulate the waste, and concrete (60 vol%) with an overall density of 1.6 g/cm^3 to simulate the soil in the source volume. The ground between the edge of the pool and the receptor was modeled, in the direct shine calculations, as a side clad shield of concrete with a density of 1.6 g/cm^3. Use of low density concrete has been shown to adequately simulate the shielding effects of soil. The SST radionuclide concentrations summarized in Table 3.4.1-4 were used to establish the gamma emitter source term in the disk. Photons produced indirectly by beta emitters in the waste because of the brehmsstrahlung effect were included in the shine and skyshine calculations. The shine and skyshine doses were calculated for a 12-h exposure.

In the accident analysis without controls, the onsite receptor is exposed to direct radiation and skyshine from a standing pool of waste for 1 h. The integrated dose was conservatively estimated based on the geometry and the radionuclide inventory of the fully grown pool (at the point at which the pump is shut off). The pool was modeled to be 2.54-cm (1-in.) deep, as discussed previously. The radius of the pool, based on a 2.54-cm (1-in.) depth and the 12,900-L (3,400-gal) volume, was estimated to be 12.7 m (42 ft). To include self-shielding, the source was modeled as water with a density equivalent to that estimated for the waste—1.4 g/cm^3. As in the accident analysis without controls, the soil between the edge of the pool and the onsite receptor was modeled as a side clad shield consisting of concrete with a density equal to that of Hanford Site soil—1.6 g/cm^3. Brehmsstrahlung effect was included, as in the accident analysis without controls.

Key Parameters and Assumptions—Accident Analysis Without Controls. The dominant dose contributor to both the onsite and offsite receptors in the accident analysis without controls is the inhalation dose caused by resuspension of contamination off the soil surface after the waste has soaked in. The inhalation dose estimates primarily depend on waste inventory, the contaminated soil resuspension release fraction, and the total pool release volume. The conservatisms in each key parameter and the sensitivity of the radiological dose estimates to each key parameter are addressed in the following subsections:

- **Waste Inventory**—The inhalation dose estimates depend on the radiological inventory of the waste, which in turn is a function of the waste type released and the solids content of the waste. The waste released in the representative accident is SST waste. The waste was assumed to contain 33 vol% entrained solids. The majority of the dose comes from the solids constituents in the waste. The 33 vol% solids value is conservative. The solids content during most transfers is expected to range from trace amounts to 5 vol% solids, based on grab sample results and measured solids level increases in receipt tanks during transfers. The ULD for SST waste containing 5 vol% solids is a factor of 3.7 times smaller than the ULD

for SST waste containing 33 vol% solids. Using a nominal solids content of 5 vol% solids would be expected to reduce the inhalation dose estimated in the representative accident by a factor of 3.7.

- **Contaminated Soil Resuspension Release Fraction**—The contaminated soil resuspension release fraction is based on experiments where relatively small quantities (approximately 25 mL) of UNH solution were spread thinly on soil and dried out under low wind speed conditions. The release fraction used, 8.4×10^{-5} over 24 h, is likely very conservative for large pooling releases, for the following reasons.

  - Large pooling releases will leave a smaller fraction of the solids and salts in solution subject to resuspension. The filtering effect of the soil on large pooling releases will pile up the solids and salts as a much deeper surface layer than in the UNH experiments. Only the top few millimeters of the surface contamination are subject to release under 99.5 percentile meteorological conditions. Large pooling releases will also soak into the ground farther than the small volumes spilled in the UNH experiments. This may allow a larger fraction of the dissolved salts to migrate deeper in the soil where the salts will not be subject to resuspension.

  - Large pooling releases will keep the soil damp longer. The resuspension rate off a pool or a damp soil surface is much smaller than off a dry soil surface. Over a given recovery period, the release will be reduced if the contaminated soil surface remains damp longer.

Quantitatively estimating the conservatism in using the UNH resuspension fractions for large pooling releases of tank waste (given the different physical and chemical considerations) is beyond the scope of the analysis. The UNH resuspension fraction, however, can be compared with resuspension fractions measured for powders spilled on soil. BNWL-2000, "Resuspension Rates from a Circular Field Source" measures resuspension rates of a powder deposited on a soil surface and deduced that a reasonable value for resuspension rate ranged from 4.0×10^{-5}/h to 4.0×10^{-7}/h. This range compares very well with the resuspension rate of 4.0×10^{-6}/h measured in the UNH experiments (see Section 3.2.4.4 of DOE-HDBK-3010-94). It is inherently assumed in the analysis that the waste spreads out thinly before soaking in, simulating the UNH experiments. The contaminated soil resuspension release fraction is independent of surface area affected and is therefore only a function of total spill volume.

- **Pool Volume**—The release volume of 142,000 L (37,500 gal) used in the analysis was set based on a raw water leak experienced in the tank farms. The assumed leak volume is approximately four times as large as than the largest surface waste leak recorded in the occurrence reporting database between 1972 and 1996. The 142,000 L (37,500 gal) pool, at the maximum pump flow rate of 189 L/min

(50 gal/min), can be formed in 12.5 h but would require that several material balances not be performed during the transfer to avoid detection.
The contaminated soil resuspension rate is independent of surface area (see previous discussion). Therefore, the inhalation dose is proportional only to release volume. A pool release one-fourth as large as that assumed in the analysis could be expected to produce inhalation doses one-fourth as large as in the representative accident, using the same waste inventory.

Key Parameters and Assumptions—Accident Analysis With Controls. The offsite dose, in the accident analysis with controls, is primarily caused by resuspension of contamination off the soil surface after the liquid waste has soaked in. The waste inventory, surveillance interval, pumping duration, line drainback, and contaminated soil resuspension release fractions are the most important parameters in the offsite inhalation dose estimate. The onsite receptor is evacuated before the waste has a chance to soak in and dry out. The onsite receptor inhalation dose comes entirely from resuspension of aerosols off the growing liquid surface. The onsite receptor inhalation dose therefore depends on the waste inventory, the leakage flow rate, the operator surveillance interval, the pumping duration, the liquid resuspension flux, the pool geometry (surface area), and the receptor exposure duration (before evacuation).

For the onsite receptor, the shine and skyshine doses are the dominant contributors. These doses, however, are overestimated because of the simplistic model used. The shine and skyshine doses were estimated using the exposure rates predicted for the fully formed pool. The maximum exposure rates were multiplied by the 1-h receptor duration to estimate the integrated doses. Using this simplified model, the shine and skyshine dose estimates are sensitive to waste inventory (gamma content), the leakage flow rate, the pumping duration, the line drainback, the pool geometry (shape and soil area affected), and the receptor exposure duration.

The conservatism in each key parameter and the sensitivities of the onsite and offsite inhalation dose estimate, and the onsite skyshine dose estimate to each key parameter are addressed in the following paragraphs:

- **Waste Inventory**—The inhalation doses in the accident analysis have the same sensitivity to waste inventory and solids content as in the accident analysis without controls. Reducing the solids content in the waste will reduce the onsite shine and skyshine dose estimates because the $^{137}Cs/^{137m}Ba$ content is lower in the liquids phase of SST waste than in the solids phase. For a given size pool, the effect of reducing solids content on the shine and skyshine doses could be expected to be less than a factor of five based on the ratio of $^{137}Cs/^{137m}Ba$ in the liquids phase versus the solids phase.

- **Leak Flow Rate**—It was assumed in the analysis that the leak was catastrophic, that the leak caused washout of the berm, and that all of the waste leaked after berm washout flowed out onto the ground surface. The waste was assumed to spread to an average depth of 2.54 cm (1 in.) before soaking in. A conservative flow rate of 189 L/min (50 gal/min) was assumed for the leak rate. This is the

estimated maximum flow rate of the existing SST submersible pumps, taking into account the lift out of the tank and velocity head losses in the line up through the pump pit. The leak flow rate affects the inhalation and onsite shine and skyshine doses by affecting the size of the pool that can be formed. The offsite inhalation dose will vary in a linear relationship with leakage flow rate because that dose is only a function of total spill volume. Similarly, the onsite inhalation dose is linearly related to flow rate because the dose is approximately a linear function of surface area, which is linearly related to pool volume (assuming the spreading depth is independent of flow rate). Using a nominal leak flow rate of 76 L/min (20 gal/min) would be expected to give onsite and offsite inhalation doses approximately one-fifth of those estimated for the conservative representative case, assuming a similar pumping duration in both cases.

The effect of leak rate on the shine and skyshine doses is more complicated. Lower flow rates will limit the spread of the surface pool toward the receptor and will reduce the total gamma emitter inventory accumulated in the pool over the 1-h pumping duration. Shine and skyshine doses fall off rapidly with increasing distance between the source volume and receptor location. The sensitivity of the shine and skyshine calculations to variations in leak flow rate was not quantitatively evaluated.

- **Operator Surveillance Interval**—A surveillance interval of 30 min was assumed in the analysis. The berm is assumed to wash out shortly after a line surveillance is performed. The leak is assumed to continue undetected until the next operator surveillance 30 min later. The surveillance interval selected was the minimum surveillance interval that could be practically implemented. The inhalation and skyshine doses are affected by the surveillance interval because the total leak volume depends on the surveillance interval. The sensitivities of the inhalation, shine and skyshine dose calculations to leak volume are as discussed in the above leak flow rate discussion.

- **Pumping Duration After Detection of the Leak**—Thirty minutes was assumed for operator action to shut down the appropriate transfer pump following detection of the leak. This response time is judged to be conservative for SST transfers to DCRTs. Reducing the response time will reduce the total volume of waste spilled to the soil surface and will reduce the inhalation and skyshine estimates. As discussed previously, the inhalation dose estimates are linearly related to total pool volume. If the pumping duration is reduced to 10 min, the total pool volume is reduced to 9,100 L (2,400 gal) and the inhalation dose estimates are reduced by 29%. The effect on the shine and skyshine doses will be much more significant because of the increased distance between the receptor and the edge of the pool. This effect was not modeled.

- **Line Drainback**—The analysis assumes that 1,500 L (400 gal) of waste drains back through the leakage path after the transfer pump is shut off. This drainback

corresponds to the line holdup in 305 m (1,000 ft) of a 3-in.-dia transfer line. This assumed drainback is conservative for SST to DCRT transfers with the exception of transfers out of the 241-T tank farm. However, supernatant volumes in the two remaining tanks to be stabilized in Tank Farm 241-T preclude the use of submersible pumps. Leaks for Tank Farm 241-T transfer lines during salt well jet transfers are bounded by the representative case.

The estimated drainback affects the total volume ultimately released in the accident. As discussed previously, the inhalation dose estimates could be expected to be linearly related to total pool spill volume. Doubling the drainback would increase the total spill volume to 14,400 L (3,800 gal) and would increase the inhalation dose estimates by a factor of 11%. Halving the drainback would reduce the spill volume to 12,100 L (3,200 gal) and would reduce the inhalation dose estimates by a factor of about 6%. The effect on the onsite shine and skyshine dose estimates was not specifically modeled.

- **Onsite Receptor Exposure Duration**—The onsite receptor is assumed to be relocated at a safe distance upwind of the leak site 30 min after detection of the leak. The leak is assumed to be detected within 30 min of washing out the berm. The total onsite receptor exposure duration is 1 h. Resuspension of aerosols off the pool surface is proportional to the surface area of the pool, which grows continually over the assumed 1-h exposure period. Exposure durations greater than 1 h will have an approximately linear effect on the onsite inhalation dose, provided the onsite receptor does not remain at the location long enough for the pool to soak into the soil and for the surface of the soil to dry out. Resuspension of contamination off the dry soil surface would result in much higher dose consequences. The effect of increasing the receptor exposure duration on the shine and skyshine dose estimates is also approximately linear, because the integrated shine and skyshine doses are based on the exposure rate for the fully formed pool.

- **Surface Pool Geometry**—It is assumed in the accident analysis with controls that the pool spreads to an average depth of 2.54 cm (1 in.) and that the pool grows as an expanding disk. The assumed pool depth is judged to be conservative to model pool spread over the soil because of the unevenness of the terrain at the Hanford Site and the fact that pool spread would be expected to be limited somewhat by penetration of the waste into the soil. The assumed pool depth and shape do not affect the offsite inhalation dose estimate because that dose primarily depends on the contaminated soil resuspension release fraction, which only depends on total pool volume. The assumed pool depth does, however, affect the onsite inhalation dose. The onsite inhalation dose comes from resuspension of aerosols off the growing pool surface. The aerosol resuspension rate is proportional to pool surface area. The surface area is inversely proportional to assumed waste depth, so the estimated dose would be inversely proportional to the assumed pool depth.

The integrated shine and skyshine doses to the onsite receptor over the 1-h exposure period were conservatively estimated based on the maximum exposure rate estimated for the fully formed pool. The depth and shape of the pool could both substantially affect the maximum shine and skyshine exposure rates by affecting how close the pool encroaches toward the onsite receptor. Should the surface pool form in a longer, narrower (e.g., rectangular or elliptical) geometry, the maximum shine and skyshine exposure rates could be substantially increased over that predicted in the accident analysis with controls. No attempt was made to quantify the effect of changing pool geometries on shine and skyshine dose. The model used was judged to be sufficiently conservative to estimate the integrated shine and skyshine doses to the onsite receptor over the 1-h exposure.

- **Liquid Resuspension Flux**—The resuspension flux used in the analysis is based on measurements of sea sprays. The mass resuspension flux used in the analysis was 2.0×10^{-10} kg/m^2-s, which corresponds to the resuspension flux for a pond with a fetch of 200 m (660 ft) at a wind speed of 2 m/s (6.6 ft/s). The low wind speed value is used to correspond to 99.5 percentile meteorological conditions. This resuspension flux is conservative for the pool formed in the accident because the fetch is 12.7 m (41.67 ft).

  The offsite dose estimate is not sensitive to the liquid resuspension flux because the majority of the offsite dose is caused by resuspension of contamination off the soil surface after the waste has soaked into the soil surface. The resuspension rate for the contaminated soil is much higher than the resuspension rate predicted from the liquid resuspension flux value. The onsite receptor is evacuated before the waste has a chance to soak into the soil, so the onsite receptor inhalation dose is sensitive to the resuspension flux value used. A sensitivity analysis of this variable on the onsite inhalation dose was not performed because of a lack of data (other than in WHC-SA-1378-FP) on resuspension rates from large outdoor pools.

- **Contaminated Soil Resuspension Release Fraction**—The soil resuspension release fraction is important only for the offsite receptor because the onsite receptor is evacuated before the waste soaks into the soil and dries out. The conservatisms in the analysis with regard to soil resuspension fraction and the sensitivities on the offsite inhalation dose are qualitatively evaluated in the key parameters and assumptions discussion for the accident analysis without controls.

3.4.2.8.4 Comparison With Guidelines. The total doses and toxicological exposure estimates are compared with the risk guidelines in Tables 3.4.2.8-2 and 3.4.2.8-3. For the accident scenario without controls, the onsite and offsite doses are shown in Table 3.4.2.8-2 to be above the risk guidelines for the "anticipated" category. The toxicological exposure without controls is shown to be above the risk guideline for the onsite receptor.

Crediting operator surveillance and emergency response, the accident with controls is shown in Table 3.4.2.8-3 to produce onsite and offsite doses that are below the risk guidelines. For the

onsite receptor, the skyshine dose is the dominant contributor. The toxicological exposure estimates in the accident analysis with controls are well below the risk guidelines. The offsite toxicological sum-of-fractions value is higher than the onsite toxicological sum-of-fractions because the maximum release rate occurs after 1 h, by which time the onsite receptor has been relocated out of the plume.

3.4.2.8.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. Tables 3.4.2.8-4 and 3.4.2.8-5 summarize the safety SSCs and TSR controls selected to prevent and mitigate subsurface leaks from the three different types of transfer lines used within TWRS. For each control, the safety function required is described. Clarifying comments are also provided as necessary. See Section 3.4.2.7.5 for additional discussion of how the selected controls prevent or mitigate hazardous conditions and accidents caused by waste transfer misrouting.

Safety Structures, Systems, and Components. For unencased (direct-buried or bermed) transfer lines, no SSCs were designated as Safety-Class. For concrete and pipe-in-pipe encased transfer lines, the pipe encasements were designated Safety-Class. The safety function of the pipe encasements is to route waste leaked from the primary line back to waste transfer-associated structures (e.g., process pits) where the waste can be detected by transfer leak detection systems.[1] Containment of the leaked waste is assured by designating the abovegrade portions of process pits, diversion boxes, valve pits, and COBs as Safety-Significant. Per agreement with DOE-ORP, this Safety-Significant designation is not effective until March 30, 2000. The waste transfer-associated structures also prevent premature waste transfer structure overflow and the formation of a surface pool. The transfer system covers have also been designated Safety-Significant to serve the safety functions of (1) limiting the aerosol release created as a result of splattering and splashing and (2) limiting the shine dose to facility workers.

Transfer leak detection systems have been designated as Safety-Class to prevent pit overflows during transfers (Section 3.4.2.7.5). The transfer leak detection systems prevent pit overflows by alarming and alerting operators to shut down the transfer pump. In many cases, the leak detection systems are interlocked to transfer pumps and will result in immediate pump shut down.

Tank level detection systems and salt well flow totalizers were designated as Safety-Significant to support the performance of periodic material balances during transfers. Material balances are important to back up leak detectors and to limit the total quantity of waste that can be released to the environment.

[1]No credit was taken in the safety analysis for the containment of waste by the primary waste transfer piping. Based on the age and condition of the existing waste transfer piping and operating experience reflected in the occurrence reports, a system evaluation of the primary waste transfer piping could not demonstrate the capability of ensuring a safety function of waste containment.

For safety SSCs that require electrical power (i.e., transfer leak detection systems and tank level detection systems), a supporting SSC, the tank farm electrical distribution system, is required to ensure that the chosen safety SSCs have electrical power to perform their intended safety functions.

Technical Safety Requirement Controls. Waste transfer controls were developed to limit the potential consequences of leaks from subsurface transfer lines. For SST unencased (direct-buried or bermed) transfer lines, a key element of the waste transfer control program is that ground-level radiation surveillances are required to be performed every 30 min during submersible pump transfers and every 12 h during salt well pumping. This control is necessary to detect leaks from unencased transfer lines before they can form large surface pools. The 12-h surveillance interval during salt well pumping is adequate to limit the potential total leak volume to a value comparable with that for the submersible pump case, because of the much lower maximum flow rate of the salt well pumps (4 gal/min vs. 50 gal/min for submersible pump transfers).

Material balances are required as part of the transfer control program to limit the volume of waste potentially leaked to the soil column (without surfacing) from unencased lines and to provide backup detection for leaks into encased lines that drain back to transfer structures containing Safety-Class pit leak detectors. Material balances are required to be performed 30 min after the start of a transfer, 60 min after the start of a transfer and every 2 h thereafter for the remainder of the transfer. The material balances are especially important during low flow rate salt well transfers, because the operator surveillance interval for salt well transfers is 12 h. Over an extended time period, the skyshine from pools smaller than analyzed in the representative accident can give integrated doses approaching the evaluation guideline for the onsite receptor. For salt well transfers to DCRTs, material balances are sensitive enough to discover leaks of a few hundred gallons and will result in emergency response actions to limit nearby worker exposures.

Other key elements of the waste transfer control program include configuration management, approved transfer procedures, independent route verification during transfer setup, double valve isolation on interconnected lines, capping or plugging open nozzles not connected to jumpers, and monitoring of interconnected tanks for level increase during transfers. These key elements are required to prevent misroutes into potentially compromised transfer lines.

For pipe-encased transfer lines, a TSR control was developed to ensure the encasement seal loop valves are not in the closed position during transfers. This control ensures that if the primary pipe leaks during a waste transfer, the encasement will drain to a waste structure where the leak can be detected.

Additionally, TSR controls were determined to be necessary to ensure that the following SSCs are operable during transfers:

- Leak detection systems in all waste transfer-associated structures physically connected to the transfer route

- Covers on all waste transfer-associated structures physically connected to the transfer route.

Three other general controls were determined to be necessary: emergency preparedness controls, transfer pump administrative lock controls, and transfer system cover removal controls. In the event a leak occurs, emergency response procedures are needed to provide direction to minimize the consequences of the leak and to implement recovery activities. Placing an administrative lock on an active transfer pump that is physically connected to a waste transfer system minimizes the potential for an inadvertent pump start resulting in the unplanned transfer of waste. The transfer system cover removal controls provide compensatory measures for cover removal during waste transfers.

Defense-in-Depth. Hardware that currently exists in the tank farms that may provide Defense-in-Depth protection against leaks from buried or bermed transfer lines is summarized in Table 3.4.2.8-6.

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Table 3.4.2.8-1. Summary of Dose Consequences of Unencased Transfer Line Leak, by Pathway Without and With Controls.

Scenario	Onsite doses Sv (rem)			Offsite doses Sv (rem)	
	Inhalation	Direct shine	Skyshine	Inhalation	Ingestion
Without controls	2.9 E+00 (2.9 E+02)	3.8 E-02 (3.8 E+00)	2.1 E-01 (2.1 E+01)	6.7 E-03 (6.7 E-01)	3.6 E-04 (3.6 E-02)
With controls	3.8 E-04 (3.8 E-02)	1.0 E-03 (1.0 E-01)	2.9 E-03 (2.9 E-01)	6.2 E-04 (6.2 E-02)	3.3 E-05 (3.3 E-03)

Table 3.4.2.8-2. Summary of Consequences and Frequencies for Subsurface Leak Resulting in Pool Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Subsurface Leak Resulting in Pool	3.1 E+00 (3.1 E+02)	5.0 E-03 (5.0 E-01)	7.1 E-03 (7.1 E-01)	1.0 E-03 (1.0 E-01)	1.7 E+01	1 (ERPG-1)	3.0 E-02	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
TWA = time-weighted average.
SOF = sum-of-fractions.

Table 3.4.2.8-3. Summary of Consequences and Frequencies for Subsurface Leak Resulting in Pool With Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				With controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Subsurface Leak Resulting in Pool	4.2 E-03 (4.2 E-01)	5.0 E-03 (5.0 E-01)	6.5 E-04 (6.5 E-02)	1.0 E-03 (1.0 E-01)	2.4 E-03	1 (ERPG-1)	5.4 E-03	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
TWA = time-weighted average.
SOF = sum-of-fractions.

Table 3.4.2.8-4. Summary of Safety Structures, Systems, and Components for Subsurface Leak Resulting in Pool. (2 sheets)

Structures, systems, and components	Safety classification	Safety function	Comments
Pipe encasements	Safety-Class	The safety function of the waste transfer system pipe encasement is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Subsurface Leak Resulting in Pool accident.	--
Transfer leak detection systems	Safety-Class	The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures, and to either provide an alarm to alert operators to take mitigative action, or provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Subsurface Leak Resulting in Pool accident.	--
Tank level detection systems	Safety-Significant	The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route, and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Subsurface Leak Resulting in Pool accident.	--
Salt well flow totalizers	Safety-Significant	The safety function of the salt well flow totalizers is to provide the total salt well flow parameter used in periodic material balance calculations during waste transfer operations. These calculations enable operators to terminate the waste transfer operation if waste leaks or mistransfers are detected, thus decreasing the consequences of the Subsurface Leak Resulting in Pool accident.	--

Table 3.4.2.8-4. Summary of Safety Structures, Systems, and Components for Subsurface Leak Resulting in Pool. (2 sheets)

Structures, systems, and components	Safety classification	Safety function	Comments
Transfer system covers	Safety-Significant	The safety functions of the transfer system covers are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure and to limit the shine dose from the waste leak, thus decreasing the consequences of the Subsurface Leak Resulting in Pool accident.	--
Abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes	Safety-Significant	The safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and clean-out boxes are to provide an intact boundary for the leaked waste, and when leak detector alarms and appropriate operator response times to shut off the transfer pump are credited, to prevent premature waste transfer structure overflow and the formation of a surface pool. This decreases the consequences of the Subsurface Leak Resulting in Pool accident.	Per agreement with DOE-ORP, this Safety-Significant designation is not effective until March 30, 2000.

SSC = structure, system, and component.

Table 3.4.2.8-5. Summary of Technical Safety Requirement Controls for Subsurface Leak Resulting in Pool. (2 sheets)

Control	Safety function	Comments
Transfer pump administrative lock controls	Eliminates motive force for unplanned transfers	–
Transfer system cover removal controls • Obtain management approval before removing a transfer system cover • Provide continuous monitoring for waste leaks while covers are removed • Establish procedures that identify required operator responses to the detection of a waste leak	Provides compensatory measures for cover removal during transfers and minimizes risk from unplanned transfers.	–
Transfer system covers	Ensure structures physically connected to the transfer route are covered during transfers	–
Transfer leak detection systems	Ensure operability of the transfer leak detection system in physically connected transfer-associated structures during waste transfers.	
Transfer controls • Transfer system configuration management		
- Establish and maintain controlled status of waste transfer systems as-built and jumper configuration	Prevents mistransfers into waste transfer-associated structures.	–
- Perform waste transfer operations by approved procedures	Prevents mistransfers into waste transfer-associated structures.	–
- Perform independent route verification during transfer setup (includes items such as verification of correct pump and correct valve alignment)	Prevents mistransfers into waste transfer-associated structures.	–
- Perform double valve isolation on interconnected lines	Prevents mistransfers into waste transfer-associated structures.	–
- Open nozzles physically connected to waste transfer lines shall be sealed with caps, process blanks, or equivalent.	Prevents mistransfers through open nozzles in waste transfer-associated structures.	High flow rate leak through open nozzle could overflow pit in less than the assumed 30-min operator response time to a leak detector alarm.

Table 3.4.2.8-5. Summary of Technical Safety Requirement Controls for Subsurface Leak Resulting in Pool. (2 sheets)

Control	Safety function	Comments
Transfer controls (cont'd) • Operating requirements		
- Perform material balances to identify discrepancies in the amount of material transferred	Periodic material balances provide a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	Material balances are required to be performed at 30 min, 60 min, and every 2 h thereafter for the duration of the transfer. For salt well transfers to DCRTs, material balances are required along with emergency response procedures to limit onsite worker exposures. 12-h operator surveillances may not be sufficient to prevent onsite exposures in excess of evaluation guidelines. Material balances for salt well transfers directly to DSTs are not as sensitive as the material balances performed for salt well transfers to DCRTs. Transfers from SSTs directly to DSTs are not normally performed, but if done require separate evaluation.
- Monitor for increasing level in all tanks (including catch tanks) physically connected to the waste transfer route, during a waste transfer through a waste transfer system	Monitoring interconnected tanks for level increases provides a means to detect leaks in transfer lines or mistransfers and limit the quantity of material leaked should the preventive controls fail.	--
- Perform radiation surveillance on single-walled direct-buried/ bermed lines during waste transfer operations (every 12 h during salt well pumping, and every 30 min during submersible pumping).	Periodic radiation surveillance will allow for early detection of leaks and mitigate the radiological dose consequences to the facility worker.	The surveillance times are based on a maximum flow rate of 15 L/min (4 gal/min) and a maximum submersible pumping flow rate of 189 L/min (50 gal/min).
Encasement seal loop controls (i.e., isolation valves are not in the closed position).	Ensure that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure.	--
Emergency Preparedness Program with the following key element: • Response procedures.	Mitigate the consequences of a waste overflow from a waste transfer-associated structure.	--

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

DCRT = double-contained receiver tank.
DST = double-shell tank.
SST = single-shell tank.

Table 3.4.2.8-6. Summary of Defense-in-Depth Controls for Subsurface Leak Resulting in Pool.

Control	Safety function	Comments
Pressure test annually on active lines that have not completed a transfer within 1 yr.	Decreases likelihood of leaks.	Applies to unencased transfer lines (bermed and direct buried).

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3.4.2.9 Spray Leak in Structure or From Waste Transfer Lines. The mitigated consequence analysis presented in this accident analysis section should not be used for Unreviewed Safety Question (USQ) screenings or determinations. This is because the implementation of the control on which this analysis is based (i.e., Aging Waste Facility transfer limitations) has been deferred per agreement with DOE-ORP. The mitigated accident analysis that is valid for this accident analysis is contained in HNF-5147, *FSAR Transition Spray Leak Analyses*. The summary of safety SSCs and TSRs, as shown in this FSAR section, are valid for use.

Should a breach of containment occur along a transfer route during a transfer, a pressurized spray release could result. Pressurized spray releases are a safety concern because, depending on waste pressure and leak dimensions, they can be relatively efficient generators of respirable-sized aerosols. Pressurized spray releases could result from small holes or cracks in transfer piping, improperly installed transfer jumpers, or defective or degraded seals or gaskets.

Chapter 2.0, Figures 2-4 and 2-5, provide an overview of routes that can be used for waste transfers. During transfers, spray leaks that can emanate to the atmosphere are a concern at the following specific locations.

- Inside process pits along transfer routes. Process pits include SST, DST, and AWF tank central and feed pump pits; DCRT pump pits; catch tank pump pits; SST and DST valve pits; and SST and AWF tank sluice pits.

- Inside other process pits not along normal transfer routes where waste could be inadvertently misrouted. These pits can be connected to waste transfer lines and include DST and AWF tank leak detection pits and DST and AWF tank annulus pump pits.

- Inside diversion boxes.

- Inside vaults (e.g., 244-AR Vault, 244-CR Vault) used in SST and AWF tank transfers.

- Inside COBs along slurry transfer lines. The cleanout lines in these boxes are tied directly to primary slurry lines. Should the flanges, valves, or plugs in these lines fail during a transfer, waste could be sprayed in the box, which is located at ground level.

- From encasement risers on pipe-encased transfer lines. Encasement risers include hydrotest risers, test risers, and leak detection risers (see Chapter 2.0). Should the encasement drains be closed and the primary line develop a leak, the encasement pipe and risers could fill with waste and pressurize. An additional failure in the abovegrade portion of the test riser would allow a spray to emanate to the atmosphere.

- Inside flush pits or service buildings. Waste could backflow or be misrouted to these areas and spray from failed piping, valves, or connectors.

- From abovegrade components of flush water systems. Some transfer lines are flushed by connecting to abovegrade water supplies. Waste can spray from these components because of backflows or misroutes.

- From temporary overground transfer lines. These lines are used for SST salt well or submersible pump transfers where no intact buried lines are available.

- Inside the 204-AR Waste Unloading Facility. Waste is pumped from the facility to various DSTs under pressure. A short section of pipe within the facility is susceptible to spray leaks. Spray leaks are also postulated in the hazard analysis to be possible because of backflows of waste from the tank farms.

- From buried or bermed sections of transfer lines if uncovered and damaged in an excavation accident during a transfer.

- Inside ventilated waste storage tanks (DSTs, DCRTs, and some SSTs). Aerosols could be generated inside a storage tank during a transfer because of a leak from the portion of the transfer pipe inside the tank. The tank ventilation system could help disperse the aerosols to the atmosphere should the vent system HEPA filters fail.

Process pits, diversions boxes, valve pits, and flush pits are covered with concrete blocks or metal plates, except during routing changes or maintenance activities. Most COBs are covered with removable metal lids, some upgraded COBs are enclosed with a bolted steel flange and HEPA filter to allow breathing. Should the pits or COBs be uncovered at the time of a spray leak, aerosols generated in the accident could emit directly to the atmosphere. The other locations listed above provide potential pathways for pressurized waste to be sprayed at or above the soil surface into the atmosphere, or for aerosols generated in a spray leak to be dispersed to the atmosphere. Pressurized spray leaks from buried or bermed sections of transfer pipe are considered to be adequately mitigated by soil cover. Subsurface plumes and surface pools formed as a result of belowground leaks are addressed in Sections 3.3.2.4.7 and 3.4.2.8, respectively.

The potential consequences of bounding uncontrolled and controlled spray leaks from TWRS transfer equipment are developed in detail in WHC-SD-WM-CN-048, *Calculation Notes in Support of TWRS FSAR Spray Leak Accident Analysis* and HNF-SD-WM-CN-096, *Refined Radiological and Toxicological Consequences of Bounding Spray Leak Accidents in Tank Farm Waste Transfer Pits*. The analyses in WHC-SD-WM-CN-048 were developed in a very conservative manner. HNF-SD-WM-CN-096 supplements WHC-SD-WM-CN-048, using a more reasonable, yet still conservative, set of modeling assumptions and parameters. The following sections summarize the scenarios, source term analyses, and consequence analyses developed in WHC-SD-WM-CN-048, reflecting the refinements of HNF-SD-WM-CN-096.

Supplemental safety analysis and controls required for Tank 241-SY-101 remediation activites and operations are documented in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

3.4.2.9.1 Scenario Development. Spray leaks in valve pits can be caused by gasket failures, valve packing failures, pump seal failures, or by cracks or holes that might develop in valve bodies, piping, or jumpers. Mechanisms such as aging, corrosion, erosion, water hammer, overpressurization, freezing, mechanical fatigue, and thermal stress can lead to these pressure boundary failures. Human error is also a contributor. Spray leaks can occur as the result of misalignment of jumpers during routing changes or as the result of improper valve lineups that may result in transfers being routed through compromised transfer paths.

Accident Scenario Without Controls. A representative spray leak from TWRS waste transfer systems was determined to be a spray leak from a misaligned jumper in a valve pit. For the scenario without controls it was postulated that the spray leak occurs from a misaligned jumper in an uncovered valve pit, with the spray directed up and out of the pit into the atmosphere. Without appropriate controls, the pit where the spray leak occurs can be postulated to be uncovered because of human error to replace the pit covers following a prior jumper change or maintenance activity or because of a transfer misroute into a pit where the covers are off for performing jumper changes or maintenance. The spray leak was assumed to occur during a transfer of aging waste slurry because aging waste solids have the highest dose potential of the three tank waste types. Potential discovery of the leak via periodic material balances normally performed during transfers, pit leak detectors, or operator observation was not considered to ascertain the risk posed by unmitigated spray leaks. The leak was assumed to continue unabated for 24 h consistent with the approach discussed in Section 3.4.1.

The offsite receptor doses were modeled for the duration of the passage of the plume. For the onsite receptor, the inhalation dose was originally estimated for a 12-h exposure, consistent with the approach discussed in Section 3.4.1. However, the caustic content of the plume would be high enough and irritating enough to cause the receptor to move laterally out of the plume in a short time period. For this analysis, it is assumed the maximally exposed onsite receptor self-evacuates within 10 min of exposure to the plume. For the slurry mix used in this analysis, about 50% of the sum-of-fractions is caused by sodium hydroxide (NaOH) (Appendix E, WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*). The calculated sum-of-fractions of 25 for the onsite receptor (Table 3.4.2.9-1) is roughly 12 times the ERPG-1 (AIHA 1988) limit of 2 mg/m^3, giving an airborne NaOH concentration of 24 mg/m^3. This concentration is between the ERPG-1 and ERPG-2 values for NaOH. At this caustic concentration the plume would be mildly irritating to the nose and lungs of the receptor, making the release detectable by the onsite receptor.

Other chemical components in the waste will contribute to self-detection of plume exposure. The spray leak is also likely to be audible. Operators within 100 m of the leak are trained in the hazards posed by tank wastes and will know to quickly evacuate an area with a visible plume that is irritating. At 100 m, 95% of the gaussian shaped plume occupies an area no

greater than 8 m wide (under the worst-case meteorological conditions assumed in the accident analysis.) So the receptor can readily move laterally out of the plume. The assumed 10 min self-evacuation is reasonable given that (1) the plume is audible, the spray leak is likely to be heard by operators within 100 m (328 ft) (depending on whether other noisy equipment is operating), (2) the plume is irritating to the receptor, and (3) the plume is only 8 m (26 ft) wide.

Accident Frequency Without Controls. The accident frequency without controls is assigned based on the frequency of the initiating event. In this case, the initiating event is the equipment leak that results in the pressurized spray release during a transfer. The initiating event frequency is considered to be in the "anticipated" category when applied across the entire tank farm. This frequency is justified by Hanford Site experience. Several spray leaks have occurred in tank farm transfer systems since 1972. The occurrence reporting database (Section 3.3.2.1.4) contains 14 instances where waste or contaminated water was found to have leaked during transfers or during flushing of lines from failed equipment inside pump pits, valve pits, sluice pits, or flush pits. In four of the occurrence reports, the leaks are specifically described as sprays. It is unknown whether the remaining leaks in the database were sprays or low-pressure liquid leaks.

Accident Scenario With Controls. The primary mitigative feature against spray leaks inside pits are the pit covers. The covers substantially limit the quantity of aerosol that can be released to the atmosphere by preventing the spray from jetting directly into the atmosphere and by creating a relatively stagnant air volume that fosters agglomeration and rainout of aerosols within the pit. For the analysis with controls, the spray leak occurs inside a covered valve pit (where installation of the covers prior to a transfer is assured by administrative control). In the refined analysis in HNF-SD-WM-CN-096, it was found that two separate mitigated scenarios warranted analysis: a spray leak of DST slurry inside a covered DST valve pit, and a spray leak of AWF tank slurry inside a covered AWF tank valve pit. The two separate analyses were found to be necessary because of the differences in DST and AWF tank radiological inventories and differences in maximum pit dimensions for the two types of waste transfers. Potential spray leaks inside SST transfer enclosures were also evaluated in WHC-SD-WM-CN-048 and were found to be bounded by the DST and AWF tank cases because of higher potential waste pressures in DST and AWF tank waste transfers and higher ULDs associated with DST and AWF slurries.

Postulated driving mechanisms that could force aerosol-laden air from the valve pit include an initial expansion of the pit air caused by a temperature and humidity increase in the pit air (caused by spraying hot waste into an initially cooler pit), displacement of the pit air caused by spilled waste accumulating in the bottom of the pit (applies only to pits with closed or plugged drains), natural breathing caused by barometric pressure and temperature changes, and breathing caused by wind blowing over the pit surface.

Of these driving mechanisms, the first two mechanisms are the most important and are the mechanisms specifically factored into the mitigated accident analysis models in HNF-SD-WM-CN-096. The initial volume expansion dominates because the temperature and humidity in the pit air can increase significantly during the spray leak if the spray leak involves hot waste sprayed into a relatively cool pit in the winter. In comparison, the potential volume of contaminated air that could be expelled from the pit because of barometric pressure and

temperature changes over the course of the accident is very small (maximum of 0.0045 vol fraction per day based on WHC-EP-0651, *Barometric Pressure Variations*). Breathing caused by wind effects would also be negligible in the 95th percentile low wind speed, stable atmospheric conditions assumed in the majority of the accident analyses in this FSAR. In a brisk wind, the marginal increase in total release from the pit was found to be more than offset by the increased dispersion provided by the brisk wind.

Displacement of aerosol-laden air from the pit occurs only if the pit drain is closed, which would allow spilled liquid waste to accumulate on the floor of the pit. DST and AWF tank valve pit drains are connected to ventilated underground storage tanks. An open DST or AWF tank drain would therefore allow the tank ventilation system to draw on the pit. The slight negative pressure in the pit would limit the total release of aerosols from the pit. Although the initial temperature and humidity increase in the pit air could initially overwhelm the draw through the pit drain, the residual long-term release through the pit cover penetrations would be negligible.

Because the closed drain scenario results in the largest volumetric displacement of air from the pit, it was assumed in the mitigated accident analyses in HNF-SD-WM-CN-096 that the DST and AWF tank valve pit drains were closed during the spray release. The DST and AWF tank valve pits are provided with leak detectors (designated Safety-Class in Section 3.4.2.7) to prevent the pits from overflowing with waste should a large volume leak occur (e.g., misroute through an open nozzle). The pit leak detector in the closed drain spray leak scenario will eventually alarm and spur operator action to shut down the appropriate transfer pump. The pit leak detector was therefore credited with limiting the volume of contaminated air displaced from the pit. Thirty minutes was assumed in both scenarios for operator action to shut down the appropriate transfer pump after the pit leak detector alarmed. The onsite and offsite receptor doses were calculated assuming those receptors were exposed for the duration of the passage of the plume. The airborne concentration of caustic waste in these scenarios was not found to be high enough for self-detection and evacuation by the onsite receptor.

Accident Frequency With Controls. The accident frequency with controls is the same as the frequency category of the accident without controls, or "anticipated," as no safety SSCs or TSR controls are credited with reducing the likelihood of the initiating event.

3.4.2.9.2 Source Term Analysis. The source term analyses for the accident scenarios without and with controls are summarized in the following subsections.

Accident Source Term Without Controls. The SPRAY computer model was used to determine the flow rate and particle size distribution of the aerosols generated in the uncontrolled spray release. For a detailed description of the spray model, see WHC-SD-GN-SWD-20007, *A Model for Predicting Respirable Releases from Pressurized Leaks*.

The leak was assumed to occur at a misaligned jumper connection to a 2-in., Schedule 40 slurry transfer pipe. The leak was assumed to be 5.1 cm (2 in.) long. This leak length was selected because it represents, approximately, the fraction of the jumper connection circumference that could orient a spray up and out of an uncovered pit. The Darcy frictional losses across the

depth of the leakage path were estimated by SPRAY assuming an equivalent crack depth of 0.406 cm (0.16 in). This is the estimated width of the sealing surface at the jumper connection. The walls of the leakage path were assumed to have a surface roughness equivalent to that of steel, or 0.0046 cm (1.8×10^{-3} in.).

The leak was assumed to occur at a waste gauge pressure of 1.7 MPa (250 lb/in^2). This waste pressure was selected based on a review of DST and AWF tank transfer pump performance curves. Because of the high shear rate induced in the spray leak, the thixotropic slurry was assumed to have a viscosity approaching that of water, or 1 cPs.

The waste spraying through the leak was conservatively assumed to be AWF tank waste containing 33 vol% entrained solids. Aging waste was selected as the bounding source term material because aging waste solids produce higher doses, on a volumetric basis, than DST or SST waste. The assumed solids content was judged to be bounding for all types of waste transfers as it is well above measured values on grab samples taken from supernatant layers in waste storage tanks and corresponds to the upper operating range of the 242-A Evaporator, which produces the most concentrated waste stream in active routes.

At 33 vol% solids, aerosols up to 14.5 μm in diameter can evaporate down to their solids constituents in the respirable (10 μm) size range after being emitted into the atmosphere. The SPRAY code was therefore used to iteratively solve for the crack width that produced the maximum flow rate of particles 14.5 μm in diameter and less. Sub-14.5 μm particles emitted from the misaligned jumper are treated as 100% respirable in the dose calculations in Section 3.4.2.9.3.

Results of SPRAY analysis: The optimum crack width was found by SPRAY to be 0.116 mm (4.55×10^{-3} in.). The maximum respirable (<14.5 μm) aerosol release rate was found to be 2.28×10^{-3} L/s (3.6×10^{-2} gal/min). The total flow rate through the optimum sized leakage path was found to be 0.141 L/s (2.24 gal/min), giving a respirable fraction of 1.6×10^{-2} (volume basis). Over the assumed 24-h duration of the accident, the total airborne respirable release is 197 L (52 gal). This release quantity applies to the offsite receptor, who is exposed to the release for the entire duration of the plume's passage. For the onsite receptor, a 10-min exposure duration is assumed because of the irritating effect of the caustic components in the plume will have on that receptor, which motivates the receptor to evacuate cross-wind out of the plume. The total release volume over 10 min for the onsite receptor is 1.37 L (0.36 gal).

Source Term With Controls. As discussed in Section 3.4.2.9.1, two accident scenarios with controls were found to warrant analysis: a spray leak of DST waste inside a covered DST valve pit, and a spray leak of AWF tank waste inside a covered AWF tank valve pit. In both the DST and AWF tank spray leak scenarios, the pit leak detector is credited with eventually detecting the leak and causing the manual shut down of the appropriate transfer pump. The largest valve pit associated with DST waste transfers is larger than the largest valve pit associated with AWF tank transfers. Hence, the duration of the spray leak and the quantity of spilled waste required to activate the pit leak detector is higher in the DST case. However, the inhalation dose potential of the AWF tank waste is higher on a unit liter basis, somewhat offsetting the larger volumetric release in the DST case.

In both scenarios, the pit covers provide an impaction surface that prevents the jetting of aerosols directly into the atmosphere. The covers also create a relatively stagnant air volume that fosters agglomeration and rainout of aerosols within the pit. Aerosol removal also occurs because of condensation on the pit walls and the underside of the cover blocks. Aerosol is further removed from any air expelled from the pit through the cover block gaps because the leakage paths are tortuous and provide additional surfaces for impingement and condensation.

However, the pit cover blocks are not sealed and thus do not ensure confinement of aerosols generated in the spray leak. Gaps around cover blocks, gaps around plugs in the drain ports, gaps around camera access hatches, and valve handle penetrations provide leakage paths for some of the aerosol laden air created in the accident to be expelled from the pit.

Taking credit for aerosol removal mechanisms inside the pit and in passing through penetrations in the cover blocks, the concentration of aerosols in the air expelled from the pit was conservatively set at the quasi-stable aerosol loading limit of 100 mg/m^3 (NUREG/CR-2651, *Accident Generated Particulate Materials and Their Characteristics—A Review of Background Information*, Section 2.4.14). This loading limit value is comparable to dense fog. The aerosols expelled from the pit were all conservatively assumed to be in the respirable size range (<10 μm in diameter). The leak path dimensions and flow rate are not important in determining the aerosol concentration in the air expelled from the pit. It can be shown using the SPRAY code previously discussed that many leak dimensions and pressures are capable of saturating the pit air.

As discussed in Section 3.4.2.9.1, the dominant driving mechanisms that can force contaminated air from pits include an initial volumetric expansion of the pit air caused by spraying warm waste into cooler pit air (this increases the pit air temperature and humidity), volumetric displacement of the pit air by the leaked liquid waste accumulating on the floor of the pit (assuming the pit drain is closed or plugged).

The initial volume expansion was determined using psychrometric charts and estimates of the maximum potential temperature and humidity change that could occur in the pit air during the spray release. The maximum temperature and humidity change produces the largest volumetric expansion. Hence, the accident was assumed to occur in winter with the pit air at an initial temperature of -1 °C (30 °F) and 15% relative humidity. Spray leaks that are efficient generators of aerosols will saturate the pit air with moisture. Conservatively assuming adiabatic pit walls, the pit air temperature in a spray leak will eventually approach the temperature of the waste being sprayed. For the mitigated accident analyses, it was assumed the air in the pit reached a final temperature of 49 °C (120 °F) (nominal waste temperature) and 100% relative humidity. Based on specific air volumes read from psychrometric charts at the appropriate temperatures and humidities, the volume of air expelled from the pit due to the initial expansion was estimated to be 35 vol%.

Using this conservative model, the release volume of aerosol-laden air from the pit is proportional to the volume of the valve pit where the spray occurs. The largest DST valve pit (241-AP) was determined to have an inner volume (with cover blocks on) of 74.9 m^3. Multiplying by the 35 vol%, the initial volume expansion was determined to expel 26.2 m^3 of

aerosol laden air from the DST valve pit. The largest AWF tank valve pit (241-AZ-152) was determined to have an inner volume (with cover blocks on) of 10.2 m^3. The initial volumetric release from this pit was therefore determined to be 3.57 m^3. The time required to heat up and saturate the pit air is indeterminate but was assumed to be 1 h.

To estimate the liquid displacement term, the pit leak detectors were conservatively assumed to alarm after the liquid level in the pit reached 5.1 cm (2 in.). Pit leak detectors are expected to alarm before the liquid accumulates to 2.54 cm (1 in.). The total volumetric displacement depends on the flow rate of waste through the leakage path. Because 30 min is assumed for operator action to shut down the transfer pump, the highest flow rate that produces an efficient aerosol generating spray produces the maximum release from the pit. The flow rate that was selected was the flow that would set off the leak detector in each pit within 30 min, giving a total duration of the accident of 1 h. For the DST case, this leak rate was determined to be 9.24×10^{-2} m^3/min (24.5 gal/min), based on the length and width of the pit and the 2-in. activation height for the leak detector. For the AWF case, the flow rate to set off the pit leak detector in 30 min was determined to be 1.88×10^{-2} m^3/min (4.98 gal/min). Over the 1-h course of the accident, the total volumetric release of contaminated air from the valve pit in the DST case was determined to be 31.7 m^3 (26.2 m^3 + [9.24×10^{-2} m^3/min][60 min]). The total volumetric release of contaminated air from the AWF valve pit was determined to be 4.7 m^3.

The total airborne release from the pit on a mass basis was calculated by multiplying the total air volume release in both cases by the quasi-stable aerosol loading limit of 100 mg/m^3. For the DST case, the total aerosol release was determined to be 3.17 g. For the AWF tank case, the total aerosol release was determined to be 0.470 g. The releases in equivalent liters of waste were determined by dividing the mass releases by an assumed slurry density of 1,400 g/L. For the DST valve pit spray leak case, the equivalent waste release on a volume basis was found to be 2.27×10^{-3} L. For the AWF tank valve pit spray leak case, the equivalent waste volume release was found to be 3.36×10^{-4} L.

3.4.2.9.3 Consequence Analysis. The atmospheric dispersion model discussed in Section 3.4.1 conservatively does not consider plume depletion caused by gravitational settling of airborne particulates and aerosols. For the uncontrolled and controlled spray leak accident scenarios, gravitational settling of the released aerosols was included using the Chamberlain model included in the GXQ code (WHC-SD-GN-SWD-20007). An average dry deposition velocity of 0.15 cm/s was used for the respirable aerosols released in the spray leak scenarios. Factoring in dry deposition had the effect of reducing the acute ground-level onsite χ/Q' shown in Table 3.4.1-6 by approximately 15%, and the acute ground-level offsite χ/Q' shown in Table 3.4.1-7 by approximately 43%. The 24-hour offsite χ/Q' was reduced by approximately 40%. The calculations correcting the onsite and offsite χ/Q's for dry deposition are contained in HNF-SD-WM-CN-096.

The onsite and offsite doses and toxicological exposures were calculated using the methodology discussed in Section 3.4.1, with the χ/Q's corrected for dry deposition as discussed above. For the spray leak scenario without controls, the onsite and offsite doses and toxicological exposures are summarized in Table 3.4.2.9-1. For the spray leak scenario with controls, the

onsite and offsite doses and toxicological exposures for both the DST and AWF tank slurry spray leak cases are summarized in Table 3.4.2.9-2.

For the spray leak scenario without controls, the inhalation dose to the onsite receptor (with 10-min exposure because of self-evacuation) was found to be 7.4 Sv (7.4×10^2 rem) (50-yr committed effective dose equivalent). The inhalation plus ingestion dose to the offsite receptor (24-h exposure) was found to be 8.3×10^{-2} Sv (8.3 rem). The toxicological sum-of-fractions for the onsite and offsite receptors were found to be 2.5×10^1 and 8.9×10^{-2}, respectively.

For the spray leak scenarios crediting controls, the inhalation dose to the onsite receptor in the DST slurry spray leak case was determined to be 3.9×10^{-3} Sv (3.9×10^{-1} rem). The inhalation plus ingestion dose to the offsite receptor in the DST slurry spray leak case was found to be 2.2×10^{-6} Sv (2.2×10^{-4} rem). The toxicological sum-of-fractions for the onsite and offsite receptors in the DST slurry spray leak case were found to be 2.4×10^{-2} and 8.5×10^{-5}, respectively.

The doses to the onsite and offsite receptors in the AWF tank slurry spray leak case were found to be 1.8×10^{-3} Sv (1.8×10^{-1} rem) and 1.0×10^{-6} Sv (1.0×10^{-4} rem), respectively. The toxicological sum-of-fractions for the onsite and offsite receptors in the AWF tank slurry spray leak case were found to be 3.4×10^{-3} and 1.2×10^{-5}, respectively. The toxicological sum-of-fractions value was determined by conservatively assuming the initial volume expansion in the pit caused by temperature and humidity increase occurs in the first 15 min of the accident.

Key Parameters and Assumptions—Accident Analysis Without Controls. The consequence estimates summarized above for the accident scenario without controls were calculated in a conservative manner. The sensitivity of the analysis results to key parameters and assumptions used in the analyses are addressed in this section.

- **Slit Length**—In the representative accident analysis, the leak path was postulated to be a slit 5 cm (2 in.) long. The 5-cm (2-in.) slit length was selected to model a leak at a bad jumper connection. Along its entire length, the slit was assumed to be of optimal width to produce the maximum flow rate of respirable sized aerosols. At a given pressure and crack width, the SPRAY model predicts that the respirable flow rate will be proportional to crack length. Leakage paths less than 5 cm (2 in.) long can therefore be expected to produce doses proportionately smaller than the 5-cm (2-in.) case. In addition to spray leaks from improperly aligned jumper connections, leaks can develop from holes or cracks in pipes, jumpers, or valve bodies. The 5-cm (2-in.) slit length was judged to be sufficiently conservative to model respirable aerosol releases from cracks in equipment or improperly connected jumpers. Although cracks longer than 5 cm (2 in.) can be postulated, they would not be expected to produce respirable flow rates proportionately higher than the representative case, as they are unlikely to be of optimum width along their entire length. Very long cracks would also result in higher flow rates and significant pressure loss in the line, which would also result in lower respirable aerosol production.

- **Slit Width**—The SPRAY code was used to iteratively solve for the slit width that produced the maximum flow rate of respirable-sized aerosols. A sensitivity analysis was performed to examine the effect of varying the slit width on the respirable aerosol release rate. The sensitivity analysis was performed for a waste pressure of 2.1 MPa (300 lb/in.^{2} gauge). This is the approximate deadhead pressure of the largest DST and AWF tank waste transfer pumps. The optimum slit width at 2.1 MPa (300 lb/in.^{2} gauge) was found to be 0.11 mm (4.5 x 10^{-3} in.). Nozzles used in the spray-drying industry tend to be 0.025 cm (0.01 in.) in diameter or larger. At a slit width of 0.025 cm (0.01 in.), the doses were found to be about half as large as the dose calculated for the optimum 0.11-mm-wide slit assuming a 5-cm slit length in both cases. The respirable flow rate and doses for a much wider crack 0.25 cm (0.1 in.) across were found to be a factor of 71 times smaller than in the optimum case. The respirable flow rate and doses for a narrower slit 0.005 cm (2 x 10^{-3} in.) across were found to be about 63% of those estimated for the optimum case.

- **Waste Pressure**—Depending on the location of the leak with respect to the transfer pump, the transfer line resistance, static assist, waste viscosity, and other factors, the pressure of the waste at the leak location under flowing conditions could vary anywhere between 0 and 2.1 MPa (0 and 300 lb/in.^{2} gauge). The maximum pressure of 2.1 MPa (300 lb/in.^{2} gauge) corresponds to the approximate deadhead pressure of the largest waste transfer pumps. The analysis assumed a conservative pressure of 1.7 MPa (250 lb/in.^{2} gauge) to account for frictional losses up to the point of the leak. To examine the effect of pressure on the consequences, two spray leak pressures were examined in addition to the 1.7 MPa (250 lb/in.^{2} gauge) maximum base case: a moderate pressure case at 1.0 MPa (150 lb/in.^{2} gauge) and a low pressure 0.34 MPa (50 lb/in.^{2} gauge) case. At 1.0 MPa (150 lb/in.^{2} gauge), the optimum spray leak was found to produce doses 39% as large as the 1.7 MPa (250 lb/in.^{2} gauge) case. The doses at 0.34 MPa (50 lb/in.^{2} gauge) were found to be 7% as large as the 1.7 MPa (250 lb/in.^{2} gauge) case.

- **Accident Duration**—The spray leak accident without controls is assumed to continue undetected for 24 h. The total respirable aerosol release is directly proportional to the assumed accident duration. However, changing wind direction, wind speed, and atmospheric stability result in a logarithmically decreasing χ/Q' as a function of time (see Section 3.4.1). The decreasing χ/Q' value offsets the increase in release quantity over increasing accident durations. Therefore, the 24-h dose to the offsite receptor was found to be only a factor of 2.6 times that for a 2-h release at the same leak rate. Alternatively, increasing the accident duration to 3 days was found to produce only about a 50% increase in the total offsite dose estimate. The onsite receptor is assumed in the accident analysis to be exposed for 10 min because of self-evacuation, as the estimated airborne sodium hydroxide concentration in the accident is high enough to be irritating to the receptor. The exposure duration assumed for the onsite receptor was judged to be conservative.

The dose to the onsite receptor is proportional to assumed exposure duration within the first hour of the accident.

- **Solids Content**—The waste sprayed from the leak in the analysis without controls was assumed to be an AWF tank slurry composed of 33 vol% solids and 67 vol% supernate. The solids content assumed in the analysis is bounding, as previously discussed. Based on grab sample results from supernatant liquid layers in DSTs and measured sludge level changes in receiving tank following transfers, however, it is estimated that typical transfers contain less than 5 vol% entrained solids. The ULD for AWF solids is much higher than for AWF tank liquids (Section 3.4.1). The ULD for a composite slurry of aging waste consisting of 5 vol% solids was found to be a factor of 6.7 times smaller than the ULD for the bounding 33 vol% case. The assumed solids content, however, has an offsetting effect on the particle size distribution in the plume downstream of the site of release. Dilute solutions experience greater evaporation and can have a larger fraction of the original release material evaporate into the respirable size range (<10 μm in diameter). Because of this competing effect, dose results are only weakly dependent on assumed solids content. A higher solids content generally produces only slightly higher doses.

- **Waste Inventory**—The analysis was conducted for a leak of aging waste, which has the highest ULD. Assuming 33 vol% solids, the SST and DST ULDs are approximately 7.1 and 3.1 times smaller, respectively, than for aging waste.

- **Dry Deposition**—The analysis factors in gravitational settling of the released aerosols using the Chamberlain model and a deposition velocity of 0.15 cm/s. This deposition velocity was chosen as it agrees well with the deposition velocity determined in an actual tank farm release event, based on collected air sampler data and measured ground contamination profiles (HNF-SD-WM-CN-096). The deposition velocity of 0.15 cm/s is similar to the generic value of 0.1 cm/s recommended for respirable sized particles in PNL-6584, *GENII - The Hanford Environmental Radiation Dosimetry Software System*. Other deposition velocities were not considered in the analysis. However, the limiting case is a release with no gravitational settling of particulates. As discussed previously, such a case would be expected to increase transport of respirable sized particles to the onsite receptor during the 10 min exposure period by only about 15%. Transport of respirable sized particles to the offsite receptor during this assumed 24-h exposure duration would increase by about 40% if no gravitational settling is credited. Intermediate deposition velocities would therefore produce doses less than 15% higher to the onsite receptor and less than 40% higher to the offsite receptor.

Key Parameters and Assumptions—Accident Analysis With Controls. The sensitivity to waste inventory is the same in the analysis with controls as the analysis without controls. The accident analysis with controls estimates that the pit air will become overloaded with aerosols for a wide range of leak conditions. The consequences with controls are therefore independent of

crack length, crack width, and waste pressure. Because evaporation of aerosols is not relevant to the accident analysis model, assumed solids content is not important to the analysis. The remaining key parameters and assumptions used in the analysis are addressed below.

- **Aerosol Concentration of Air Expelled from the Pit**—In the accident analysis with controls, the air breathed from the pit is assumed to be limited in aerosol concentration to a value of 100 mg/m^3, comparable to fog. The fog value provides an upper bound for the analysis. The dose is proportional to the assumed aerosol concentration. NUREG/CR-2651 suggests a metastable aerosol concentration of 10 mg/m^3. This aerosol concentration may be more appropriate for aerosols passing through tortuous cover block penetrations far removed from the site of the spray leak. Using the 10 mg/m^3 value gives doses approximately 10 times smaller than those reported for the representative analysis.

- **Temperature and Humidity Change**—The mitigated analysis estimates an initial volumetric expansion of the pit air based on a temperature and humidity change from -1 °C (30 °F), 15% relative humidity to 49 °C (120 °F), 100% relative humidity. From psychrometric charts, the volume expansion results in a pit air exchange equal to 35% of the pit volume. This volume expansion is conservative because the initial temperature of the pit at the start of the spray leak would normally be much higher than -1 °C (30 °F), and the final pit air temperature was set equal to the nominal expected waste temperature. Heat sinking into the pit walls would be expected to keep the final pit air temperature considerably below the temperature of the waste being pumped. Because of a lack of a model to rigorously predict the aerosol behavior and heat transfer inside the pit, no sensitivity analyses were performed on initial pit conditions or final pit air temperature.

- **Leak Flow Rate**—The analysis with controls assumes for the DST valve pit spray leak and the AWF tank spray leak scenarios that the leak rate is such that it sets off the pit leak detector alarms 30 min after the spray leak develops. Operators are assumed to shut down the appropriate transfer pump within another 30 min after activation of the pit leak detector alarm. Larger volumetric flow rate leaks were judged to not be efficient aerosol generators. The accident analyzed in Section 3.4.2.7 is considered to adequately cover high flow rate leaks into pits. Lower flow rate leaks will produce marginally smaller dose consequences as the volume of air displaced from the pit by the spilled liquid waste over the 1-h accident will be smaller. The majority of the contaminated air expelled from the pit occurs because of the postulated temperature and humidity change in the pit air. The results of the analysis are therefore only weakly dependent on assumed leak rate. The assumed leak rate does not have an effect on the aerosol concentration in the air expelled from the pit, which is conservatively assumed to have an aerosol content comparable to dense fog.

- **Spray Leak Location**—In the DST slurry spray leak case, the leak was assumed to occur in the largest valve pit associated with DST transfers. Similarly, in the AWF tank slurry spray leak case, the largest AWF valve pit was assumed to be the site of the spray leak. The simplistic model used in the analysis predicts that 35% of volume of air in the pit is expelled because of a temperature and humidity increase in the pit air caused by overloading the pit air with warm liquid aerosols. The volume of air expelled from the pit because of displacement by accumulating liquid waste in the bottom of the pit is small compared with the postulated release caused by the temperature and humidity change. The dose consequences to the onsite and offsite receptors is therefore approximately proportional to pit volume. In the DST slurry spray leak case, the other valve pits in the 200 East Area have holding capacities that are much less than the 241-AP valve pit. The 241-A-A, 241-A-B, 241-AX-A, and 241-AX-B valve pits are typical of DST valve pits and are all similar in size. The estimated internal volume of these pits is approximately 15.1 m^3 (533 ft^3) (from Section 3.4.2.7.2), compared to the estimated internal volume of the 241-AP valve pit of 74.9 m^3 (2,645 ft^3). A spray leak inside the 241-A-A, 241-A-B, 241-AX-A, or 241-AX-B pit would produce onsite and offsite doses approximately 20% of those estimated for the 241-AP case analyzed. In the AWF tank slurry spray leak case, the discrepancy in pit sizes is not as great as in the DST slurry spray leak case.

- **Operator Response Time to Pit Leak Detector Alarm**—The analysis assumes 30 min for operators to respond to the pit leak detector alarm and to shut down the appropriate waste transfer pump. The release of aerosols from the pit is caused primarily by the initial volume expansion of the pit air due to temperature and humidity increase. For low-volume efficient aerosol-generating spray leaks, liquid displacement of aerosol-laden air from the pit is small compared with the initial volume expansion, given the operator responds in a reasonable time. In addition, displacement of contaminated air from the pit over longer time periods is subject to greater dispersion than the short-term initial volume expansion. For these reasons, the results of the consequence analysis are only weakly dependent on the assumed operator response time. A long-term release that causes the pit to fill to half its capacity with waste submerging the spray leak, as could be caused by delayed operator response or an inoperable leak detector, is quantitatively assessed in the next item.

- **Reliability of Pit Leak Detector**—For the reasons discussed above, the accident consequences with controls are not sensitive to the alarm setpoint of the pit leak detector. The potential consequences of a spray leak in a pit with a closed drain, should the pit leak detector completely fail, were evaluated in WHC-SD-WM-CN-096. In the analysis, the pit drain was assumed to be plugged to maximize liquid displacement of aerosol-laden air through the pit cover block penetrations. The spray leak was assumed to continue until the leaking jumper was submerged, which was assumed to occur when the pit was half-full of waste (submerging the jumper suppresses aerosol generation). Both the DST and AWF

tank slurry spray leak cases were re-evaluated in this manner. Without operating leak detectors, one-half a pit volume of aerosol-laden air is expelled in addition to the 35 vol% of the pit air estimated to be released because of the initial temperature and humidity increase. However, the release occurs over a longer time, which increases atmospheric dispersion. The resulting onsite and offsite doses for the DST slurry spray leak case were found to be only 13% and 27% higher, respectively, than the doses estimated crediting the pit leak detector. For the AWF tank slurry spray leak, assuming failure of the pit leak detector resulted in onsite and offsite doses that were only 11% and 30% higher, respectively.

The pit leak detector will only detect the spray leak if the pit drain is closed or plugged. Should the pit drain be open the liquid waste spilled to the floor will drain without being detected. However, the open drain will connect the pit to a ventilated DST or AWF tank that will draw on the pit, limiting the quantity of aerosols that could escape from the pit. The initial volume expansion on heating up the pit air may still occur, but releases beyond that point would be small in the open drain case. The consequences of spray leak in a pit with an open drain connected to a ventilated tank are judged to be bounded by the consequences discussed above for a tank with a closed drain and a failed leak detector(s). The closed drain/failed leak detector scenario maximizes the displacement of aerosol-laden air from the pit.

3.4.2.9.4 Comparison With Guidelines. The accident doses and toxicological exposures without controls and with controls are compared with the offsite and onsite risk guidelines in Tables 3.4.2.9-1 and 3.4.2.9-2.

The accident radiological doses without controls are well above both the offsite and onsite risk guidelines. Crediting controls, the DST and AWF tank spray leak scenarios are shown to produce doses below the risk guidelines for the "anticipated" frequency category.

The toxicological sum-of-fractions is well above the risk guideline for the accident scenario without controls at the onsite receptor location. The offsite toxicological consequences for the accident without controls are below risk guidelines. The toxicological sum-of-fractions for both of the accident scenarios with controls are well below the risk guidelines, for both the onsite and offsite receptors.

3.4.2.9.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. Safety SSCs and TSR controls selected to prevent and/or mitigate potential spray leaks in TWRS waste transfer systems, based on the accident analyses presented above, are summarized in Tables 3.4.2.9-3 and 3.4.2.9-4. The safety SSCs and TSR controls in Tables 3.4.2.9-3 and 3.4.2.9-4, respectively, include the necessary and sufficient controls required for (1) the specific accident analyzed (i.e., the valve pit spray leak); (2) spray leaks from other enclosures along waste transfer routes (i.e., spray leaks from other process pits, diversion boxes, valve pits, COBs, and encasement risers); and (3) other identified hazardous conditions that are represented by the analyzed accident (i.e., spray leaks caused by backflows of

waste into service water supply systems, spray leaks from abovegrade transfer systems, spray leaks inside the 204-AR Waste Unloading Facility, spray leaks inside ventilated storage tanks, and spray leaks from buried transfer lines caused by excavation accidents). See Section 3.4.2.7.5 for additional discussion of how the selected controls prevent or mitigate hazardous conditions and accidents caused by waste transfer misrouting.

Safety Structures, Systems, and Components. Covers on waste transfer system enclosures and structures are designated as Safety-Class because they are required to mitigate the consequences of spray leaks inside transfer enclosures. During transfers, covers are required on all enclosures along transfer routes and on all enclosures where waste could be misrouted. These enclosures include valve pits, central and feed pump pits, sluice pits, DCRT pump pits, catch tank pump pits, annulus pump pits, leak detection pits, flush pits, diversion boxes, valve pits, and COBs. In addition to crediting the transfer system covers, the abovegrade portions of the process pits, diversion boxes, valve pits, and COBs have also been designated Safety-Class to provide an impaction surface that prevents a waste leak from jetting directly into the atmosphere and to limit the overall release of waste aerosols from the waste transfer-associated structures. Per agreement with DOE-ORP, this Safety-Class designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

Although the pit leak detector is credited in the accident analysis with controls, leak detectors are not specifically required to mitigate the consequences of potential spray leaks inside transfer enclosures. For enclosure leak detectors to provide a benefit in a spray leak situation, the enclosure drain must be closed or plugged to allow liquid buildup in the bottom of the pit. Closed drains cannot be assured for all TWRS transfer enclosures because some pit drains are required to be open for tank ventilation balance. Open enclosure drains limit the consequences of a spray leak inside a covered pit by preventing the displacement of aerosol-laden air through penetrations in the pit covers and prevent liquid waste from accumulating in the bottom of the pit. The open drain case therefore is bounded by the closed drain case. The consequences of a spray leak inside a covered valve pit with a closed drain and an inoperable leak detector are shown to be below risk guidelines in HNF-SD-WM-CN-096. Transfer leak detection systems are still considered as Defense-in-Depth controls (Table 3.4.2.9-5).

To protect against the backflow of waste into service water lines and the potential for spray leaks of waste from the service water system, pressure switches on the service water lines and their transfer pump interlocks or alarms (where interlocks are not available) are designated Safety-Class. The backflow prevention devices located in the raw water and other service system connections to the waste transfer system in the 204-AR Waste Unloading Facility Area leading to the Mechanical Equipment Room are also designated as Safety-Class. Other backflow prevention devices in the service water lines connected to the waste transfer systems are designated Safety-Significant to prevent general contamination of the service water system.

For temporary SST overground transfer lines, the encasement pipe and flange connections have been designated Safety-Class. The encasement pipe provides confinement for waste spray leaks from the primary line. The overground transfer line concrete shielding system is also designated Safety-Class. The Safety-Class safety function of the shielding system is to protect the

overground transfer line from damage from vehicle impact or other external events for cases where it is not practical to prohibit vehicle traffic in a tank farm during a transfer.

In the 204-AR Waste Unloading Facility, the ventilation stack CAM interlock system that will shut down the exhaust fan upon high radionuclide particulate activity is designated as Safety-Class. The ventilation stack CAM interlock system ensures that aerosols generated in the spray leak are not dispersed to the atmosphere without being filtered. This control applies to permanent and temporary ventilation systems that may be used at the 204-AR Waste Unloading Facility. Upon shutdown of the exhaust fans, the facility structure mitigates the release to below the offsite guidelines in a similar manner to the covered valve pit cases evaluated in this accident analysis. The facility structure has been designated Safety-Class consistent with the selection and crediting of transfer enclosure covers.

For potential spray leaks inside ventilated storage tanks during transfers, ventilation stack CAM interlock systems are designated as Safety-Class. The safety function of the ventilation stack CAM interlock systems is the same as for the Safety-Class ventilation stack CAM interlock system at the 204-AR Waste Unloading Facility. This control applies to permanent and temporary ventilation systems that may be used to ventilate storage tanks.

For safety SSCs that require electrical power (i.e., ventilation stack CAM interlock systems and pressure switch interlock or alarm systems [service water lines]), a supporting SSC, the tank farm electrical distribution system, is required to ensure that the chosen safety SSCs have electrical power to perform their intended safety functions.

Technical Safety Requirement Controls. The TSR controls for the prevention or mitigation of waste transfer spray leaks and represented hazardous conditions are primarily those required to ensure the operability of the Safety-Class and Safety-Significant features (i.e., operability) of the following:

- Waste transfer system covers
- Pressure switch interlock or alarm systems (service water lines)
- Service water backflow prevention devices (204-AR Waste Unloading Area only)
- 204-AR Waste Unloading Facility ventilation stack CAM interlock system
- Waste storage tank ventilation stack CAM interlock systems.

For pipe-encased transfer lines, a TSR (i.e., encasement seal loop controls) is also required to ensure that the hydrostatic test valve (or isolation valve) on encasement drain lines is not closed during waste transfers through those lines. This ensures that, in the event of a primary line leak, the encasement will not fill and pressurize.

To protect overground transfer lines from damage caused by vehicle impacts, a TSR control was defined which requires that vehicle traffic be precluded in tank farms during transfers where an overground transfer line is being used or that the concrete shielding system be installed over the overground transfer line. The shielding system is required to withstand credible vehicle impacts.

To mitigate the effects of possible spray leaks inside the 204-AR Waste Unloading Facility, the west exterior rollup door and the west exterior personnel access door must be closed during waste transfers physically connected to the 204-AR Waste Unloading Facility. This transfer control minimizes the chances for a spread of contamination from the facility caused by a spray leak inside the facility. HNF-SD-WM-CN-112, *Effects of a Spray Leak Inside the Unloading Area of the 204-AR Waste Unloading Facility*, documents the calculations that show the onsite radiological dose and toxicological exposure consequences can be exceeded if the doors providing access to the unloading area are open during a spray leak accident. The offsite consequences of the scenario analyzed do not exceed the offsite risk guidelines.

To protect key assumptions in the accident analysis with controls (HNF-SD-WM-CN-096), AWF tank waste (i.e., AWF tank liquids and AWF tank solids) can only be transferred through AWF waste transfer-associated structures. (Note that implementation of this control has been deferred until March 30, 2000 [Allen 1999b].)

To prevent excavating transfer lines during transfers, excavation controls were developed. Excavation controls require that (1) excavation permits be used in areas where waste transfer lines exist (key requirements of the permitting process are delineated in Table 3.4.2.9-4); (2) waste transfer lines outside tank farm fences must be identified with aboveground labeling; (3) when transfer lines must be uncovered to repair, replace, or install other underground utilities, compensatory controls must be established to replace the shielding provided by the removed soil before transfers are initiated to protect the exposed transfer line and to provide shielding for facility workers; (4) transfers must not be conducted through transfer lines located within approximately 4.5 m (15 ft) of ongoing excavation activities; and (5) communication links must be established between the excavation site and tank farm operations before digging.

Defense-in-Depth. In addition to the above identified safety SSCs and TSR controls which are further described in Chapters 4.0 and 5.0, respectively, other engineering and administrative controls provide further Defense-in-Depth protection for the public and workers against the risk of waste transfer system spray leaks. The Defense-in-Depth controls are identified in Table 3.4.2.9-5 along with their safety function and additional comments, as appropriate.

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Table 3.4.2.9-1. Summary of Consequences and Frequencies for Spray Leak in Structure or From Waste Transfer System Without Controls.[1]

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose[2]	Risk guideline	Calculated dose[3]	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Spray Leak from Waste Transfer System	7.4 E+00 (7.4 E+02)	5.0 E-03 (5.0 E-01)	8.3 E-02 (8.3 E+00)	1.0 E-03 (1.0 E-01)	2.5 E+01	1 (ERPG-1)	8.9 E-02	1 (PEL-TWA)	Anticipated

[1]Prior to using the consequences in this table, refer to the discussion on page 3.4.2.9-1 regarding the spray leak analysis.
[2]Dose reflects 10 min exposure duration due to assumed self evacuation.
Dose is for 24 h exposure period.
ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.4.2.9-2. Summary of Consequences and Frequencies for Spray Leak in Structure or From Waste Transfer System With Controls.[1]

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				With controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Spray Leak from Waste Transfer System - DST Slurry Spray Leak	3.9 E-03 (3.9 E-01)	5.0 E-03 (5.0 E-01)	2.2 E-06 (2.2 E-04)	1.0 E-03 (1.0 E-01)	2.4 E-02	1 (ERPG-1)	8.5 E-05	1 (PEL-TWA)	Anticipated
Spray Leak from Waste Transfer System - AWF Slurry Spray Leak	1.8 E-03 (1.8 E-01)	5.0 E-03 (5.0 E-01)	1.0 E-06 (1.0 E-04)	1.0 E-03 (1.0 E-01)	3.4 E-03	1 (ERPG-1)	1.2 E-05	1 (PEL-TWA)	Anticipated

[1]Prior to using the consequences in this table, refer to the discussion on page 3.4.2.9-1 regarding the spray leak analysis.
ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
SOF = sum-of-fractions.
TWA = time-weighted average.

Table 3.4.2.9-3. Summary of Safety Structures, Systems, and Components for Spray Leaks in Structure or From Waste Transfer System. (4 sheets)

Structures, systems, and components	Safety classification	Safety function	Comments
1.0 Spray Leaks Inside Process Pits,* Diversion Boxes, Valve Pits, and Cleanout Boxes			
1.1 Transfer system covers	Safety-Class	The safety functions of the transfer system covers are to provide an impaction surface that prevents a waste leak from jetting directly into the atmosphere and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages between adjacent surfaces that promote impingement and condensation, thus reducing the consequences of the Spray Leak in Structure or from Waste Transfer Lines accident.	Waste transfer-associated structure covers are also a mitigative feature for other accidents and provide radiation protection (i.e., shielding) for facility workers.
1.2 Abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes	Safety-Class	The safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes are to provide an impaction surface that prevents a waste leak from jetting directly into the atmosphere and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages between adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or from Waste Transfer Lines accident.	Designation of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes as safety SSCs ensure that any modifications do not compromise the physical integrity in a way that prevents the waste transfer-associated structure from meeting the intended safety function. Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.
2.0 Spray Leaks from Encasement Risers (for Pipe-in-Pipe Transfer Lines)			
No safety SSCs identified	--	--	See Table 3.4.2.9-4 for Technical Safety Requirement controls.
3.0 Spray Leaks from Service Water Supply System Components Coincident with Backflows of Waste			
3.1 Pressure switch interlock or alarm systems for service water lines (except the 204-AR Waste Unloading Facility)	Safety-Class	The safety function of the pressure switch interlock or alarm systems is to limit the volume of tank waste, which could backflow into and leak from the service water piping system, thus decreasing the consequences of the Spray Leak in Structure or from Waste Transfer accident.	The pressure switch in the service water lines connected to the waste transfer system are not automatically interlocked to some waste transfer pumps (e.g., waste transfer pumps in interfacing facilities that transfer waste to tank farms). An acceptable alternative is isolation of the service water line by two closed valves and a pressure switch with an alarm in a continuously monitored area. Pressure switch alarm procedures would require the immediate shutdown of the transfer pump on alarm.

Table 3.4.2.9-3. Summary of Safety Structures, Systems, and Components for Spray Leaks in Structure or From Waste Transfer System. (4 sheets)

Structures, systems, and components	Safety classification	Safety function	Comments
3.2 Backflow prevention devices (except 204-AR Waste Unloading Facility; see Section 5.3 below)	Safety-Significant	The safety function of the backflow prevention devices is to is to prevent a backflow leak of tank waste from the waste transfer system into the service water piping system, thus decreasing the frequency of the Spray Leak in Structure or from Waste Transfer Lines accident.	The hazardous condition of concern is contamination of the service water system and not specifically a spray leak
4.0 Spray Leaks from Single-Shell Tank Overground Transfer Lines			
4.1 Overground transfer system - encasement and connections	Safety-Class	The safety function of the OGT system encasement and connections is to provide confinement for waste spray leaks from the primary line, thus decreasing the consequences of the Spray Leak in Structure or from Waste Transfer Lines accident.	The OGT pipe encasement shall be designed to withstand the design basis earthquake and high wind.
4.2 Overground transfer system - concrete shielding system	Safety-Class	The safety function of the OGT concrete shielding system is to protect the primary line from external events (e.g., vehicle impacts), thus decreasing the frequency of the Spray Leak in Structure or from Waste Transfer Lines accident.	Also provides radiation shielding protection for facility workers.
5.0 Spray Leaks Inside the 204-AR Waste Unloading Facility			
5.1 Ventilation stack CAM interlock system	Safety-Class	The safety function of the ventilation stack CAM interlock system is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the Spray Leak in Structure or from Waste Transfer Lines accident.	Aerosol-laden air could eventually saturate the HEPA filters, resulting in their failure. Control applies to permanent and temporary ventilation systems.
5.2 204-AR Waste Unloading Facility structure	Safety-Class	The safety functions of the 204-AR Waste Unloading Facility structure are to provide impaction surfaces that prevent a waste leak from jetting directly into the atmosphere and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages with adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or from Waste Transfer Lines accident.	--
5.3 Backflow prevention devices (204-AR Waste Unloading Area only)	Safety-Class	The safety function of the backflow prevention devices located in the 204-AR Waste Unloading Area is to prevent a backflow of waste into the raw water or other service systems leading to the Mechanical Equipment Room where a spray leak could occur, thus decreasing the frequency of the Spray Leak in Structure or from Waste Transfer Lines accident.	Prevents backflow should isolation valves leak or should a transfer pump be inadvertently turned on during flushing or chemical addition operations.

Table 3.4.2.9-3. Summary of Safety Structures, Systems, and Components for Spray Leaks in Structure or From Waste Transfer System. (4 sheets)

Structures, systems, and components	Safety classification	Safety function	Comments
6.0 Spray Leaks Inside Actively Ventilated Tanks			
6.1 Ventilation stack CAM interlock systems	Safety-Class	The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the Spray Leak in Structure or from Waste Transfer Lines accident.	Aerosol-laden air could eventually saturate the HEPA filters, resulting in their failure. Control applies to permanent and portable ventilation systems.
6.2 Stack CAM and interlock to exhaust fan (For portable exhausters, applies only to the following configurations or activities: (a) the portable exhauster is operating; and (b) the portable exhauster is installed on tanks whose waste transfer system is "physically connected" to any active waste transfer pump that is not under an administrative lock. Note: For definition of "physically connected," refer to Section 5.3.2, "Accident Analysis Scenarios." For definition of "active," refer to HNF-SD-WM-TSR-006, Section 1.1, "ACTIVE.")	Safety-Class	Ensure exhaust fan is shut down should exhaust HEPA filters break through	Aerosol-laden air could eventually saturate the HEPA filters, resulting in their failure. The stack CAM and interlock system on a portable exhauster is not required to be Safety-Class if: (a) the tank's waste transfer system is not "physically connected" to any active waste transfer pump(s); (b) "physically connected" active waste transfer pumps are under administrative lock; or (c) the portable exhauster is not operating.
7.0 Spray Leaks from Buried Transfer Lines Uncovered and Damaged During Excavation			
No safety SSCs identified	–	–	See Table 3.4.2.9-4 for Technical Safety Requirement controls.

*Includes valve pits, central and feed pump pits, sluice pits, leak detection pits, annulus pump pits, service pits, and catch tank pump pits.

CAM = continuous air monitor. OGT = overground transfer.
HEPA = high-efficiency particulate air (filter). SSC = structure, system, and component.

Table 3.4.2.9-4. Summary of Technical Safety Requirement Controls for Spray Leaks in Structure or From Waste Transfer Lines. (5 sheets)

Systems, structures, or components	Safety function	Comments
General Applicability		
Transfer system cover removal controls • Obtain management approval prior to removing a transfer system cover • Provide continuous monitoring for waste leaks while covers are removed • Establish procedures that identify required operator responses to the detection of a waste leak.	Provides compensatory measures for cover removal during transfers and minimizes risk from unplanned transfers.	--
Transfer pump administrative lock controls	Eliminates motive force for unplanned transfers	To address spray leaks that may occur during inadvertent waste transfer pump starts, the waste transfer-associated covers and service water pressure detection systems shall be operable or the waste transfer pump(s) physically connected to waste transfer-associated structures shall be locked out
Emergency Preparedness Program with the following key element: • Response procedures.	Mitigate the consequences of a spray leak.	--
1.0 Spray Leaks Inside Process Pits,[a] Diversion Boxes, Valve Pits, and Cleanout Boxes		
1.1 Transfer system covers	Operable covers mitigate spray leak by knocking down/confining the spray. This control ensures covers are operable when the waste transfer-associated structure is physically connected to the waste transfer piping during waste transfer	An exception is allowed if the waste transfer-associated structure is separated by two locked valves and continuous monitoring for spray leaks is provided

Table 3.4.2.9-4. Summary of Technical Safety Requirement Controls for Spray Leaks in Structure or From Waste Transfer Lines. (5 sheets)

Systems, structures, or components	Safety function	Comments
1.2 Transfer controls		–
• Transfer system configuration management		
- Perform waste transfer system operations by approved procedures	Prevents mistransfers into waste transfer-associated structures.	
- Establish and maintain controlled status of waste transfer systems as-built and jumper configuration	Prevents mistransfers into waste transfer-associated structures.	
- Perform double valve isolation on interconnected lines	Double valve isolation on lines interconnecting with the transfer route provides compensatory protection to prevent a spray leak or mistransfer in an interconnected waste transfer-associated structure when the cover is off	
- Perform waste transfer operations by approved procedures	Prevents mistransfers into waste transfer-associated structures.	
- Perform independent route verification during transfer setup (includes items such as verification of correct pump and correct valve alignment).	Prevents mistransfers into waste transfer-associated structures.	
• AWF tank transfer limitations.	Prevents the transfer of AWF tank liquids and AWF tank solids through DST waste transfer-associated structures.	Protects key accident analysis assumptions. (Note that implementation of the AWF tank transfer limitations has been deferred until March 30, 2000 [Allen 1999].)
- AWF tank waste (i.e., AWF tank liquids and AWF tank solids) can only be transferred through AWF waste transfer-associated structures.		
2.0 Spray Leaks from Encasement Risers (Pipe-in-Pipe Transfer Lines)		
2.1 Encasement seal loop controls (i.e., hydrostatic test valves are not in the closed position)	Ensures that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure	Control prevents pressurizing encasement risers which could result in abovegrade spray release

Table 3.4.2.9-4. Summary of Technical Safety Requirement Controls for Spray Leaks in Structure or From Waste Transfer Lines. (5 sheets)

Systems, structures, or components	Safety function	Comments
3.0 Spray Leaks from Service Water Supply Components Coincident with Backflows of Waste		
3.1 Service water pressure detection systems (except the 204-AR Waste Unloading Facility)	Ensure operability of pressure switch interlock or alarm systems. This ensures pressure switch interlock or alarm systems are operable during waste transfers, transfer line flushing, pump priming, and transfer line pressure testing.	Includes the pressure switch/waste transfer pump interlock systems used for connections to the permanent service water system and for pressure switch interlock systems used for connections to temporary, abovegrade service water systems. Temporary abovegrade water lines are used for flushing and priming of SST salt well systems. Note: Pressure switch/waste transfer pump interlocks or alarm shall be operable during waste transfers to prevent backflow of waste into service water lines. To address backflow of waste during inadvertent waste transfer pump starts, either the pressure switch/waste transfer pump interlock shall be operable or the waste transfer pump(s) physically connected to the service water line shall be locked out.
4.0 Spray Leaks from Single-Shell Tank Overground Transfer Lines		
4.1 Transfer controls • Transfer system configuration management - Prior to waste transfer through overground waste transfer piping, verify either vehicle restrictions (i.e., vehicle access limitations to the tank farm) or concrete shielding systems surrounding the overground transfer line portion of the transfer route are in place.	Ensure the OGT line is protected from vehicle collisions that could result in a loss of integrity of the primary and encasement pipes. Ensure worker radiation protection by design feature or administrative control.	--
4.2 Encasement seal loop controls (i.e., hydrostatic test valves are not in the closed position)	Ensures that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure.	Control prevents pressurizing encasement which could result in a spray release.
5.0 Spray Leaks Inside the 204-AR Waste Unloading Facility		
5.1 Ventilation stack CAM interlock systems	Ensures interlock is operable during transfers out of the facility and during tank farm transfers through routes physically connected to the unloading facility	Control applies to permanent and temporary ventilation systems.
5.2 Backflow prevention devices (204-AR Waste Unloading Area only)	Prevents contamination of the raw water system via backflow of waste and prevents spray leak in Mechanical Equipment Room from waste entering raw water or other service systems.	Backflow prevention system is required when raw water and other service systems are physically connected.

Table 3.4.2.9-4. Summary of Technical Safety Requirement Controls for Spray Leaks in Structure or From Waste Transfer Lines. (5 sheets)

Systems, structures, or components	Safety function	Comments
5.2 Transfer Controls • Transfer System Configuration Management - Verify that the west exterior roll-up door and the west exterior personnel access door are closed during waste transfers physically connected to the 204-AR Waste Unloading Facility.	Ensures doors are closed to mitigate the effects of potential spray leaks inside the unloading area of the 204-AR Waste Unloading Facility.	–
6.0 Spray Leaks Inside Actively Ventilated Tanks		
6.1 Ventilation stack CAM interlock systems	Ensures interlock is operable during transfers into and out of the actively ventilated tank and during tank farm transfers through routes physically connected to the actively ventilated tank.	Control applies to permanent and temporary ventilation systems.
7.0 Spray Leaks from Buried Transfer Lines Uncovered and Damaged During Excavation[c]		
7.1 Excavation controls • Obtain an excavation permit prior to excavating in areas where underground waste transfer lines exist.[b] The excavation permitting process shall provide for the following. - Composite map for the planned excavation site indicating approximate horizontal and vertical locations of waste transfer piping, piping encasements, and transfer structures. - Radiological evaluation for the planned excavation activity, including the issuance of a radiological work permit as required. - Physical marking of the ground surface to identify waste transfer lines based on the composite map and a documented subsurface scan. - Approval of the proposed excavation activity by TWRS cognizant facility engineer and facility manager or delegate. - All excavations within 4.5 m (15 ft) of an ongoing waste transfer are prohibited.	Prevents leaks in waste transfer lines caused by excavation activities by ensuring: • Excavation activities are not inadvertently performed near waste transfer lines during waste transfers • Excavation activities are carefully controlled when required near waste transfer lines.	–

Table 3.4.2.9-4. Summary of Technical Safety Requirement Controls for Spray Leaks in Structure or From Waste Transfer Lines. (5 sheets)

Systems, structures, or components	Safety function	Comments
• Encased pipe (concrete encased and pipe-in-pipe encased) outside of the tank farm boundaries shall be identified with permanent aboveground labels.	Prevents leaks in waste transfer lines caused by excavation activities by ensuring that excavation activities are not inadvertently performed near waste transfer lines outside of tank farms	
• Waste transfers are prohibited through lines uncovered by excavation activities unless compensatory controls are established (e.g., vehicle access limitations, concrete shielding system installed).	Prevents transfers through waste transfer lines that are uncovered by excavation activities that could cause worker radiation doses exceeding limits established by the radiation protection program	
• Prior to initiation of an excavation activity, identify emergency response actions and establish communications between the excavation site and operations personnel to ensure immediate shutdown of waste transfers when leakage is indicated.	Mitigates waste transfer leaks caused by excavation activities by prompt shutdown of the waste transfer pump	

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

[a]Includes valve pits, central and feed pump pits, sluice pits, leak detection pits, annulus pump pits, service pits, and catch tank pump pits.

[b]Excavation activities include: (1) movement of earth by mechanical means below existing grade, or (2) any hand-digging to a depth greater than approximately 1 ft.

[c]The controls in this section are provided to address the accident that was originally present in Section 3.4.2.10.

AWF = Aging Waste Facility.
CAM = continuous air monitor.
OGT = overground transfer.
SST = single-shell tank.

Table 3.4.2.9-5. Summary of Defense-in-Depth Controls for Spray Leak in Structure or From Waste Transfer Lines. (2 sheets)

Control	Safety function	Comments
General Applicability		
Leak testing of jumpers	Reduce the likelihood of a spray leak from a failed or misaligned jumper, when testing is performed with water. Reduce the duration of a spray leak when leak test is performed during initial stages of waste transfer.	Repositioned jumpers are leak tested with pressurized water (where available) before initiating waste transfers. Cameras lowered through penetrations in the cover block are used to verify initial jumper integrity during the leak test. Where water is not readily available, the jumper leak test is performed during the initial stages of the transfer.
Encasement and transfer leak detection systems	Limit duration of spray release. The liquid fraction of the release will drain past the leak detector.	Leaks that produce low flow rates of liquid may not be detected.
Drains in waste transfer system structures	Allow routing of spray leak condensates to tanks and limit the release of spray leak aerosols from waste transfer system structures attached to active ventilation systems.	--
Specific to Spray Leaks from Service Water Supply Components Coincident with Backflows of Waste		
Service pit leak detection systems (where installed)	Detect leaks of waste/service water in service pits.	--
Valve position limit switches/interlocks (where installed and maintained)	Prevent backflow of waste into service water supply by stopping transfer pump.	Permissive interlock allows waste transfer pump to operate only when the hydrostatic test valves are closed
Check valves (salt well systems)	Prevent backflow of waste into the service water supply.	--
Specific to Spray Leaks from Single-Shell Tank Overground Transfer Lines		
Heat tracing and insulation (where provided)	Heat tracing prevents freezing and potential rupture of primary line. Insulation also provides additional mitigative barrier to spray release.	--
Specific to Spray Leaks Inside the 204-AR Waste Unloading Facility		
Ventilation system deentrainer, heater, and HEPA filters	The deentrainer and heater remove moisture and reduce the relative humidity of air exhausted from unloading area. These items prevent moisture plugging of downstream HEPA filters. The HEPA filters remove radioactive aerosol particulates generated in the spray from the exhaust air.	The potentially pressurized portion of piping in the facility where spray leaks could occur is near the catch tank vent inlet
CAMs in the unloading area and mechanical equipment room	May detect spray leak.	Workers trained in responding properly to all alarms.
HEPA filter high differential pressure interlock	Indicate plugging of HEPA filters, which could be caused by aerosols generated in a spray leak	High differential pressure interlock will shutdown the exhaust fan, mitigating potential consequences.
HEPA filter low differential pressure alarm	Indicative of gross breakthrough of filter, which could result in a release of aerosols without controls	Workers trained in responding properly to all alarms.

Table 3.4.2.9-5. Summary of Defense-in-Depth Controls for Spray Leak in Structure or From Waste Transfer Lines. (2 sheets)

Control	Safety function	Comments
Specific to Spray Leaks Inside Actively Ventilated Tanks		
Ventilation system deentrainer, heater, and HEPA filters	The deentrainer and heater remove moisture and reduce the relative humidity of air exhausted from the storage tank. These items prevent moisture plugging of downstream HEPA filters. The HEPA filters remove radioactive aerosol particulates generated in the spray from the exhaust air.	–
HEPA filter high differential pressure alarms	Indicate plugging of HEPA filters, which could be caused by aerosols generated in a spray leak; activation of alarm will notify operator to switchover to redundant train or manually shutdown exhaust fan	Workers trained in responding properly to all alarms.
HEPA filter low differential pressure interlocks	Detect gross breakthrough of filter. Activation of interlock will result in switchover to redundant train or automatic shutdown of exhaust fan.	–

Note: Some of the controls is in this list may be determined to be Safety-Class or Safety-Significant for other accidents.

CAM = continuous air monitor.
COB = cleanout box.
HEPA = high-efficiency particulate air (filter).
SSC = structure, system, and component.

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Section 3.4.2.10
Spray Leak from Underground Waste Transfer Lines

NOTE: The information originally contained in this section was incorporated in Sections 3.4.2.7, 3.4.2.8, and 3.4.2.9.

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3.4.2.11 Tank Bump. A tank waste thermal rollover phenomenon, known as a tank bump, is a rapid steam pressurization of tank headspace. A tank bump is a safety concern because of the potential for a release of aerosolized waste to the environment.

Certain initial conditions define which tanks are at risk for a tank bump. For an SST to be at risk for a tank bump, the waste heat generation rate must be greater than 7,600 W (26,000 Btu/h) with a waste height of 6.7 m (22 ft) to result in a waste temperature at or above atmospheric saturation temperature (WHC-SD-WM-SARR-010, *Heat Removal Characteristics of Waste Storage Tanks*). At heat generation rates below 7,600 W (26,000 Btu/h) in SSTs, heat transfer by natural conduction to the surrounding soil removes enough heat to maintain waste temperatures below the atmospheric saturation temperature. At lower waste heights, a greater heat generation rate is required to obtain the saturation temperature of the waste (see Table 3.4.2.11-1). This is because the majority of the heat loss is out the top of the tank (especially in actively ventilated tanks). Therefore, greater waste heights impair heat loss resulting in greater temperatures (WHC-EP-0709, *Estimation of Heat Load in Waste Tanks Using Average Vapor Space Temperatures*). Similar characteristics are expected in DSTs.

Saturation temperature of tank liquid waste is 104 °C (220 °F) (WHC-SD-WM-ER-198, *Development of a Dynamic Computer Simulator for Aging Waste Tank Operations and Safety Assessment*) at atmospheric pressure because of the dissolved salt content in the waste. Hydrostatic head (i.e., the pressure caused by the weight of a fluid) for the total waste height (including sludge) increases local pressure and, therefore, local saturation temperature.

An amount of sludge is also required for a tank bump. Tank sludge contains the highest density of heat producing isotopes, is highly viscous, and therefore is generally nonconvective. The heat source in sludge provides a location for steam to generate. The nonconvective nature of the sludge means that any heat generated must be conducted out (conduction is efficient only near the surface of the sludge). The high viscosity and hydrostatic head trap the steam generated in the sludge.

Hanford Site waste tanks that presently have a heat generation rate of about 7.3 kW (25,000 Btu/h) or higher and contain sludge are summarized in Table 3.4.2.11-2.

With the exception of specific watch-list DSTs, all other DSTs (i.e., 241-AN, 241-AP, 241-AW, 241-SY Tank Farms, and the AWF tanks) are active. This means that they can receive waste such that a waste composition with a heat generation rate greater than 7,600 W (26,000 Btu/h) could result from normal operations. All SSTs are out of service and will not receive any additional waste; therefore, only those SSTs that currently have a heat generation rate above 7,600 W (26,000 Btu/h) have the potential for a tank bump.

Tanks 241-A-104 and 241-A-105 are not considered to have the proper initial conditions for a tank bump despite their estimated heat load. This is because they have been without engineered heat removal (i.e., active ventilation) for several years and the waste temperatures have stabilized well below 104 °C (220 °F).

Tank 241-C-105 contains only 1.6 m (5.2 ft) of waste and, therefore, requires a heat load in excess of 9.4 kW (32,000 Btu/h) to be considered a tank bump threat. Because the tank contains only 7.3 kW (25,000 Btu/h) there is sufficient margin to exclude it from consideration. Tank 241-SX-109 similarly contains only 2.4 m (8.0 ft) of waste, but its estimated heat load of 9.1 kW (31,035 Btu/h) is within 5% of the required heat load, which is not sufficient margin to exclude it from consideration.

Tank 241-C-106 and several tanks in the 241-SX tank farm, therefore, are the only SSTs with the proper initial conditions for a tank bump. These tanks contain much less water than the DSTs and are less likely to generate the large volumes of steam required for large tank bumps. They may, however, still generate and release significant quantities of steam. This type of event is classified as a steam release event and is bounded by the tank bump.

3.4.2.11.1 Scenario Development. Engineered heat removal methods are implemented when heat removal by natural conduction to the soil is insufficient to maintain acceptable operating temperatures. The most common heat removal method is active ventilation of the tank headspace. An initiating event is the result of (1) equipment failures or operational decisions that result in impaired heat transfer from the sludge to the supernate or heat transfer from the supernate to the tank ventilation system, or (2) operational decisions that increase the heat generation capacity of the waste to above the heat removal capacity of the tank.

Tank waste temperature begins to rise when the engineered heat removal mechanism (e.g., active ventilation) is lost or certain operational decisions (see previous) are implemented. The rate of the temperature increase is highly dependent on the heat generation rate and is somewhat dependent on the quantity of waste involved. A large quantity of waste with a low power density can act to retard the heating process because of the amount of waste that must be heated. Equipment (e.g., mixer pumps) or operating modes (e.g., high sludge loading) can also cause waste temperatures to rise above local saturation temperature.

Steam generation represents the onset of tank bump conditions. The time lapse from the initiating event to steam generation is the time it takes the tank waste to rise from operating temperature to saturation temperature after the initiating event. Operating temperature is the equilibrium temperature resulting from the tank heat generation rate and the total (i.e., natural and engineered) heat removal rate. Steam generation begins when any portion of the waste reaches local saturation temperature. The waste at the bottom center of the tank is the most likely portion to reach local saturation temperature. The temperature profile is expected to extend parabolically from the point of initial steam generation, as depicted in Figure 3.4.2.11-1. Once the steam is generated, it is trapped in the settled sludge because of the high viscosity of the sludge and the high hydrostatic head. If the waste did not contain sludge or if the hydrostatic head were low, the steam would simply escape from the waste. In addition, steam is generated in small quantities and cannot pressurize the headspace when the sludge has low water content.

Steam is released when collected steam causes the sludge to become buoyant (i.e., unstable) despite the high viscosity of the sludge and the high hydrostatic head. The time between vapor generation and vapor release is directly proportional to the sludge height.

The stored vapor can be released before the sludge becomes buoyant by mechanically agitating the sludge (i.e., abrupt mixing) or by artificially increasing the amount of stored steam (e.g., injecting compressed air into the sludge) thus initiating the tank bump. High heat sludge is carried with the vapor as it travels through the overlying supernate.

When steam and high heat sludge travel through the supernate, the heat is transferred to the supernate. This heat transfer condenses the steam and raises the temperature of the supernate. The cycle of steam generation and release then begins again at a higher temperature. Condensation is suppressed if the supernate is at or near saturation temperature when the steam is released. When condensation is suppressed, the steam and sludge travel completely through the supernate to the tank headspace and the volume of steam increases. The steam volume increases when it travels through the supernate for several reasons including (1) the reduction in hydrostatic head lowers the local saturation temperature, therefore, supernate that was held in liquid form from the pressure suddenly flashes to steam, (2) the existing steam expands as pressure (hydrostatic head) reduces, and (3) supernate at or near local saturation absorbs heat from the high heat sludge and flashes to steam.

A large steam volume released into tank headspace results in a pressure increase. The heat and rising steam produce fluid velocities high enough to carry liquid and solid particles into tank risers. The pressure and high velocity fluid force steam, waste particles, and headspace vapor out of the tank through any existing filtered and unfiltered pathways. When this environmental release, or bump occurs, a large portion of the tank liquid and steam is near the saturation temperature and, therefore, susceptible to phase changes. These phase changes cause the released waste to expand and contract rapidly, resulting in an oscillating headspace pressure. The peak headspace pressure of this event is proportional to the waste temperature when the bump occurs (WHC-SD-WM-CN-022, *Evaluation of Potential and Consequences of Steam Bump in High Heat Waste Tanks and Assessment and Validation of GOTH Computer Code*).

The quantity of waste material released to the environment during a tank bump event depends on the size, shape, and location of release paths. The time required to relieve the pressure generated by the tank bump depends on the size of the release path. Pressure relief for smaller release paths takes more time, therefore, a pressurization would last longer. The shape and location of release paths can also affect bump releases by affecting the momentum of the fluid. Fluid impacts in nonlinear pathways reduce momentum. The fluid directly above the bump origination point will have the highest momentum during a tank bump; therefore, any release path near the center of the bump will receive the majority of the waste.

As shown in Table 3.4.2.11-2, the AWF tanks currently represent the upper bound on heat load for the tanks that pose a tank bump threat. The AWF tanks also have the highest radionuclide content (i.e., highest ULD). AWF Tank 241-AZ-101 has a significantly higher heat load than any other AWF tank and, therefore, a postulated tank bump in Tank 241-AZ-101 was used as the bounding accident in this analysis.

The following assumptions were made in the Tank 241-AZ-101 accident analysis to ensure conservative results (WHC-SD-WM-CN-043, *Tank Bump Consequence Analysis*):

- Consequences of the bounding tank bump were calculated based on the entire waste volume rising to local saturation temperature with a uniform temperature profile, as depicted in Figure 3.4.2.11-2. This calculation involved a maximum amount of tank waste and ensured conservative results.

- No credit was taken for condensation effects in the supernate. Without taking credit for the condensation effects the supernate is assumed to reach 104 °C (220 °F).

Accident Scenario Without Controls. For the accident scenario without controls it was postulated that active ventilation for Tank 241-AZ-101 would be lost for an indefinite amount of time. The temperature of the tank waste was postulated to rise above local saturation throughout the tank.

Accident Frequency Without Controls. The frequency without controls of a Tank 241-AZ-101 tank bump was categorized as "unlikely" based on the expected frequency of the initiating event and heating of tank waste.

For example, given Tank 241-AZ-101 waste conditions of 60 °C (140 °F) in the sludge and between 19 °C (66 °F) and 29 °C (84 °F) in the supernate (current waste conditions), a ventilation outage of approximately 90 days duration would be required for vapor generation. Extreme conditions would be necessary to cause such an extended outage. The most frequent event judged to be capable of producing such extreme conditions is an earthquake that caused widespread damage such that the ventilation system was rendered inoperable and repair crews were assigned elsewhere.

Accident Scenario With Controls. The controls selected for the tank bump scenario are preventive in nature and are presented in Section 3.4.2.11.5. These controls prevent tank waste from reaching saturation temperatures, thereby precluding the tank bump event. Tank waste temperature is monitored by Safety-Significant temperature monitoring systems. Should a rising temperature trend be detected, the controls are set to provide a minimum of 1 week during which time potential heat sources (e.g., mixer pumps) would be eliminated and waste cooling techniques (e.g., ventilation, water addition) would be restored or initiated.

Accident Frequency With Controls. With the controls identified for the tank bump scenario in Section 3.4.2.11.5, the accident is prevented from occurring. See Section 3.4.3 for an assessment of the residual risk associated with the potential failure of controls.

3.4.2.11.2 Source Term Analysis. The Tank 241-AZ-101 waste conditions were modeled with the GOTH thermal hydraulics computer code, a transient computer program used to model multiphase flow (WHC-SD-WM-CN-022). The mass of waste released (i.e., the release fraction and inventory at risk) was an output of the GOTH code.

The entire amount of released waste was conservatively assumed to be respirable (i.e., respirable fraction equals 1). The waste types assumed for radiological dose consequence calculations were AWF tank liquids and solids. The waste types assumed for toxicological consequences were DST liquids, DST solids, and nonslurry gas.

Accident Source Term Without Controls. The postulated release paths used in the GOTH model were open risers of various diameters (WHC-SD-WM-CN-022). Various diameters were used to model various tank configurations. The results accurately predict the quantity of waste released because of pressurization effects and conservatively estimate the quantity of waste released as the result of fluid dynamics. This is because the model assumes a direct path to the atmosphere for any waste with sufficient momentum; however, release pathways in tank configurations are tortuous and would severely reduce the momentum of any released waste.

GOTH model estimates showed that a tank bump in Tank 241-AZ-101 without cover blocks would release 0.1 L (0.03 gal) of respirable solids and 21 L (5.6 gal) of respirable liquids (WHC-SD-WM-CN-043) with a peak tank headspace pressure of about 7 kPa gauge (1 lb/in.^{2} gauge) (WHC-SD-WM-CN-022). The entire head space volume of 1,900 m^3 (67,000 ft^3) is assumed to be released during the event. Cover blocks are assumed to not be in place because they serve a mitigative function.

The pressure pulse of 7 kPa (1 lb/in.^{2} gauge) is approximately 2.5 times the minimum pressure required for HEPA filter blow out. Therefore, HEPA filter damage in most tank farm ventilation systems should be expected during a tank bump event. However, the dose contribution of HEPA filter blow out is insignificant compared with the dose consequences of the tank bump. The contribution of HEPA filter blow out is not included in the consequences presented in Table 3.4.2.11-3 but is quantified in Section 3.3.2.4.2.

Accident Source Term With Controls. No source term with controls was derived as the accident controls are preventive in nature.

3.4.2.11.3 Consequence Analysis. The onsite and offsite dose consequences and toxicological exposures were determined using the methodology discussed in Section 3.4.1 (WHC-SD-WM-CN-043).

Consequences Without Controls. The radiological and toxicological consequences of this release are presented in Table 3.4.2.11-3.

Consequences With Controls. No consequences with controls were derived as the accident controls are preventive in nature.

Key Parameters and Assumptions.

- **Fluid Dynamics (Ventilation Path)**—The quantity of waste released given by the GOTH model contained two components (WHC-SD-WM-CN-022). One

component is the quantity of waste forced out of the tank because of increased pressure. The other component (the fluid dynamic portion) is the quantity of waste with enough fluid velocity to be ejected from the tank. The fluid dynamic portion is an artifact of the simple tank geometry used in the GOTH model (i.e., the vent paths were modeled as open pipes). Most GOTH simulations produced a bump directly below the vent path. Some simulations produced a bump near, but slightly away from, the vent path. The reduction in radiological dose consequences caused by this single change was one order of magnitude. Actual tank configuration yields no direct path to the atmosphere such that the fluid dynamic portion of the release (and therefore the total quantity released) would be significantly reduced from the values presented in this analysis. The effect this would have on the radiological dose consequences cannot be quantified but is judged to be approximately another order of magnitude.

- **Saturated Sludge Volume**—Only saturated sludge becomes involved in a tank bump. Therefore, the severity of the tank bump is directly related to the volume of saturated sludge. It is expected that the tank sludge will first reach saturation temperature in the bottom center of the tank with isothermal lines extending out parabolically (Figure 3.4.2.11-1). The fraction of sludge that is saturated in this situation is much less than one. To perform a bounding analysis, it was assumed that all of the tank sludge is at local saturation temperature such that isothermal lines are linear (Figure 3.4.2.11-2). This involves the entire sludge volume in the bump event.

- **Condensation**—Computer simulation shows that the tank sludge will reach saturation temperature long before the tank supernate. Therefore, any steam generated in the sludge that is subsequently released will transfer heat to the supernate and condense. For this analysis, condensation was suppressed such that all released steam retained the maximum amount of heat energy. The amount of conservatism in this assumption varies with the length of the ventilation outage. For short outages such that the sludge becomes saturated while the supernate temperature remains well below saturation, condensation would probably prevent the release of any waste material caused by a tank bump. For long ventilation outages, the supernate temperature can rise to saturation such that very little, if any, condensation would occur during a tank bump event, resulting in a release of waste material similar to the values calculated.

3.4.2.11.4 Comparison With Guidelines. Table 3.4.2.11-3 contains a comparison of tank bump consequences with the risk guidelines. Onsite consequences without controls for both radiological and toxicological exposure are above the risk guidelines. Therefore, to protect the onsite worker from both radiological and toxicological hazards of a tank bump, the event must be controlled. Offsite consequences are below the risk guidelines in all cases. Therefore, no controls are required to protect the offsite public.

3.4.2.11.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems, and Components. Because none of the offsite consequences exceed risk guidelines, no Safety-Class SSCs are identified for the tank bump accident. Because the onsite guidelines are exceeded, Safety-Significant SSCs are required (Table 3.4.2.11-4).

Tank waste temperature monitoring systems are Safety-Significant SSCs. The safety function is to monitor tank sludge and supernate temperature and to identify when operator action is required. These systems provide information to operators on the existing temperature in tanks susceptible to a tank bump (or similar steam release event). If specified limits are reached, operators can take actions necessary to prevent exceeding temperatures at which significant tank bumps or steam release events can occur.

It is recognized that there is a radial temperature distribution in the tank. The position of the thermocouple tree within the tank is not significant to temperature measurement because of the conservative assumptions in the accident analysis. The bounding accident consequences were based on the entire sludge volume being saturated with steam and being released in total through the entire supernate volume, which was assumed to be at or near the saturation temperature (WHC-SD-WM-CN-022). These assumptions allowed calculation of the bounding event but are very conservative. If portions of the tank not covered by a thermocouple element have localized heating, any potential steam release would be significantly below the bounding consequences because of the smaller volumes. Also, consequences would be reduced from any small localized heating because the small steam releases would minimize solids carryover into the air stream, which contributed to the majority of the dose consequences. Lastly, the majority of the SST topography is not considered wet enough nor having sufficient confinement phenomena (e.g., supernate head, thickened sludge) to match the assumed accident of total sludge saturation.

More flexible temperature limits can be used if credit is taken for the effects of hydrostatic head. Therefore, the tank waste level detection systems are also Safety-Significant SSCs.

For safety SSCs that require electrical power (i.e., temperature monitoring systems and tank level detection systems), a supporting SSC, the tank farm electrical distribution system, is required to ensure that the chosen safety SSCs have electrical power to perform their intended safety functions.

Technical Safety Requirement Controls. The TSR controls selected to prevent tank bumps are listed in Table 3.4.2.11-5. These controls establish tank waste temperature limits, ensure operability of tank waste temperature monitoring instrumentation and transfer controls to ensure that waste transfers do not create in-tank conditions conducive to bump initiation. The controls selected also provide protection against a postulated "chemical runaway" accident (Section 3.4.2.6).

Defense-in-Depth. Existing prevention and mitigation features support Defense-in-Depth as shown in Table 3.4.2.11-6. Existing features that may preclude this accident scenario from occurring include the following:

- **Active Ventilation or Other Heat Removal Mechanism**—Enough heat must remain in the tank to reach the local saturation temperature of the waste before steam can be generated.

- **Sludge Mixing**—Mixed sludge is incapable of storing steam. Steam can only be trapped in settled sludge.

Pit cover blocks will mitigate an in-process tank bump accident. Cover blocks impede aerosol transport from the tank and, therefore, reduce the quantity of waste released. Additional mitigation can be obtained from any other feature that acts to seal the tank.

References

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-EP-0709, 1993, *Estimation of Heat Load in Waste Tanks Using Average Vapor Space Temperatures*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-022, 1996, *Evaluation of Potential and Consequences of Steam Bump in High Heat Waste Tanks and Assessment and Validation of GOTH Computer Code*, Rev. 0B, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-043, 1996, *Tank Bump Consequence Analysis*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-198, 1993, *Development of a Dynamic Computer Simulator for Aging Waste Tank Operations and Safety Assessment*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-350, 1995, *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 East Areas*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-454, 1996, *Tank Characterization Report for Double-Shell Tank 241-AY-102*, Rev. 0-A, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-010, 1995, *Heat Removal Characteristics of Waste Storage Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Figure 3.4.2.11-1. Limited Sludge Volume at Local Saturation Temperature (Best Estimate Temperature Profile).

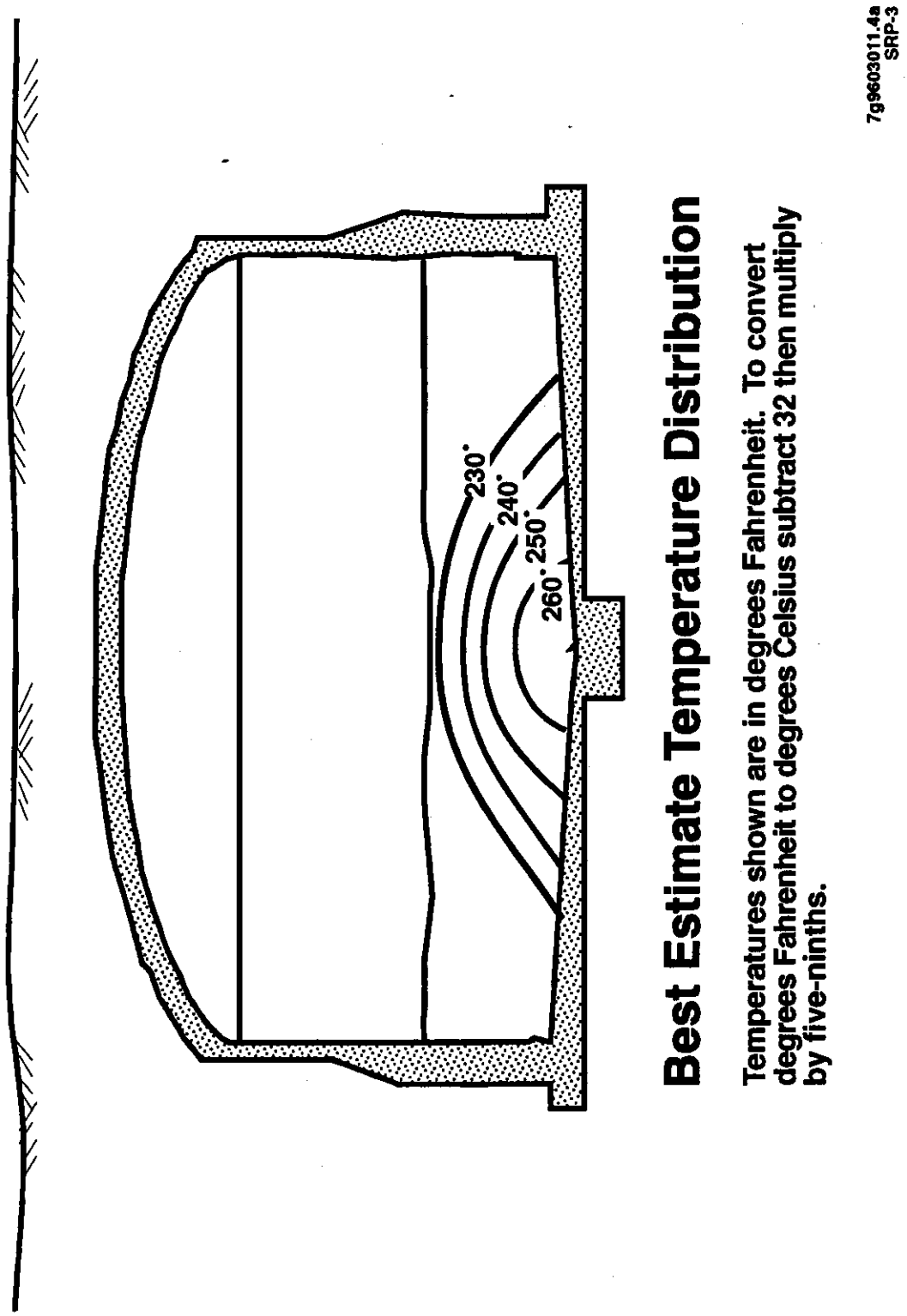

Figure 3.4.2.11-2. Entire Sludge Volume at Local Saturation Temperature (Conservative Temperature Profile).

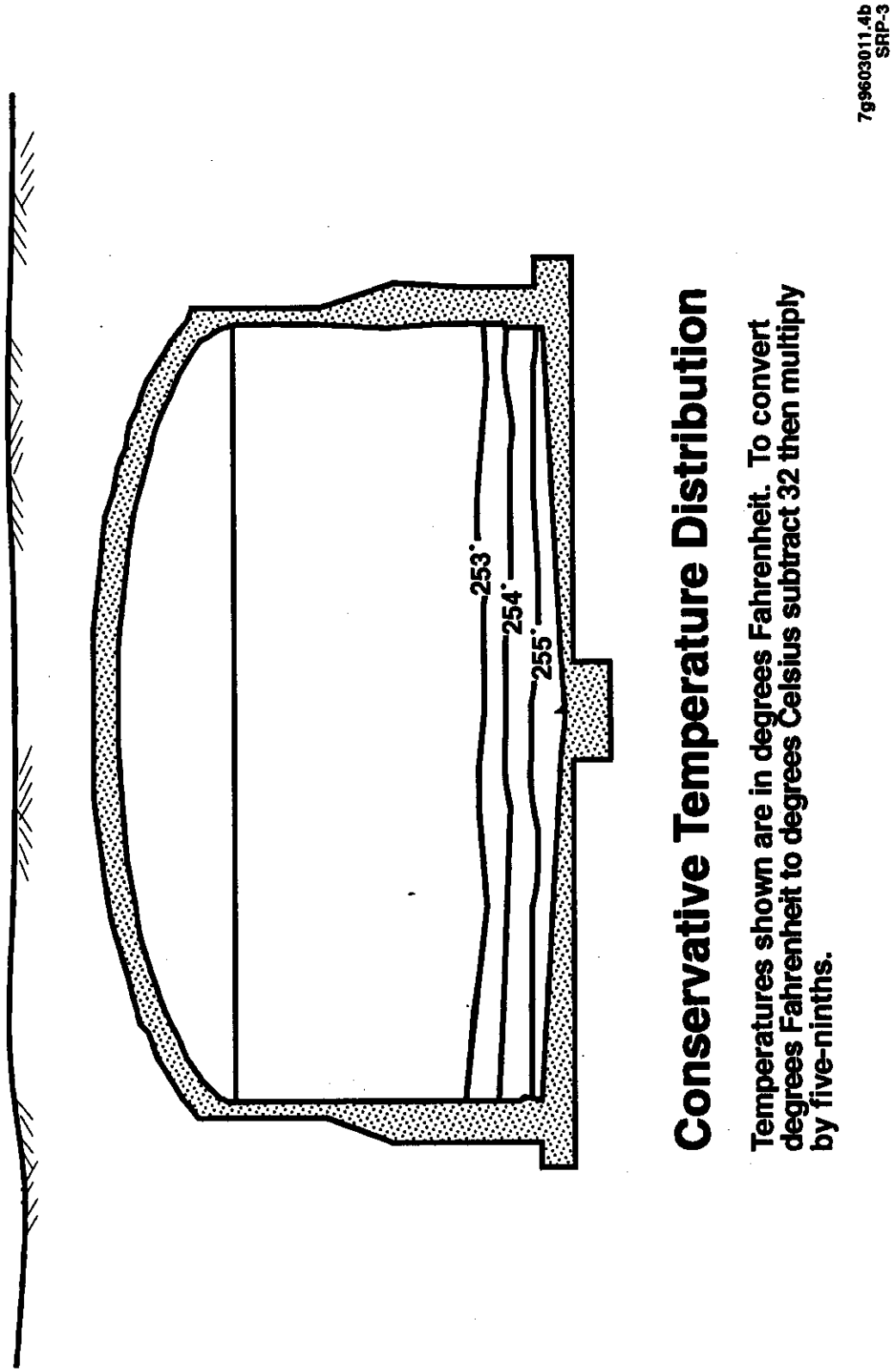

Table 3.4.2.11-1. Heat Load Required in Single-Shell Tank to Obtain a Waste Temperature of 104 °C (220 °F).

Waste height	Heat load
6.7 m (22 ft)	7.6 kW (26,000 Btu/h)
4.6 m (15 ft)	8.2 kW (28,000 Btu/h)
2.4 m (8 ft)	9.4 kW (32,000 Btu/h)

Source: WHC-SD-WM-SARR-010, 1995, *Heat Removal Characteristics of Waste Storage Tanks*, Rev.1, Westinghouse Hanford Company, Richland, Washington.

Table 3.4.2.11-2. Hanford Site Waste Tanks With Heat Loads Greater Than 7.3 kW (25,000 Btu/h).

Tank	Waste level	Heat load
Single-Shell Tanks		
241-A-104	0.3 m (0.9 ft)	15.3 kW (52,120 Btu/h)
241-A-105	0.4 m (1.2 ft)	14.7 kW (50,000 Btu/h)
241-C-105	1.6 m (5.2 ft)	7.3 kW (25,000 Btu/h)
241-C-106	2.3 m (7.6 ft)	32.2 kW (110,000 Btu/h)
241-SX-103	6.2 m (20.2 ft)	8.1 kW (27,742 Btu/h)
241-SX-107	1.1 m (3.6 ft)	16.1 kW (54,779 Btu/h)
241-SX-108	1.2 m (3.9 ft)	16.4 kW (55,983 Btu/h)
241-SX-109	2.4 m (8.0 ft)	9.1 kW (31,035 Btu/h)
241-SX-110	0.7 m (2.3 ft)	11.9 kW (40,767 Btu/h)
241-SX-111	1.3 m (4.2 ft)	17.9 kW (61,013 Btu/h)
241-SX-112	1.0 m (3.2 ft)	12.2 kW (41,594 Btu/h)
241-SX-114	1.8 m (5.9 ft)	17.2 kW (58,692 Btu/h)
Double-Shell Tanks		
241-AN-102	varies	12.0 kW (41,000 Btu/h)
241-AN-103	varies	13.2 kW (45,000 Btu/h)
241-AN-104	varies	17.2 kW (58,692 Btu/h)
241-AN-105	varies	7.3 kW (25,000 Btu/h)
241-AN-107	varies	7.9 kW (27,000 Btu/h)
241-AW-101	varies	9.4 kW (32,000 Btu/h)
241-AW-104	varies	10.8 kW (37,000 Btu/h)
241-SY-101	varies	11.7 kW (40,000 Btu/h)
Aging Waste Facility Tanks		
241-AY-101	varies	15.7 kW (53,600 Btu/h)[a]
241-AY-102	varies	9.2 kW (31,300 Btu/h)[b]
241-AZ-101	varies	89.4 kW (305,000 Btu/h)[c]
241-AZ-102	varies	62.1 kW (212,000 Btu/h)[a]

Source: WHC-SD-WM-SARR-010, 1995, *Heat Removal Characteristics of Waste Storage Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[a]WHC-SD-WM-ER-350, 1995, *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 East Areas*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[b]WHC-SD-WM-ER-454, 1996, *Tank Characterization Report for Double-Shell Tank 241-AY-102*, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

[c]WHC-SD-WM-ER-198, 1993, *Development of a Dynamic Computer Simulator for Aging Waste Tank Operations and Safety Assessment*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. This corresponds to the bounding heat load value used in the accident analysis rather than the most recent available data, which is significantly lower.

Table 3.4.2.11-3. Summary of Consequences and Frequencies of Tank Bump Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Tank Bump	2.5 E+00 (2.5 E+02)	5.0 E-02 (5.0 E+00)	2.2 E-03 (2.2 E-01)	5.0 E-03 (5.0 E-01)	4.9 E+03	1 (ERPG-2)	7.3 E-01	1 (ERPG-1)	Unlikely

ERPG = Emergency Response Planning Guidelines.
SOF = sum-of-fractions.

Table 3.4.2.11-4. Summary of Safety Structures, Systems, and Components for Tank Bump.

Structures, systems, and components	Safety classification	Safety function	Comments
Temperature monitoring systems[a]	Safety-Significant	The safety function of the temperature monitoring systems is to provide tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding temperatures at which significant tank bumps or steam release events could occur, thus decreasing the frequency of the Tank Bump accident.	A steam release event is a specific type of tank bump. This SSC also serves to protect the potential occurrence of a chemical runaway accident involving organic salt-nitrate (Section 3.4.2.6).
Tank level detection systems[b]	Safety-Significant	The safety function of the tank level detection systems is to support the implementation of the level-dependent tank temperature controls, thus decreasing the frequency of the Tank Bump accident.	This SSC also serves to protect the potential occurrence of a chemical runaway accident involving organic salt-nitrate (Section 3.4.2.6).

[a]Applies to 241-C-106, -SX-103, -SX-107, -SX-108, -SX-109, -SX-110, -SX-111, -SX-112, and -SX-114; all double-shell tanks; and all Aging Waste Facility tanks.

[b]Applies all double-shell tanks and Aging Waste Facility tanks.

SSC = structure, system, and component.

Table 3.4.2.11-5. Summary of Technical Safety Requirement Controls for Tank Bump. (2 sheets)

Control	Safety function	Comments
SST waste temperature controls[a] • The waste temperature shall be ≤205 °F (96 °C). DST and AWF tank temperature controls[b] • The waste temperature shall be either: ≤195 °F (91 °C) in all levels of the waste <u>OR</u> ≤195 °F (91 °C) in the top 4.6 m (15 ft) the waste <u>AND</u> ≤215 °F (102 °C) in the waste below 4.6 m (15 ft).	Ensure that tank waste temperature monitoring system (and, if required, tank waste level monitoring system) is operable and that temperatures at which a tank bump or steam release event could occur are not reached.	The specific waste temperature limits for SSTs and DSTs/AWF tanks were established during the development of the TSRs by the accident analysts and operations personnel. Temperatures must be maintained below those that could result in a tank bump or steam release. Control also provides protection against a postulated "chemical runaway" accident (Section 3.4.2.6).
Transfer controls • Waste compatibility controls - Evaluate pumped and received tank prior to waste transfers to ensure that controls for tank bumps are applied to the final state of the tank.	Ensure final tank states remain within analyzed topography of the tank bump accident.	Control also provides protection against a postulated "chemical runaway" accident (Section 3.4.2.6).
Process instrumentation and measuring and testing equipment • Identification and traceability of TSR-related instrumentation and equipment shall be maintained • Instrumentation and equipment shall have a functional test or calibration as applicable at appropriate intervals to verify required performance	Ensures instrumentation used to monitor temperature is maintained.	Control also provides protection against a postulated "chemical runaway" accident (Section 3.4.2.6).

Table 3.4.2.11-5. Summary of Technical Safety Requirement Controls for Tank Bump. (2 sheets)

Control	Safety function	Comments
Process instrumentation and measuring and testing equipment (continued) • Records shall be maintained to provide evidence that the instrumentation and equipment are within the functional test or calibration when used		

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington..

[a]Controls apply to 241-C-106, -SX-103, -SX-107, -SX-108, -SX-109, -SX-110, -SX-111, -SX-112, and -SX-114.

[b]Controls apply to all DSTs and AWF tanks.

AC = Administrative Control.
AWF = Aging Waste Facility.
DST = double-shell tank.
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 3.4.2.11-6. Defense-in-Depth Controls for Tank Bump.

Control	Safety function	Comments
Active SST ventilation[a]	Maintain sludge and supernate temperatures below the required control levels for tanks with a potential for tank bump.	Control also provides protection against a postulated "chemical runaway" accident (Section 3.4.2.6).
Active DST/AWF tank ventilation[b]	Maintain sludge and supernate temperatures below the required control levels for tanks with a potential for tank bump.	Control also provides protection against a postulated "chemical runaway" accident (Section 3.4.2.6).
ALCs (where installed)	Mixing sludge makes it incapable of storing steam.	--
Cover blocks (or other tank sealing features)	Provide containment and confinement function in the event of a tank bump and limit onsite and offsite radiological dose and toxicological exposures.	WHC-SD-WM-CN-043 quantifies the reduction in consequences provided by cover blocks.
Emergency preparedness	Protect onsite personnel and facility workers from unnecessary radiological and toxicological exposure in the event of a tank bump.	Emergency preparedness program identified as a TSR-level control for other accidents.

Source: WHC-SD-WM-CN-043, 1996, *Tank Bump Consequence Analysis*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

[a]Controls apply to 241-C-106, -SX-103, -SX-107, -SX-108, -SX-109, -SX-110, -SX-111, -SX-112, and -SX-114.

[b]Controls apply to the primary tank and annulus ventilation systems on all DSTs and AWF tanks.

ALC = air lift circulator.
AWF = Aging Waste Facility.
DST = double-shell tank.
SST = single-shell tank.
TSR = Technical Safety Requirement.

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3.4.2.12 Natural Phenomena. Requirements in DOE 5480.23, *Nuclear Safety Analysis Reports*, and the associated implementing guidance in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, mandate that accidents initiated by natural phenomena are to be considered in accident analyses for safety analysis reports. Natural phenomena accident assessments differ from the assessments of accidents with other initiators. Natural phenomena assessments must address specific design (or evaluation) performance goals for new and existing SSCs depending on the potential consequences of accidents as outlined in DOE 5480.28, *Natural Phenomena Hazards Mitigation*, and summarized for the Hanford Site in Chapter 1.0, Table 1-33. DOE 5480.28 invokes the criteria and guidance in the following standards:

- DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*
- DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*
- DOE-STD-1022-94, *Natural Phenomena Hazards Characterization Criteria*
- DOE-STD-1023-95, *Natural Phenomena Hazards Assessment Criteria*
- DOE-STD-1024-92, *Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites.*

Table 3.3.2.1.3-1 summarizes the natural phenomena analyzed as accident initiators in the Tank Waste Remediation System facilities. A number of potential accidents were postulated for each natural phenomenon listed in Table 3.3.2.1.3-1 and were assigned to the consequence and frequency categories as discussed earlier in this chapter. Based on the hazard evaluation and accident analysis selection process, accident types initiated by high wind, lightning, and seismic events were selected for further analysis as summarized in the following subsections. The seismic load, wind load, and lightning strike frequencies are consistent with those found in Chapter 1.0, Table 1-32.

3.4.2.12.1 Natural Phenomena—High Wind. High winds at TWRS facilities pose a natural phenomenon hazard because winds could initiate single or multiple accidents from a common cause. Straight winds and tornados at the Hanford Site are characterized in Chapter 1.0, Section 1.4. Accidents initiated by high winds are assessed to establish the need for and effectiveness of safety SSCs and TSR controls. To ensure that the level of conservatism is appropriate for facility characteristics, such as hazards to people and the environment as well as cost, DOE-STD-1020-94 provides guidance for facility-appropriate design wind speeds, depending on the facility hazard category and Performance Category of equipment. For existing Hazard Category 2 facilities with Performance Category 3 equipment such as the underground storage tanks, a straight "fastest mile" wind speed of 113 km/h (70 mph) and a return frequency of 10^{-3}/yr is used for the evaluation basis (Chapter 1.0, Table 1-33). Analysis of wind-blown

missiles is not required per DOE-STD-1020-94, for existing Hazard Category 2 facilities with Performance Category 3 equipment. More severe wind speeds are considered only in beyond evaluation basis accident assessments.

For the accidents considered here, wind gusts rather than straight winds are appropriate to characterize accident likelihoods. High wind gusts are expected events at the Hanford Site as shown in Table 3.4.2.12.1-1. Wind gusts in excess of 100 km/h (62 mi/h) have been experienced during every month of the year, with the highest wind gusts recorded at the Hanford Meteorological Station (mid-way between the 200 East and 200 West tank farm areas) of 129 km/h (80 mi/h) in January 1972 and January 1990.

A number of potential wind-related accidents were identified by the hazard analysis. On the basis of hazard evaluation and accident analysis selection process, four accidents initiated by high wind were selected for further analysis. Three associated accident scenarios involve (1) the transport of waste samples, (2) the collapse of a crane boom, and (3) a tear or puncture of a flexible receiver bag. As illustrated below, these three wind scenarios are analyzed as independent accidents because it is unlikely that a single wind storm would initiate all three accidents. However, the likelihood of any of the wind-initiated accidents without controls is the sum of the likelihoods of the three accidents presented, which is in the "anticipated" frequency bin. The fourth accident also includes rain or snow and is analyzed in Section 3.3.2.4.10, "Sodium Fire."

Part A. Waste Transport Vehicle Accident. Vehicle crashes that occur during high wind storms are usually associated with wind gusts that cause a sudden side load on a vehicle, resulting in a loss of control of the vehicle. The more susceptible vehicles are those with a high cross-wind surface area to weight ratio and a high center of gravity. Such characteristics are more commonly present in lightly loaded tractor-trailer rigs than in vehicles used to transport sample casks.

Tank waste samples are routinely collected and sent to onsite laboratories for sample analysis and waste characterization. After collected, waste samples are placed in either an onsite transport cask or a pig, and then loaded onto a transport vehicle. After being loaded onto the transport vehicle, "ownership" of the waste transfers from the Tank Waste Remediation System to Transportation and Packaging. The containers are transported using WHC-SD-TP-SARP-002, *Safety Analysis Report for Packaging Onsite Transport Cask*, as the safety and Authorization Basis for the onsite transport cask or WHC-SD-TP-SARP-001, *Sample Pig Transfer System Safety Analysis Report for Packaging (On-site)*, for pigs. Each document shows compliance with the transport performance standards of 10 CFR 71, "Packaging and Transportation of Radioactive Materials for Transport," through either cask design or a combination of cask design and administrative controls. Accident assessments, including potential failure mechanisms for the containers (crush, puncture, fire) are documented explicitly in the safety analysis reports for packaging. Because the safety analysis reports for packaging provide the Authorization Basis for cask and pig transport, their transport is not considered further in this Final Safety Analysis Report.

Other types of vehicle accidents within TWRS that contribute to the uncontrolled release of material from TWRS facilities are addressed in this safety analysis report. In addition, the safety analysis (i.e., hazard and accident analysis) structure is generalized to support the determination of the applicability of the Authorization Basis to additional vehicle-related accidents as they are postulated or discovered.

Part B. Crane Boom Collapse in High Winds.

- **Scenario Development**

Accident Scenario Without Controls—This scenario postulates that a mobile crane operating with heavy loads in a tank farm is subjected to a high wind gust. The gust collapses the crane boom and causes the crane load to fall on an underground waste storage tank riser. In turn, the riser then punctures the tank dome. The contribution of the crane boom collapse to the load impact is uncertain. The boom would absorb energy during its deformation, but depending on its failure mode, could also add to the total impact. Because of the uncertainty in impact load, the consequences of the crane boom collapse and dome puncture are assumed bounded by the drop of a mixer pump in a pit as analyzed in Section 3.4.2.1.

Accident Frequency Without Controls—The frequency of occurrence of the wind-induced failure was estimated qualitatively based on (1) a conservative crane drop frequency of 3×10^{-4} per lift, and (2) an assumption that no more than five percent of such drops are related to high winds. This assumption is believed conservative because available failure statistics do not show any wind-induced failures, perhaps because crane lifts are usually not performed in high winds. Using an estimated 1,000 heavy lifts per year above underground tanks results in a drop frequency without controls of 1.5×10^{-2}/yr. Finally, it is estimated that no more than 10% of the load drops would hit risers and cause a puncture of the dome. This estimate is based on crane operators' tendency to avoid areas with potentially vulnerable equipment below and to minimize the length of load paths for heavy loads. Although the collapse of the crane boom could increase the impact area over the tanks and thereby increase the likelihood of impacting a tank riser, the collapse would also distribute the impact over a larger area and may not have enough impact to cause a riser to puncture the dome. Therefore, the likelihood of a wind-induced drop of a heavy load without controls that results in a punctured tank dome is estimated as 1.5×10^{-3}/yr or in the "unlikely" frequency category.

Accident Scenario With Controls—After imposing controls to preclude crane operations in high winds, the crane boom collapse in high winds is prevented; therefore, no accident with controls was developed.

Accident Frequency With Controls—Implementing controls prevents the accident; therefore, no accident frequency with controls was developed.

- **Source Term Analysis**

  Source Term Without Controls—The source term without controls for a wind-induced load drop is bounded by that developed in Section 3.4.2.1 for the drop of a mixer pump.

  Source Term With Controls—The accident is prevented by the selected controls; therefore, a source term with controls was not developed.

- **Consequence Analysis**

  Consequences Without Controls—Dispersion of contaminants (plume width) increases with increasing wind speed such that at any down-wind position, the exposure a receptor receives is less in high winds than in stable atmospheric conditions. Therefore, the consequences without controls of a wind-induced load drop are bounded by and included in the consequence analyses developed in Section 3.4.2.1 for the mixer pump load drop where stable atmospheric conditions were assumed.

  Consequences With Controls—Controls prevent the accident; therefore, consequences with controls were not developed.

- **Comparison With Guidelines**—The onsite and offsite radiological and toxicological consequences of the wind-induced crane boom collapse is represented and bounded by the consequences of the drop of a mixer pump in a pit. Mixer pump analysis is located in Section 3.4.2.1. The crane boom collapse resulting in the puncture of a riser through the tank dome is considered more likely than the drop of a mixer pump in a pit because of the number of heavy lifts over the tanks, and the consequences of the punctured dome would be less severe than the drop of a mixer pump in a pit. Because the scenario without controls exceeds the onsite toxicological risk guidelines, controls are required.

- **Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls**

  Natural Phenomena—High Wind Controls—High wind controls are outlined below and apply to all mobile crane activities.

  Safety Structures, Systems, and Components—No Safety-Class or Safety-Significant SSCs are associated with high winds.

Technical Safety Requirement Controls—TSR controls for operations in high winds are given in Table 3.4.2.12.1-2. Mobile crane activities used for lifting cover blocks from pump and valve pits and for supporting equipment being installed or removed from waste tanks are managed through compliance with DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*, with close coordination of tank farm operations. The manual requires that wind speed be considered before starting a lift and prohibits lifts if weather conditions are adverse to safe load-handling operations.

Defense-in-Depth—As shown in Table 3.4.2.12.1-3, restrictions on operations during high winds are credited as Defense-in-Depth controls. The Hanford Meteorological Station issues weather advisories including high wind warnings.

Part C. Flexible Receiver Bag Failure. A flexible receiver is an engineered system of components used to wash, contain, transport, and dispose of contaminated equipment upon removal from underground waste storage tanks. The flexible receiver is bolted onto a tank riser and is supported by four hydraulically controlled legs that rest on the ground surface above the tank dome. The first flexible receiver station above the riser contains a spray ring that uses high-pressure water to wash contaminants from the equipment; contaminated wash-water drains back to the underground tank. The equipment is then withdrawn through a pipe spool into a flexible receiver bag that provides containment of the contaminated equipment. The cylindrical receiver bag is initially folded (like an accordion), and then unfolds as a crane withdraws the equipment from the tank riser. The bag is sealed at the top, and as the equipment is withdrawn above the tank riser, the bottom is sealed with a cable. Cutters then separate the flexible bag from unused bag material. The flexible receiver bag inflates with air that is drawn from the tank head space, through the riser, and to the washing station. When used on a tank that is ventilated actively and drawn down to a slight vacuum, the bag tends to collapse around the instrument with a minimum of air inflation. The flexible receiver bags are made of an abrasion-resistant, tear-resistant fabric.

- **Scenario Development**

Accident Scenario Without Controls—A wind-induced failure of a flexible receiver bag containing contaminated equipment removed from an underground waste storage tank was postulated. Failure of the flexible receiver bag occurs when the equipment is withdrawn above the riser and just before sealing the bottom. High winds cause the crane and supported equipment to swing and tear or puncture the bag in the area where the bottom seal would have been placed. Because the equipment is fully withdrawn, it offers no resistance against the riser, and only moderate resistance by the bag guide rods. The maximum contaminants are present when the equipment is fully withdrawn.

Accident Frequency Without Controls—During preoperational testing, crane operators reported difficultly in precisely positioning a loaded flexible receiver bag in winds greater than about 32 km/h (20 mi/h). For winds up to 64 km/h (40 mi/h), it is assumed crane operators could manage a loaded flexible receiver bag if necessary. For wind gusts at 97 km/h (60 mi/h) it is assumed that a loaded flexible receiver bag would be essentially out of control. Therefore, it is assumed that winds gusts of 97 km/h (60 mi/h) are sufficient to cause the flexible receiver bag to swing and puncture or tear the fabric. As listed in Table 3.4.2.12.1-1, such wind gusts occur once every 2 yr. Operations estimate that flexible receiver, withdraw equipment no more than 24 days/yr. Without controls, the combined frequency of operating the flexible receiver bag and having wind speeds of 97 km/h (60 mi/h) is then 3×10^{-2} occurrences per year ("anticipated").

Accident Scenario With Controls—The flexible receiver bag failure accident without controls is within the risk guidelines; therefore, a case with controls was not calculated.

Accident Frequency With Controls—A case with controls was not calculated.

- **Source Term Analysis**

Source Term Without Controls—Source term calculations and details are given in WHC-SD-WM-CN-061, *Releases from Failure of a Flexible Receiver Bag in High Winds*, and summarized here. Because of the high-pressure washing jets in the lower portion of the flexible receiver bag, most concentrated tank wastes are removed from the equipment and drained to the tank before the equipment enters the flexible receiver bag. Some surface contaminants remain on the equipment, and the washing jets create aerosols that enter the flexible receiver bag as it inflates with air from the tank headspace. Field readings show radiation levels near the flexible receiver bag are less than about 1.0×10^{-1} Sv/h (1.0×10^{1} rem/h). This external dose rate corresponds to a source of 11.6 L (3 gal) of tank waste (aging waste liquids) distributed over a 9.1-m (30-ft) section of the flexible receiver bag. As discussed below, the wastes are partitioned among the aerosols in the vapor space of the flexible receiver bag and on the internal surfaces of the instrument and bag.

The inside surfaces of the flexible receiver bag and instrument were assumed to have a water film carrying the 11.6 L (3 gal) of contaminants. These surfaces were assumed to drain to the ground when the flexible receiver bag was torn by high winds. High winds would cause aerodynamic entrainment and suspension of the waste from the ground. Using DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and*

Respirable Fractions for Nonreactor Nuclear Facilities, the bounding airborne release rate for suspension of contaminants deposited on soil was 9×10^{-5}/h. The resulting time-dependent source term from the soil was 1.04×10^{-3} L/h.

To bound the release from the vapor space inside the flexible receiver, it was assumed that the aerosol content could be no greater than 100 mg/m^3 (quasi-stable maximum). Using a bounding mass density of 1 kg/m^3, the material at risk in the 2.7 m^3 vapor space of the bag was determined to be 2.7×10^{-4} L. Therefore, the resulting source term (puff release) from the vapor space was 2.7×10^{-4} L.

The integrated source term for 12 h (used for onsite exposures) was 1.28×10^{-2} L, and the source term for 24 h (used for offsite exposures) was 2.52×10^{-2} L.

Source Term With Controls—No source term with controls was developed because the case without controls was within the risk guidelines.

- **Consequence Analysis**

Consequences Without Controls—Consequences of a wind-induced failure of the flexible receiver bag are listed in Table 3.4.2.12.1-4. The radiological doses without controls are based on a combined puff release of aerosols from the vapor space of the flexible receiver and a time-dependent release of aerosols from liquids dispersed in soil. The ULD corresponded to aging waste liquids. Likewise, the sum-of-fractions was based on a combined DST liquid puff release and a DST liquid time-dependent release. DST liquids include the toxic constituents of aging waste. The dispersion coefficients χ/Q corresponded to the 99.5th percentile with plume meander correction. This is initially very conservative because the accident occurs because of the high wind. However, high winds would not be expected to persist for the 12- and 24-h exposure durations for onsite and offsite individuals, respectively. The supporting calculations are documented in WHC-SD-WM-CN-061.

Consequences With Controls—No consequences with controls were developed because the case without controls was within the risk guidelines.

- **Comparison With Guidelines**—The comparisons of the consequences without controls to the risk guidelines are shown in Table 3.4.2.12.1-4. In all cases, the radiological and toxicological exposures are below the risk guidelines. Because the scenario consequences without controls are within the risk guidelines, no safety SSC or TSR controls are required. The flexible receiver bag failure accident

without controls is within the risk guidelines; therefore, a case with controls was not evaluated. Defense-in-Depth controls are identified that prevent the accident (Table 3.4.2.12.1-3).

- **Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls**

  Natural Phenomena—High Wind Controls. High wind controls are summarized below and apply to operation of the flexible receiver bag in high winds.

  Safety Structures, Systems, and Components—No Safety-Class or Safety-Significant SSCs are associated with operation of the flexible receiver bag in high winds.

  Technical Safety Requirements Controls—TSR controls for operations in high winds are shown in Table 3.4.2.12.1-2. Mobile crane activities used for lifting cover blocks from pump and valve pits and for supporting equipment being installed or removed from waste tanks are managed through compliance with DOE/RL-92-36 with close coordination of tank farm operations. The manual requires wind speed be considered before starting a lift and prohibits lifts if weather conditions are adverse to safe load-handling operations.

  Defense-in-Depth—Use of the flexible receiver constitutes a critical lift subject to the requirements of DOE/RL-92-36. The manual requires wind speed be considered before starting a lift and prohibits lifts if weather conditions are adverse to safe load-handling operations (Table 3.4.2.12.1-3). Also, the contractor Health and Safety Plan restricts tank farm operations during periods of high winds. The Hanford Meteorological Station issues weather advisories including high wind warnings.

3.4.2.12.2 Natural Phenomena—Lightning. Thunderstorms can produce lightning strikes that discharge the electrical potential between the atmosphere and the ground. Although rare, ash fall and dust storms can also produce lightning. Lightning strikes at the tank farms are a safety concern because they are potential initiators of (1) flammable gas deflagrations, (2) organic solvent fires, or (3) organic salt-nitrate reactions. Sections 3.4.2.2, 3.4.2.4, 3.4.2.6, 3.4.2.12.3, 3.4.3.2.1, and 3.4.3.2.2 discuss the consequences of these three accident scenarios. This section addresses the likelihood of accident scenarios initiated by lightning and establishes the basis for lightning controls.

Operational records report no incidence of lightning strikes on a tank riser or appurtenance during the 50-yr history of the Hanford Site. However, these records do indicate that a number of lightning strikes have hit 200 East and 200 West Area structures, power poles,

and transformers. Recent research on lightning as a potential accident initiator at the tank farms is reported in WHC-SD-WM-ES-387, *Probability, Consequences, and Mitigation for Lightning Strikes to Hanford Site High-Level Waste Tanks*. WHC-SD-WM-ES-387 establishes that, after conservatively accounting for detection frequency and uncertainties, the observed lightning strike frequency at the tank farms is 0.06 strikes/yr/km^2 (0.16 strikes/yr/mi^2). The report discusses a number of factors necessary for a lightning strike to initiate an accident including the following:

- Lightning must strike a tank riser, appurtenance, or the ground in the immediate vicinity of a tank farm.

- At the time of the strike, the tank must contain a flammable gas above the LFL or a concentration of organic solvent or organic nitrate sufficient to support combustion.

- The discharge must pass from the riser or appurtenance into the tank through conduction paths such as instrumentation lines or other equipment connected to the tank riser or by arcing across nonconductive segments.

- The discharge must have sufficient energy to create an arc or cause ohmic heating to temperatures high enough to ignite the materials.

The three lightning scenarios (in-tank flammable gas ignition, organic solvent fire, organic salt-nitrate reaction) have been evaluated independently. Analysis to date suggests accident independence (i.e., an accident of one type is unlikely to lead to another); however, the likelihood of any lightning-initiated accident is the sum of the likelihoods of the three accidents. The sum of the likelihoods places the three scenarios in the "unlikely" frequency category.

Part A. Flammable Gases Ignited by Lightning. Lightning is one of a number of different potential ignition sources for flammable gas deflagrations. The scenario for lightning as an initiator for a flammable gas deflagration requires a flammable condition to exist at the time the lightning strike occurs. Several scenarios that have the potential to create flammable conditions are described in Section 3.4.2.2. One group of scenarios addresses flammable conditions that result from a GRE. GREs can occur spontaneously or can be induced by waste-disturbing activities or seismic events. The accident frequencies associated with these scenarios described in Section 3.4.2.2 already consider lightning as a possible ignition source. The evaluation for the frequency of flammable gas deflagrations that result from GREs include lightning as an initiator and conclude that lighting is not a major contributor to the overall accident frequency. Some reduction in accident frequency is obtained by stopping waste-disturbing operations in tanks where induced GREs are postulated (i.e., tanks assigned to flammable gas Facility Group 1, 2, or 3) when lightning is in the area. This cessation of operations reduces the likelihood that flammable conditions may exist when lightning is a potential ignition source.

Source terms and consequences from flammable gas deflagrations for a number of scenarios are described in Section 3.4.2.2. The source terms and consequences as described in Section 3.4.2.2 are applicable to deflagrations caused by lightning as well as those caused by other ignition sources.

- **Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls**

  Natural Phenomena—Lightning Controls for Flammable Gas Deflagrations. Lightning controls are outlined below and apply to all tanks with the potential for concentrations of flammable gas in excess of the LFL.

  Safety Structures, Systems, and Components—No Safety-Class or Safety-Significant SSCs are associated with lightning protection.

  Technical Safety Requirements Controls—Because waste-disturbing operations and activities may increase the likelihood of flammable gases being present above the LFL because of induced GREs, a TSR control is imposed as illustrated in Table 3.4.2.12.2-1.

  Exemptions to Lightning Controls—The lightning controls do not apply to intrusive activities related to the operation of air-lift circulators (ALCs) or mixer pump operation (for all mixer pump operating modes) associated with the 241-AZ-101 Mixer Pump Test, Project W-151, once global waste mixing has begun (i.e., initiation of pump operation). For exemption of ALCs or mixer pump operation activities due to the flammable gas ignited by lightning hazard, see FSAR Addendum 4, Section 3.4.2.3.1, "Flammable Gas Deflagration."

  Defense-in-Depth—Additional items that provide Defense-in-Depth protection against impacts from lightning strikes are shown in Table 3.4.2.12.2-2.

Part B. Organic Solvent Fire Initiated by Lightning.

- **Scenario Development**

  Accident Scenario Without Controls—This scenario postulates that a lightning strike ignites the waste in an individual underground waste storage tank containing a combustible concentration of organic solvents.

  Accident Frequency Without Controls—Using the observed 0.06 strikes/yr/km^2 (0.02 strikes/yr/mi^2) as an estimate of lightning strike

frequency, and considering the cross-sectional area of a large underground tank to be bounded by 500 m^2 (5,400 ft^2), the likelihood of a direct strike over a particular tank is 3×10^{-5}/yr and can be characterized as "extremely unlikely." This value is considered appropriate for use as an organic solvent initiator where a comparatively high energy is required to ignite the solvent. Assuming 20 tanks are capable of supporting an organic solvent fire (WHC-SD-WM-CN-032, *Analysis of Consequences of Postulated Solvent Fires in Hanford Site Waste Tanks*) and the likelihood of ignition given a lightning strike is unity, the expected frequency for all tanks would be 6×10^{-4} fires/yr ("unlikely"). A lightning strike ignition probability of one is conservative because (1) data shows lightning strikes at the Hanford Site are less energetic than lightning typical of this latitude (WHC-SD-WM-ES-387), (2) the tank geometry must be favorable to arcing in or near the waste surface, and (3) most energy would preferentially dissipate through the comparatively conductive steel shells, concrete, and rebar.

Accident Scenario With Controls—The accident scenario with controls is the same as the scenario without controls.

Accident Frequency With Controls—Although lightning-related controls have been identified as discussed below, their ability to prevent ignition of organic solvents or otherwise mitigate the scenario has not been quantified. Therefore, the frequency of the scenario with controls is conservatively represented by the scenario without controls ("unlikely"). Based on the assumption for the accident frequency without controls, the efficiency of the lightning protection system would have to be about 80% to change the accident frequency with controls to the "extremely unlikely" category and 99.8% to change to the "beyond extremely unlikely" category.

- **Source Term Analysis**

Source Term Without Controls—The source term without controls for the ignition of organic solvents is developed in Section 3.4.2.4.

Source Term With Controls—The source term with controls is the same as the source term without controls.

- **Consequence Analysis**

Consequences Without Controls—The onsite and offsite radiological and toxicological exposures resulting from lightning-initiated organic solvent fires and other initiators are presented in Section 3.4.2.4.

Consequences With Controls—The consequences with controls of the ignition of organic solvents are the same as the consequences without controls.

- **Comparison With Guidelines**—The consequences without controls of the ignition of organic solvents by lightning presented in Section 3.4.2.4 exceed the risk guidelines; therefore, controls are required.

- **Summary of Safety Structures, Systems, and Components and Technical Safety Requirements Controls**

Natural Phenomena—Lightning Controls for Organic Solvent Fire. Lightning controls are outlined below and apply to all tanks with the potential for combustible concentrations of organic solvents.

Safety Structures, Systems, and Components—No Safety-Class or Safety-Significant SSCs are associated with lightning protection.

Technical Safety Requirement Controls—Because intrusive activities may increase the likelihood of ignition of organic solvent fires, a TSR control is imposed as illustrated in Table 3.4.2.12.2-1.

Exemptions to Lightning Controls—The lightning controls do not apply to intrusive activities related to the operation of ALCs or mixer pump operation (for all mixer pump operating modes) associated with the 241-AZ-101 Mixer Pump Test, Project W-151, once global waste mixing has begun (i.e., initiation of pump operation). For the controls selected to mitigate the risk associated with the organic solvent fire initiated by lightning, the operation of the ALCs or mixer pumps is exempted because the equipment is installed and its operation has no bearing on the geometry relative to the generation of an arc.

Defense-in-Depth—Additional items that provide Defense-in-Depth protection against impacts from lightning strikes are shown in Table 3.4.2.12.2-2.

Part C. Organic Salt-Nitrate Reaction Initiated by Lightning.

- **Scenario Development**

Accident Scenario Without Controls—This scenario postulates that lightning strikes an individual underground waste storage tank containing organic nitrates and initiates an organic nitrate-salt reaction.

Accident Frequency Without Controls—For the initiation of an organic salt-nitrate reaction, the lightning must strike a tank that can sustain an organic salt-nitrate reaction. As for organic solvent ignition, the frequency of a direct strike over a particular tank is conservatively assessed at 3×10^{-5}/yr. The likelihood of ignition of organic salts given a lightning strike is taken to be unity. A lightning strike ignition probability of one is conservative because (1) data shows lightning strikes at the Hanford Site are less energetic than lightning typical of this latitude (WHC-SD-WM-ES-387), (2) the tank geometry must be favorable to arcing in or near the waste surface, and (3) most energy would preferentially dissipate through the comparatively conductive steel shells, concrete, and rebar. Assuming 10 tanks are capable of supporting an organic salt-nitrate reaction (Section 3.4.2.6) and a 1.0 likelihood of a lightning-induced organic salt-nitrate reaction, the expected frequency would be 3×10^{-4} fires/yr ("unlikely").

Accident Scenario With Controls—The accident scenario with controls is the same as the scenario without controls.

Accident Frequency With Controls—Although lightning-related controls have been identified as discussed below, their ability to prevent initiation of an organic salt-nitrate reaction or otherwise mitigate the scenario is unquantifiable. Therefore, the frequency of the scenario with controls is conservatively represented by the scenario without controls ("extremely unlikely"). Based on the assumption for the accident frequency without controls, the efficiency of the lightning protection system would have to be about 70% to change the accident frequency with controls of a DST deflagration to the "beyond extremely unlikely" category.

- **Source Term Analysis**

Source Term Without Controls—The source term without controls for an organic salt-nitrate reaction is developed in Section 3.4.2.6.

Source Term With Controls—The source term with controls is the same as the source term without controls.

- **Consequence Analysis**

Consequences Without Controls—The onsite and offsite radiological and toxicological exposures resulting from a lightning-initiated organic salt-nitrate reaction and other initiators are presented in Section 3.4.2.6.

Consequences With Controls—The consequences with controls of an organic salt-nitrate reaction are the same as the consequences without controls.

- **Comparison With Guidelines**—The consequences without controls of the lightning-initiated organic salt-nitrate reaction presented in Section 3.4.2.6 exceed the risk guidelines, therefore, controls are required.

- **Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls**

Natural Phenomena—Lightning Controls for Organic Salt-Nitrate Reaction. Lightning controls are outlined below and apply to all tanks with the potential for organic salt-nitrate reactions.

Safety Structures, Systems, and Components—No Safety-Class or Safety-Significant SSCs are associated with lightning protection.

Technical Safety Requirement Controls—Because intrusive activities may increase the likelihood of the initiation of an organic salt-nitrate reaction, a TSR control is imposed as illustrated in Table 3.4.2.12.2-1.

Exemptions to Lightning Controls—The lightning controls do not apply to intrusive activities related to the operation of ALCs or mixer pump operation (for all mixer pump operating modes) associated with the 241-AZ-101 Mixer Pump Test, Project W-151, once global waste mixing has begun (i.e., initiation of pump operation). For the controls selected to mitigate the risk associated with the organic salt-nitrate reaction initiated by lightning, the operation of the ALCs or mixer pumps is exempted because the equipment is installed and its operation has no bearing on the geometry relative to the generation of an arc.

Defense-in-Depth—Additional items that provide Defense-in-Depth protection against impacts from lightning strikes as shown in Table 3.4.2.12.2-2.

3.4.2.12.3 Natural Phenomena—Seismic. Seismic events at the tank farms pose a natural phenomenon hazard because they could initiate an accident or initiate multiple accidents from a common cause. As discussed in Chapter 1.0, the Hanford Site lies within the Pasco Basin of the Columbia Plateau. The region has a relatively low seismic activity level (DOE/EIS-0212, *Final Environmental Impact Statement, Safe Interim Storage of Hanford Tank Wastes*). No evidence of surface faulting exists in the immediate vicinity of the tank farms where the exposed surfaces consist primarily of sands, gravels, and silts deposited through a series of prehistoric cataclysmic floods. The surface also contains outcroppings of the underlying basalt and sedimentary materials.

Potential earthquakes at the Hanford Site are dominated by regional crustal faults rather than faults related to the tectonic plate subduction zones located near the Pacific coast (WHC-SD-W236A-TI-002, *Probabilistic Seismic Hazard Analysis, DOE Hanford Site, Washington*). Of the possible crustal fault types, those related to the Yakima Fold Belt (a series of east-west trending ridges caused by faulting and folding of the underlying basalt by north-south compression) are capable of producing the highest accelerations. The most important fault in the Yakima Fold Belt for tank farm earthquakes is the Umtanum-Gable Mountain Structure; other potential faults that could affect the tank farms include the Saddle Mountains Structure, the Yakima Ridge Structure, and the Rattlesnake-Wallula Alignment (DOE/EIS-0212; WHC-SD-W236A-TI-002).

Seismic accident analyses are performed to establish the need for and effectiveness of safety SSCs and TSR controls. To ensure that the level of conservatism is appropriate for facility characteristics such as hazards to personnel, the public, and the environment, as well as cost, DOE-STD-1020-94 provides guidance for facility-appropriate design accelerations. Use of specific guidance depends on the facility hazard category and Performance Category of equipment. For existing Hazard Category 2 facilities with Performance Category 3 equipment such as the underground storage tanks, a peak horizontal ground acceleration of 0.19 *g* and a return frequency of 10^{-3}/yr is used as the evaluation basis acceleration (WHC-SD-W236A-TI-002) (Chapter 1.0, Table 1-32). Accelerations of this magnitude, usually associated with Modified Mercalli Intensity Levels of VII or greater (ORNL-NSIC-28, *Earthquakes and Nuclear Power Plant Designs*), have never been recorded at the Hanford Site. More severe accelerations are considered only in beyond evaluation basis accident assessments.

Scenario Development. On the basis of structural analyses of the underground storage tanks (WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*), tank failures or collapse of major structures would not be expected from accelerations associated with an evaluation basis earthquake. Although the postulated damage to other TWRS facilities from postulated seismic events is uncertain, an estimate based on worldwide experience of typical damage to structures as a function of the acceleration was used (Table 3.4.2.12.3-1). By comparing these characteristics with potential failure initiators of various structures and potential initiators of high-consequence accidents considered in the preceding sections, three seismically induced accidents dominate: (1) spray leaks, (2) waste transfer pool leaks from an underground pipe break, and (3) seismically induced GREs and deflagrations of flammable gas.

Because of the known leak sensitivity of jumper connections subjected to torque in valve pits, spray leaks may be caused by seismic forces acting on various pipe connections. Although characteristic of somewhat higher accelerations than 0.19 *g*, underground pipe breaks leading to a pool release are assumed to occur because of the potential for degraded transfer lines. Seismic excitation of tank sludge is assumed to cause release of retained gases to tank headspaces. The gas is then assumed to ignite from seismically induced mechanical or electrical sparks. Multiple occurrences of seismically induced spray leaks, pool leaks, and deflagrations may be possible, and depending on their locations, onsite and offsite consequences may be partially additive.

Derailment and leakage of a loaded railcar at the 204-AR Waste Unloading Facility are not expected at a peak horizontal acceleration of 0.19 *g* based on characteristic failures in Table 3.4.2.12.3-1. Accidents at other TWRS facilities (such as the less than 90-day storage pad, 244-AR Vault, and ventilation systems) could occur. However, because their source terms are small compared with those of the spray leak, pool leak, and seismically induced deflagration, their consequences would have a small contribution to the consequences of the selected accident types. Minor damage to roads, bridges, and communications equipment would not be expected to impede evacuation.

If the active ventilation systems were assumed to fail in the seismic event and remain failed over an extended period, the possibility of a delayed tank bump exists (Section 3.4.2.11). However, because such accidents are much delayed from the initiating earthquake, their doses would not add to the prompt dose caused by the earthquake. Delayed accidents caused by earthquakes were therefore not considered further except to assess the need for unique seismic controls.

- **Accident Scenario Without Controls**—Using the logic discussed above, the evaluation basis seismic event is represented by a spray leak in a valve pit, an underground pipe break leading to a surface pool, and a flammable GRE and deflagration in a DST and in an SST as discussed below. No credit is taken for the seismic integrity of SSCs other than the gross integrity of SSTs, DSTs, and AWF tanks to prevent collapse caused by the seismic accelerations of 0.19 *g*.

  - **Spray Leak**—A valve pit spray leak occurs in a transfer line during a transfer, and the pumps are conservatively assumed to continue to run. This accident was analyzed in detail in Section 3.4.2.9. Because damage to reinforced concrete and foundations is characteristic of accelerations of 0.3 *g* or larger (ORNL-NSIC-28), the valve pit cover blocks can be assumed in place and undamaged in the earthquake. However, to conservatively account for all potential sources of spray leaks, this seismic analysis does not credit the cover blocks for mitigating the accident consequences.

    The reliability of offsite power, electrical power, and instrumentation and control panels during an earthquake was assessed for the tank farms (LA-UR-95-1900, *Probabilistic Safety Assessment for Hanford High-Level Waste Tanks*). Offsite power was found to be reliable up to accelerations of 0.3 *g* (well above the evaluation basis acceleration). Thus, the assumption of pumps continuing to run is consistent with the expectation of power availability.

  - **Pipe Break Causing Surface Pool**—As illustrated in Table 3.4.2.12.3-1, underground pipe breaks are characteristic of seismic events of 0.3 *g* or larger. However, because of the potential for pipes weakened by aging (corrosion), and because of multiple connections with underground pits, a

seismically induced underground pipe break leading to a surface pool was conservatively assumed. As with the spray leak, the pumps are conservatively assumed to continue to run. This accident was analyzed in detail in Section 3.4.2.8. Underground pipe breaks typically occur at the interface with a solid structure that moves at a different magnitude or frequency than the earth and pipe system. While no credit is taken, a pool leak may reduce the consequences of a spray leak if it occurs in the same transfer line.

- **SST and DST Deflagration**—A seismically induced GRE and a deflagration are postulated to occur in an SST and a DST.

  Preliminary investigations of seismically induced gas releases suggest that the design basis earthquake (DBE) could result in a 50% gas release from a DST and a 10% gas release from an SST. These estimates are based on the strength of the waste (i.e., approximately 50 Pa yield for DST waste and 1,000 to 2,000 Pa yield for SST waste). Gas release fractions of this magnitude may result in small releases or large releases depending on the amount of gas retained within the waste in each tank. For tanks with a large amount of retained gas, large releases may occur. The accident scenarios, including parametric analyses of combustion pressures, waste aerosolization, venting, tank structural failure modes, and material releases described in Section 3.4.2.2, cover large gas releases that may result from seismic events.

- **Accident Frequency Without Controls**—The probabilities of spray leaks, pool leaks, and deflagrations resulting from the selected seismic events are not well understood and are conservatively assumed to be one. Therefore, the seismically induced accidents are assigned the same frequency as the initiating event frequency (i.e., that of the evaluation basis earthquake) and thus fall in the "unlikely" frequency category.

- **Accident Scenario With Controls**—The scenario with controls is the same as the scenario without controls except emergency preparedness response procedures are invoked. These procedures call for termination of waste transfers upon detection of the event to limit the amount of material released in a spray leak or pool leak. For seismically induced waste tank deflagrations, the procedures call for evacuation of nonessential personnel. Based on the characteristic failures of a 0.19 *g* earthquake, failures of structures that would impede terminating transfers or evacuating personnel would not be expected.

- **Accident Frequency With Controls**—The accident frequency with controls is the same as the accident frequency without controls: "unlikely."

Source Term Analysis

- **Source Term Without Controls**—The source terms without controls for the spray leak, pool leak, and flammable gas deflagrations are developed in Sections 3.4.2.9, 3.4.2.8, 3.4.2.2, respectively. The source term for flammable gas deflagrations depends on the amount of gas released from the waste in the seismic event. The amount of gas released is not well understood but would depend on the amount of gas retained in each affected tank, the strength of the waste, and the magnitude and duration of the seismic event. For purposes of this assessment, the seismic event is assumed to have a source term comparable with the cases summarized in Section 3.4.2.2.

- **Source Term With Controls**—The source terms with controls for the spray leak, pool leak, and flammable gas deflagration are the same as in the scenario without controls.

Consequence Analysis

- **Consequences Without Controls**—Conservative assessments of onsite and offsite radiological consequences for a single spray leak in a valve pit without controls in place are given in Section 3.4.2.9. The toxicological exposure consequences are frequency dependent, and the frequency for this accident is "unlikely" as opposed to "anticipated" in Section 3.4.2.9. The onsite and offsite toxicological exposure consequences for a spray leak event induced by a seismic initiator are documented in Table 1 of HNF-SD-WM-CN-119, *Evaluation of the Effectiveness of the Addition of Seismic Monitors Within the 200 Areas.* Conservative assessments of onsite and offsite radiological exposures for a pool leak are given in Section 3.4.2.8. Just as in Section 3.4.2.9, the frequency of the pool leak accident analyzed in Section 3.4.2.8 is "anticipated." Therefore, the on-site and offsite toxicological exposure consequences for a leak forming a pool induced by a seismic initiator are documented in Table 3 of HNF-SD-WM-CN-119. Multiple occurrences of spray leaks and pool leaks similar to or less severe than the analyzed cases can be postulated. Assessments of the onsite and offsite radiological and toxicological exposures for hydrogen deflagrations in an SST and a DST are given in Section 3.4.2.2. Multiple occurrences of deflagrations similar to the analyzed cases can be postulated.

- **Consequences With Controls**—The ability of the selected controls to mitigate consequences of seismically initiated spray leaks, pool leaks, and flammable gas deflagrations remains uncertain and unquantifiable. The seismic initiator is unique in that all personnel would be immediately aware of the potential for accidents because of ground shaking. Operators would respond to terminate waste transfers, provide for surveillance, initiate recovery actions, and initiate evacuation of nonessential personnel. Evacuation would limit the exposure duration of workers at risk to potential radiological and toxicological materials. However,

most of the exposure to personnel may occur immediately following the seismic event; therefore, evacuation of personnel from the immediate vicinity of the release site may have limited success. The consequences with controls are therefore conservatively assumed to be the same as for the accident without controls.

Comparison With Guidelines. As illustrated in Sections 3.4.2.9, 3.4.2.8, and HNF-SD-WM-CN-119, the consequences of the seismically induced spray leaks and pool leaks exceed the risk guidelines. Therefore, controls are required. The consequences of seismically induced deflagrations have only been evaluated on a parametric basis. However, as indicated in Section 3.4.2.2, onsite risk guidelines may or may not be exceeded depending on assumptions regarding flame acceleration, transition to detonation, and structural failure modes. In general, consequences exceed onsite risk guidelines for "unlikely" events (i.e., GRE plus ignition) but meet the offsite risk guidelines. Multiple occurrences of spray leaks, pool leaks, and deflagrations similar to the analyzed cases can be postulated to occur and to exceed the associated guidelines.

Summary of Safety Structures, Systems, and Components and Technical Safety Requirements Controls.

- **Natural Phenomena-Seismic Controls**—Seismic Safety-Class controls outlined below apply to all SSTs, DSTs, and AWF tanks. TSR controls apply to all Tank Waste Remediation System facilities.

- **Safety Structures, Systems, and Components**—Safety-Class SSCs associated with seismic protection are summarized in Table 3.4.2.12.3-2. The SSTs, DSTs, and AWF tanks are relied on to maintain their gross structural integrity for an evaluation basis earthquake with a peak horizontal ground acceleration of 0.19 *g*. No credit is taken for the seismic resistance or seismic integrity of other SSCs. Per agreement with DOE-ORP, the Safety-Class designation of the waste tanks is not effective until March 30, 2000.

- **Technical Safety Requirement Controls**—As summarized in Table 3.4.2.12.3-3, Emergency preparedness controls mitigate the consequences of the seismic event by terminating waste transfers as well as providing for surveillance, evacuation, and recovery actions.

- **Defense-in-Depth**—The tank integrity assessment program has been defined as a Defense-in-Depth item that is specifically associated with seismic protection. This control is summarized in Table 3.4.2.12.3-4.

- **Planned Safety and Risk Assessment**—The existing intrinsic structural integrity of the Safety-Class SSCs defined here (i.e., SSTs, DSTs, and AWF tanks) and the emergency preparedness TSR controls manage the risk of the postulated seismic event. However, even with these controls, the potential risk of a large seismic event exceeds the established risk guidelines. To address this residual risk, seismic monitors have been evaluated with respect to their ability to reduce this residual

risk and are now included as a planned safety improvement in Section 3.3.2.3.5 based on the results of an evaluation of their effectiveness performed in HNF-SD-WM-CN-119. Information presented in HNF-SD-WM-CN-119 shows that the addition of seismic monitors will not quantitatively reduce the risk below the established risk guidelines. Therefore, additional investigation to further address the residual risk is continuing. Specifically, the addition of seismic switches to stop waste transfer pumps will be analyzed on a cost/benefit basis and a comprehensive seismic vulnerability assessment will be performed. The results of the seismic vulnerability assessment will be used to identify further safety improvements to control the risk from a potential seismic event.

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WHC-SD-WM-CN-061, 1996, *Releases from Failure of a Flexible Receiver Bag in High Winds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Table 3.4.2.12.1-1. Estimates of Peak Wind Gusts and Frequencies of Occurrence at the Hanford Site.

Return period	Frequency (per yr)	Peak wind gusts (km/h)*	
		15.2 m (50 ft) aboveground	61 m (200 ft) aboveground
Once in 2 yr	0.5	97	109
Once in 10 yr	0.1	114	129
Once in 100 yr	0.01	137	151
Once in 1,000 yr	0.001	159	175

Source: PNL-6415, 1994, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 6, Pacific Northwest Laboratory, Richland, Washington.

*To convert km/h to mph, multiply by 0.621.

Table 3.4.2.12.1-2. Summary of Technical Safety Requirement Controls for Natural Phenomena—High Wind.

Control	Safety function	Comments
Dome loading controls • Use the Hanford Site Hoisting and Rigging Manual (DOE/RL-92-36)* for lifts.	Prevent load handling accidents that could damage Hazard Category 2 facilities or safety SSCs causing a significant uncontrolled release of radioactive or hazardous material or loss of safety function	--

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

*DOE/RL-92-36, 1996, *Hanford Site Hoisting and Rigging Manual*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, requires wind speed be considered before starting a lift and prohibits lifts if weather conditions are adverse to safe load-handling operations. The manual also requires securing of the crane in accordance with manufacturer recommendations when a local weather storm warning exists.

Table 3.4.2.12.1-3. Summary of Defense-in-Depth Controls for Natural Phenomena—High Wind.

Control	Safety function	Comments
Restrictions on operations during high winds	Restrictions on operations during high winds decrease the potential energy sources that could damage facilities and result in uncontrolled releases of contaminants.	The Hanford Meteorological Station issues weather advisories including high wind warnings.
Compliance with *Hanford Site Hoisting and Rigging Manual* (DOE/RL-92-36)*	Compliance with manual would prevent flexible receiver bag failure in high winds	Although uncontrolled accident is within risk guidelines, compliance with manual provides Defense-in-Depth by preventing the accident

*DOE/RL-92-36, 1996, *Hanford Site Hoisting and Rigging Manual*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Table 3.4.2.12.1-4. Summary of Consequences and Frequencies for Flexible Receiver Bag Failure Without Controls.

Accident	Consequences								Frequency
	Radiological Sv (rem)				Toxicological SOF				Without controls
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Flexible Receiver Bag Failure	1.4 E-04 (1.4 E-02)	5.0 E-03 (5.0 E-01)	2.9 E-07 (2.9 E-05)	1.0 E-03 (1.0 E-01)	7.8 E-01	1 (ERPG-1)	2.4 E-06	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline.
PEL = permissible exposure limit.
TWA = time-weighted average.
SOF = sum-of-fractions.

Table 3.4.2.12.2-1. Summary of Technical Safety Requirement Controls for Natural Phenomena—Lightning as an Accident Initiator.

Control	Safety function	Comments
Ignition controls • Intrusive controls - Stop waste-disturbing activities and operations in tanks where induced gas release events are postulated (flammable gas Facility Group 1, 2, and 3 tanks) when lightning is identified within a 48-km (30-mi) radius of the tank farm. - Stop activities in dome intrusive and waste intrusive locations of tanks with a potential organic solvent hazard, or organic salt-nitrate reaction hazard when lightning is identified within a 48-km (30-mi) radius of the tank farm. - Secure equipment in lowest position if lightning is identified within 48-km (30-mi) of the tank farm.	Ensure that activities resulting in gas releases are minimized, and therefore decreases the likelihood of ignition of flammable gas. Also decreases the likelihood of an organic solvent fire or organic salt-nitrate reaction by removing potential lightning dissipation paths in the tanks and reduces the likelihood of a strike by lowering equipment.	The Hanford Meteorological Station located midway between the 200 East and 200 West Areas monitors lightning strikes with an instrument link to a regional electronic monitoring station. Tank farm operations are notified when lightning strikes within 48-km (30-mi) of the tank farms. The lightning controls do not apply to intrusive activities related to the operation of ALCs and mixer pumps during the 241-AZ-101 Mixer Pump Test, Project W-151 (see Addendum 4).

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

ALC = air-lift circulator

GRE = gas release event.

Table 3.4.2.12.2-2. Summary of Defense-in-Depth Controls for Natural Phenomena—Lightning as an Accident Initiator.

Control	Safety function	Comments
Lightning protection (i.e., grounded air terminals and grounded tank risers and permanently installed instrumentation bonded to risers)	Decreases the frequency of a lightning-initiated flammable gas ignition, organic solvent fire, or organic salt-nitrate reaction	Promotes the dissipation of lightning energy outside of the waste volume. See Section 3.3.2.3.5 for a description of lightning protection items as planned safety improvements.
Grounding grids (where installed)	Decrease the frequency of a lightning-initiated flammable gas ignition, organic solvent fire, or organic salt-nitrate reaction	Promotes the dissipation of lightning energy outside of the waste volume

Table 3.4.2.12.3-1. Seismic Accelerations, Magnitudes, Expected Frequencies, and Effects.

Peak horizontal ground acceleration	Likelihood of occurrence per year[a]	Description[b]
"Anticipated" Events		
0.05 *g*	> 1.0 E-02	Threshold acceleration above which emergency response actions are implemented. Characteristic of MMI VI. Felt by all. Adobe and weak plaster may crack.
"Unlikely" Events		
0.12 *g*	2.0 E-03	Design criterion for existing Safety-Class 1 facilities per HPS-SDC 4.1. Threshold for evacuation of nonessential personnel. Characteristic of MMI VII. Difficult to stand. Ordinary masonry may crack, weak chimneys may fall.
0.19 *g*	1.0 E-03	Design criterion for existing Performance Category 3 equipment; selected as the FSAR evaluation basis acceleration. Characteristic of MMI VII. Noticed by vehicle drivers. Waves appear on ponds, water turbid with mud.
0.24 *g*	5.0 E-04	Design criterion for new Performance Category 3 equipment for the 200 East Area. Characteristic of MMI VIII. Collapse of ordinary nonreinforced masonry walls and chimneys; collapse of towers and stacks.
0.26 *g*	5.0 E-04	As above except for the 200 West Area.
0.3 *g*	3.0 E-04	Characteristic of MMI IX. Threshold acceleration for damage to ordinary foundations, potential underground pipe breaks.
0.43 *g*	1.5 E-04	High confidence, low probability of gross leakage of underground storage tank. Characteristic of MMI IX as above.
"Extremely Unlikely" Events		
0.6 *g*	5.0 E-05	Median acceleration for gross leakage of SSTs per WHC-SD-TWR-RPT-002. Characteristic of MMI X. Most ordinary masonry and frame buildings are destroyed.
0.8 *g*	2.0 E-05	Median acceleration for gross leakage of DSTs per WHC-SD-TWR-RPT-002. Characteristic of MMI X. Most ordinary masonry and frame buildings are destroyed.

Sources: WHC-SD-TWR-RPT-002, 1996, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

HPS-SDC 4.1, *Hanford Plant Standards,* Rev. 12, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[a]Frequency of occurrence based on WHC-SD-W236A-TI-002, 1996, *Probabilistic Seismic Hazard Analysis, DOE Hanford Site, Washington*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[b]Modified Mercalli Intensity levels and effects based on ORNL-NSIC-28, 1970, *Earthquakes and Nuclear Power Plant Designs*, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

DST = double-shell tank.
FSAR = Final Safety Analysis Report.
MMI = Modified Mercalli Intensity.
SST = single-shell tank.

Table 3.4.2.12.3-2. Summary of Safety Structures, Systems, and Components for Natural Phenomena—Seismic.

Structures, systems, and components	Safety classification	Safety function	Comments
Waste Tanks	Safety-Class	The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during and after the evaluation basis earthquake, thus decreasing the consequences of the Natural Phenomena—Seismic accident.	Applies to all SSTs, DSTs, and AWF tanks. Per agreement with DOE-ORP, this Safety-Class designation is not effective until March 30, 2000.

Table 3.4.2.12.3-3. Summary of Technical Safety Requirement Controls for Natural Phenomena—Seismic.

Control	Safety function	Comments
Emergency Preparedness Program with the following key elements: • Identification of seismic event detection method used to initiate response procedure actions • Response procedures based on the magnitude of the seismic event • Recovery plan to address restart of services and equipment • Verify safety structures, systems, and components for degradation of design criteria parameters that are credited in the analyses, following significant, relevant, natural phenomena events (e.g., seismic event).	Provides for mitigative actions to control potential releases by terminating transfers; provides provisions for surveillance and recovery actions; and provides means to evaluate the ability of safety SSCs to perform their safety function following a seismic event.	These controls manage the risk of uncontrolled releases of radioactive and toxic materials caused by an earthquake and limit direct risk of exposures to facility workers

Note: For the complete text of the controls summarized in this table refer to the latest revision of HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.

Table 3.4.2.12.3-4. Summary of Defense-in-Depth Controls for Natural Phenomena-Seismic.

Control	Safety function	Comments
Tank integrity assessments	Provides information regarding the structural integrity of waste tanks.	Not a routine activity, but integrity assessments of the primary tank in selected DST's has been performed.

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3.4.3 Beyond Evaluation Basis Accidents

Consistent with DOE 5480.23, *Nuclear Safety Analysis Reports*, and DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, this section presents the results of an assessment of beyond evaluation basis accidents analyzed to provide a perspective of the residual risk associated with tank farm operations. Beyond evaluation basis accidents are those operational accidents with more severe conditions or failures than are postulated for evaluation basis accidents. DOE-STD-3009-94 also suggests assessments of beyond evaluation basis accidents for natural phenomena accidents but excludes external events. Beyond evaluation basis accidents do not imply occurrence frequencies less than 10^{-6} per year; rather, the frequencies are reevaluated based on the initiating event and failures that characterize the accident scenario.

To assess residual risk from tank farm operations with safety SSCs and TSR controls in place, Section 3.4.3.1, "Accidents with Failures of Controls," summarizes accident scenarios that postulate failures of SSCs and TSR controls. These assessments are presented for cases where the consequences of accidents without controls in Section 3.4.2, "Evaluation Basis Accidents," were above risk guidelines. To determine if there are residual risks with catastrophic consequences as compared with evaluation basis accidents, Section 3.4.3.2, "Accident Conditions Beyond the Evaluation Basis," summarizes potential accident scenarios with phenomena or conditions more severe than evaluation basis accidents.

In addition to the bounding consequence assessments, a qualitative best estimate of consequences was performed for each beyond evaluation basis accident. The best estimate assessment was performed by qualitatively examining key assumptions and parameter values in the conservative assessment and comparing them with "nominal" or "typical" values. Dose reduction factors were determined and the bounding consequences were divided by the dose reduction factor to approximate a "best estimate" consequence. In some cases, conservatisms were identified but no credit was taken for them in the best estimate because dose reduction values were not readily available or known.

3.4.3.1 Accidents with Failures of Controls. A number of the evaluation basis accidents discussed in Section 3.4.2 had consequences without controls that exceeded the risk guidelines; when safety SSCs and controls were imposed (and assumed to not fail), the consequences with controls were less than the risk guidelines for most of the accidents. However, there are still accidents that remain outside the risk guidelines even with controls. The accidents that remain outside the guidelines even with controls are discussed in their subject sections and include "Organic Solvent Fire" (Section 3.4.2.4), "Flammable Gas Deflagrations" (Section 3.4.2.2), "Organic Salt-Nitrate Reaction" (Section 3.4.2.6), and "Natural Phenomena—Seismic" (Section 3.4.2.12.3). This section evaluates the residual risk of tank farm operations with safety SSCs and TSR controls by assessing the likelihood of failure of the SSCs and TSR controls.

3.4.3.1.1 Failure of Controls for HEPA Filter Failure—Exposure to High Temperature or Pressure. As discussed in Section 3.3.2.4.2, "HEPA Filter Failure—Exposure to High Temperature or Pressure," the consequences without controls exceed the onsite radiological guidelines for SSTs (with active ventilation) and DSTs (including AWF tanks). Section 3.3.2.4.2 also includes the analysis of a nonmechanistic ventilation system release as a result of an overpressurization event. Because an overpressurization event does not occur independent of another event, no further discussion of the Section 3.3.2.4.2 scenario is included here.

For cases with active ventilation, the high temperature HEPA failure is controlled by the following safety SSCs and TSR controls:

- Ventilation stack CAM interlock systems on the SSTs (active ventilation only) and DSTs (including AWF tanks) to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM.

- Controls on HEPA filters to provide for periodic surveillance and filter changeout before contact doses exceed maximum allowable.

The safety SSCs and TSR controls are mitigative and reduce the consequences of the accident without controls ("anticipated"). If the ventilation stack CAM interlock system fails to detect the increased radiation level and shut off the ventilation system, the consequences of the accident scenario would be identical to those of the accident scenario without controls. If this safety SSC is assumed to fail, the postulated accident scenario with failed controls would be expected to be in the "unlikely" category, at a minimum (Table 3.4.3-1).

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions. Because nearly all of the assumptions made in the analysis are considered appropriate, only one assumption was identified that may be changed to a more typical or best-estimate value. The use of 50th percentile meteorological conditions (dispersion coefficients) rather than 99.5th percentile dispersion coefficients, would reduce the radiological and toxicological consequences by a factor of approximately six, as illustrated in Table 3.4.3-1. Because the toxicological consequences of the accident scenario without controls were below the risk guidelines, no values are shown in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce consequences.

3.4.3.1.2 Failure of Controls for Fire in Contaminated Area. As discussed in Section 3.3.2.4.3, "Fire in Contaminated Area," the consequences of a crane or vehicle incident causing a fuel fire in a contaminated pit exceed the onsite radiological and toxicological guidelines. This accident is controlled by the following TSR controls:

- Physical barriers to vehicle access limit vehicle access to waste tank structures to only those vehicles with protected fuel systems.

- Controls to ensure that vehicle access within the tank farms shall be limited to vehicles with fuel systems protected from damage caused by potential collisions with tank structures.

- Controls to establish vehicle speed limits within the tank farms.

In addition, the Emergency Preparedness program shall include response procedures for fires in contaminated areas.

Assuming the TSR controls work as intended, the postulated accident is prevented. Failure of controls would involve (1) the unauthorized use of a vehicle with an unprotected fuel tank in the tank farms and (2) an unprotected vehicle being involved in an accident that results in a fuel fire in the contaminated area. Thus, two independent errors would be required to result in the accident. As summarized in Table 3.4.3-1, the postulated accident scenario with failed controls would be expected to be in the "extremely unlikely" category.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best estimate versus bounding and conservative assumptions as follows:

- If the waste type evaluated were a DST solid-liquid combination instead of an AWF tank solid-liquid combination, the radiological consequences could be reduced by a factor of approximately three. This factor reduction is currently a reasonable assumption because transfers of aging waste are not performed nearly as often as transfers of DST waste. The toxicological consequences would not be reduced by the same amount because the toxicological source term does not differentiate between DST and AWF tank waste types.

- Reducing the material at risk in the contaminated pit by 50% would reduce the radiological and toxicological consequences by a factor of two. This factor reduction is a reasonable but still conservative assumption because (1) typical contamination levels are less than the bounding amount assumed in the analysis and (2) normal contamination control procedures limit the available material for release prior to pit access.

- To account for the frequency shift from the "anticipated" category to the "extremely unlikely" category, the onsite toxicological consequences could be further reduced by a factor of approximately 37 using the appropriate frequency-dependent sum-of-fractions values. Offsite toxicological values are below the risk guidelines for the accident scenario without controls.

- Using 50th percentile dispersion coefficients rather than 99.5th percentile coefficients reduces the radiological and toxicological consequences by a factor of approximately six.

These four factors alone would reduce the radiological consequences of this accident by a factor of 36 and the toxicological consequences by a factor of 444, as illustrated in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce both the radiological and toxicological consequences.

3.4.3.1.3 Failure of Controls for Mixing of Incompatible Material-Tank Pressurization. As discussed in Section 3.3.2.4.12, "Mixing of Incompatible Material—Tank Pressurization," the consequences without controls of a postulated mistransfer of nitric acid into a DCRT exceed the onsite radiological and toxicological guidelines. This accident is controlled by the following safety SSCs and TSR controls:

- A minimum of one stage of HEPA filter units on the 244-A, 244-S, and 244-TX DCRTs have been designated as Safety-Significant SSCs to provide HEPA filtration of DCRT headspace gases before their release to the environment.

- A transfer control to ensure chemical additions are ≥ pH of 8 prior to transfer into tank farms (excludes water additions and drums containing caustic chemicals).

- Controls on HEPA filters to provide for periodic surveillance, and filter changeout before contact doses exceed maximum allowable, and efficiency testing to ensure removal efficiency.

Assuming the transfer control works as intended, the postulated accident is prevented. Failure of the transfer control would require a failure of the control to ensure chemical additions are ≥ pH of 8 before transfer into the tank farms. As summarized in Table 3.4.3-1, the postulated accident scenario with failed transfer controls would be expected to be in the "extremely unlikely" category. The Safety-Significant HEPA filters limit (i.e., mitigate) headspace material releases for events that do not create pressures high enough to fail the filters and the HEPA filter source term, and efficiency controls mitigate potential releases by protecting key accident analysis assumptions.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best estimate versus bounding and conservative assumptions:

- To account for the frequency shift from the "anticipated" category to the "extremely unlikely" category, the onsite toxicological consequences could be further reduced by a factor of approximately 37 using the appropriate frequency dependent sum-of-fractions values. Offsite toxicological values are below the risk guidelines for the accident scenario without controls.

- Using 50th percentile dispersion coefficients rather than 99.5th percentile coefficients reduces the radiological and toxicological consequences by a factor of approximately six.

These factors would reduce the radiological consequences of this accident by a factor of six and the toxicological consequences by a factor of 222, as illustrated in Table 3.4.3-1. Additionally, if

the amount of nitric acid transferred to the DCRT was reduced by 50% or the temperature of the waste in the DCRT was closer to an average value (e.g., 27 °C [80 °F]) instead of 54 °C (130 °F) as analyzed in the accident scenario without controls, the reaction with the waste would still occur, although the waste would not boil and no steam would be released from the tank. Therefore, no radiological and toxicological consequences would be created.

3.4.3.1.4 Failure of Controls for Tank Failure Due to Excessive Loads. As discussed in Section 3.4.2.1, "Tank Failure Due to Excessive Loads," the consequences of a postulated drop of a mixer pump into a pump pit without controls exceed the onsite toxicological guidelines. This accident is prevented by the following TSR control:

- Dome loading controls (1) limit mechanical lift heights of loads above the tanks and pit bottoms and (2) require the use of DOE-RL-92-36, *Hanford Site Hoisting and Rigging Manual*, in preparing for lifts.

Failure of these controls is estimated to move the accident without controls ("unlikely") to at least the "extremely unlikely" category.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions as follows:

- If the waste type assumed in the analysis was a mixture of DST liquids and solids, as opposed to all DST solids, the radiological and toxicological consequences could be reduced in excess of a factor of three. This would still be a reasonable assumption because no DSTs are filled with only solid material, and the solid material (i.e., salt cake) that does float on top of the liquid more closely resembles the constituents of the liquid in terms of radiological dose.

- To account for the frequency shift from the "unlikely" category to the "extremely unlikely" category, the onsite toxicological consequences could be further reduced by a factor of approximately five using the appropriate frequency dependent sum-of-fractions values. Offsite toxicological values are below the risk guidelines for the accident scenario without controls.

- Using 50th percentile dispersion coefficients rather than 99.5th percentile coefficients reduces the radiological and toxicological consequences by a factor of approximately six.

Although additional assumptions regarding the load weight, drop height, and drop point on the tank may be modified, it is difficult to assess the overall impact on the consequences from changing the assumptions in the analyzed accident. The three factors quantified would reduce the radiological consequences of this accident by a factor of 18 and the toxicological consequences by

a factor of 90, as illustrated in Table 3.4.3-1. Note that both the onsite and offsite radiological consequences are below the guidelines for the accident scenario without controls and are not presented in Table 3.4.3-1.

3.4.3.1.5 Failure of Controls for Flammable Gas Deflagrations. As discussed in Section 3.4.2.2, "Flammable Gas Deflagrations,"consequences of flammable gas deflagrations were analyzed in a parametric manner. Consequences can vary over a large range depending on assumptions regarding flame speed, waste aerodynamic entrainment, and tank failure modes. The consequences for the SST cases generally exceed the onsite radiological and toxicological guidelines while offsite toxicological guidelines are met. Offsite radiological guidelines are exceeded for the larger material release cases. Parametric analyses in Section 3.4.2.2 show that the consequences of flammable gas deflagrations in DSTs (including AWF tanks) without controls exceed only the onsite radiological and toxicological guidelines. Because the consequences of the analysis have some uncertainty associated with them that could cause the offsite consequences to exceed the guidelines, equipment required by the controls is given a higher designation of Safety-Class.

Flammable gas deflagration accidents fall into one of two types and are discussed separately in the following paragraphs. The first type of deflagration is postulated to occur in the accumulation of steady offgases in waste tanks. The second type of deflagration is postulated to occur in flammable gases following a GRE.

Deflagrations in the Accumulation of Off Gases. Deflagrations in the accumulation of steady offgases are primarily controlled by safety SSCs and TSR controls:

- Safety-Class ventilation systems (both active and passive) to prevent accumulation of flammable gases
- A requirement to assure ventilation systems (both active and passive) are operating
- TSR controls to assure gas monitoring systems are operating.

(See the discussion in Section 3.4.2.2 for a more complete discussion of controls related to flammable gases.)

Deflagrations from a steady-state accumulation of offgases without controls are "anticipated," and assuming controls work as intended, the accident is prevented. Failure of controls for this type of deflagration involves failure of a passive or active ventilation system, failure to detect the failed ventilation system, and failure to initiate action to restore the failed ventilation system. An ignition source or failure of the ignition control program is required also.

Because of the multiple failures, and the time available to restore operability of the ventilation system before flammable conditions occur, failure of controls leading to a deflagration are estimated to be "extremely unlikely." Consequences would be the same as those described in Section 3.4.2.2.

The bounding case is represented by the high end of the parametric range for SSTs, which is a 4.0 L release assuming the collapse of the entire dome following the deflagration.

A best-estimate consequence assessment was developed by basing material release quantities on the mechanistic analysis performed by the Delphi Panel (WHC-SD-TWR-RPT-003, *DELPHI Expert Panel Evaluation of Hanford High-Level Waste Tank Failure Modes, Fragilities, and Release Quantities*). For the SST deflagration case, the Delphi Panel's calculated release quantity was less than 20 g or 0.012 L. This represents a consequences reduction factor of 333. In addition, the use of 50th percentile dispersion coefficients rather than 99.5th percentile coefficients would reduce the radiological and toxicological consequences by a factor of approximately six. To account for the frequency shift from the "anticipated" category to the "extremely unlikely" category, the onsite toxicological consequences could be further reduced by a minimum factor of approximately 40 using the appropriate frequency-dependent sum-of-fractions values. The offsite toxicological values could be reduced by a minimum factor of approximately five using the appropriate frequency dependent sum-of-fractions values.

The two factors of (1) use of 50th percentile dispersion coefficient and (2) toxicological consequence reduction alone would reduce the radiological consequences of this accident by a factor of six and the toxicological consequences by a factor of 240 (onsite receptor) or 30 (offsite receptor). The consequences reduction factor (including accounting for a more mechanistic release) is 2,000 for radiological consequences, 80,000 for onsite toxicological consequences, and a factor of 10,000 for offsite toxicological consequences. These effects on calculated consequences are shown in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce consequences.

Deflagrations following GREs. Deflagrations in flammable gases resulting from GREs are primarily controlled by the safety SSCs and TSR controls:

- Ignition source controls for permanently installed equipment
- Specific precautions for intrusive activities including ignition source control and monitoring with work stoppage at 25% of the LFL.

(See the discussion in Section 3.4.2.2 for a more complete discussion of controls related to flammable gases.)

Deflagrations following a GRE without controls are assigned a frequency category of "anticipated," and the case with controls (assuming controls work as intended) is assigned a frequency category of "unlikely" because of the dominance of seismic events to cause a release and create a coincident spark. The case with failure of controls is also assigned a frequency of "unlikely" because, as described in Section 3.4.2.2, failure of controls is dominated by human error to fail to implement work activity controls properly during waste disturbing activities when a GRE might be induced. As summarized in Table 3.4.3-1, the accident with failure of controls is in the "unlikely" category.

The bounding case is represented by the high end of the parametric range for SSTs, which is a 4.0 L release assuming the collapse of the entire dome following the deflagration.

A best-estimate consequence assessment was developed by basing material release quantities on the mechanistic analysis performed by the Delphi Panel (WHC-SD-TWR-RPT-003). For the SST deflagration case, the Delphi Panel's calculated release quantity was less than 20 g or 0.012 L. This represents a consequences reduction factor of 333. In addition, the use of 50th percentile dispersion coefficients rather than 99.5th percentile coefficients would reduce the radiological and toxicological consequences by a factor of approximately six. To account for the frequency shift from the "anticipated" category to the "unlikely" category, the onsite toxicological consequences could be further reduced by a minimum factor of approximately two using the appropriate frequency-dependent sum-of-fractions values. The offsite toxicological values, however, could not be reduced further by considering a minimum factor using the appropriate frequency-dependent sum-of-fractions values.

The two factors of (1) use of 50th percentile dispersion coefficient and (2) toxicological consequence reduction alone would reduce the radiological consequences of this accident by a factor of six and the toxicological consequences by a factor of 12 (onsite receptor) or six (offsite receptor). The consequences reduction factor (including accounting for a more mechanistic release) is 2,000 for radiological consequences, 4,000 for onsite toxicological consequences, and a factor of 2,000 for offsite toxicological consequences. These effects on calculated consequences are shown in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce consequences.

3.4.3.1.6 Failure of Controls for Organic Solvent Fire. As discussed in Section 3.4.2.4, "Organic Solvent Fire," the consequences of an organic solvent fire in a waste tank without controls exceed the onsite radiological and toxicological guidelines. This accident is controlled by the following TSR controls:

- Physical barriers to vehicle access limit vehicle access to waste tank structures to only those vehicles with protected fuel systems.

- Controls to prevent ignition sources, including stop-work around tanks if lightning is detected within 48 km (30 mi), secure crane and other equipment in lowest position if lightning is detected within 48 km (30 mi) of the tank farm, a flame cutting debris prevention control, a vehicle fuel tank protection control to prohibit the operation of vehicles with unprotected fuel tanks within the tank farm boundaries, and speed limit controls within tank farms.

- Controls on HEPA filters to provide for periodic surveillance and filter changeout before contact doses exceed maximum allowable.

- Control on tank transfers to ensure that controls for organic solvent fires are applied to the final state of the tank.

- Emergency preparedness response procedures.

The controls reduce the accident frequency, but because of the lightning initiator, both the accidents with controls and without controls are in the "unlikely" category. The accident with failure of controls would involve either a lightning-initiated fire or a violation of procedures for ignition control in a tank capable of supporting an organic solvent fire. As summarized in Table 3.4.3-1, the accident with failure of controls is estimated to remain in the "unlikely" category.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions. Several physical phenomena neglected in the analysis have been identified that, if considered and refined, could be credited with reducing the radiological and toxicological consequences. These phenomena include aerosol depletion in the tanks, turbulent jet mixing at the tank vent, and the fire spread velocity. As of yet, these factors have not been developed to the point where quantitative values are available for reference. However, these factors taken in combination with the use of 50th percentile dispersion coefficients rather than 99.5th percentile coefficients would be expected to reduce the radiological and toxicological consequences at least by a factor of 10, as illustrated in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce consequences.

3.4.3.1.7 Failure of Controls for In-Tank Fuel Fire/Deflagration. As discussed in Section 3.4.2.5, "In-Tank Fuel Fire/Deflagration," the consequences (without controls) resulting from a deflagration of spilled vehicle fuel in a waste tank (following a vehicle crash into riser) exceed the onsite and offsite radiological and toxicological guidelines. This accident is controlled by the following TSR controls:

- Physical barriers to vehicle access limit vehicle access to waste tank structures to only those vehicles with protected fuel systems.

- Controls to ensure that vehicle access within the tank farms shall be limited to vehicles with fuel systems protected from damage caused by potential collisions with tank structures.

- Controls to establish vehicle speed limits within the tank farms.

- Emergency preparedness response procedures.

These TSR controls, assuming they work as intended, prevent the accident (accident without controls is "unlikely"). Failure of controls would involve the unauthorized use of an unprotected fuel tank in the tank farms, having that particular vehicle hitting a riser or other obstruction, breaking the fuel tank, and the spilled fuel flowing in a path that reaches the tank. As

summarized in Table 3.4.3-1, the accident with failure of controls is estimated to be in the "extremely unlikely" category.

Because gasoline is slightly more energetic, some of the consequences for the gasoline pool fire exceed those calculated for the organic solvent fire scenarios and may have increased for the gasoline pool fire. Substituting gasoline for solvent or diesel fuel does not change whether or not a scenario meets or exceeds the risk guidelines. The same control set applies to either gasoline or diesel fuel. The vehicle fuel pool fire hazard is bounded by the analyses presented in Section 3.4.2.4 (organic solvent or diesel fuel) and is supplemented by specific analyses for gasoline pool fires presented in Section 3.4.2.5.

3.4.3.1.8 Failure of Controls for Organic Salt-Nitrate Reaction. As discussed in Section 3.4.2.6, "Organic Salt-Nitrate Reaction," the consequences without controls of an organic salt-nitrate reaction in a waste tank exceed the onsite and offsite radiological and toxicological guidelines. This accident is controlled by the following safety SSCs and TSR controls:

- As noted in Section 3.4.2.6, temperature monitoring systems have been designated as Safety-Significant SSCs to provide tank waste temperature information for operator action, enabling operators to take actions necessary to prevent exceeding waste temperatures that may cause organic salt-nitrate reactions.

- Physical barriers limit vehicle access to waste tank structures to only those vehicles with protected fuel systems.

- Safety limits on the waste temperature of SST waste.

- Controls on SST, DST, and AWF tank waste temperatures.

- Controls to ensure the operability of process instrumentation and measuring and testing equipment.

- Control on tank transfers to ensure that controls for organic salt-nitrate reactions are applied to the final state of the receiving and sending tanks.

- Controls on waste moisture content and surveillance.

- Controls to prevent ignition sources, including stop-work around tanks if lightning is detected within 48 km (30 mi), secure crane and other equipment in lowest position if lightning is detected within 48 km (30 mi) of the tank farm, hot slag and hot debris prevention controls, a vehicle fuel tank protection control to prohibit the operation of vehicles with unprotected fuel tanks within the tank farm boundaries, vehicle speed limit controls within tank farms, controls to prevent hot filaments from falling and contacting the waste, and flammable gas ignition controls.

- Controls on HEPA filters to provide for periodic surveillance and filter changeout before contact doses exceed maximum allowable.

- Emergency preparedness response procedures.

The safety SSCs and controls are preventive and change the frequency category from "unlikely" (accident without controls) to "extremely unlikely" (accident with controls). Because of the dominance of the lightning-initiator, the failure of controls case is estimated to remain in the "unlikely" category. As summarized in Table 3.4.3-1, the accident with failure of controls is in the "extremely unlikely" category.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions. Because nearly all of the assumptions made in the analysis have already been refined and are considered to be best estimates, only one assumption was identified that may be changed to a more typical or best-estimate, value. The use of 50th percentile dispersion coefficients rather than 99.5th percentile coefficients would reduce the radiological and toxicological consequences by a factor of approximately six, as illustrated in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce consequences.

3.4.3.1.9 Failure of Controls for Surface Leak Resulting in Pool. As discussed in Section 3.4.2.7, "Surface Leak Resulting in Pool," the consequences without controls of a misrouted waste transfer into a open process pit, with a subsequent overflow of the pit, exceed the onsite and offsite radiological guidelines and the onsite toxicological guidelines. This accident is controlled by the following safety SSCs and TSR controls:

- The transfer leak detection systems, abovegrade portions of process pits, diversion boxes, and valve pits, primary tank leak detection systems, transfer system supplemental covers, pressure switch interlock or alarm on service water systems, backflow prevention devices (204-AR Waste Unloading Facility only), overground transfer encasement and connections, and the overground concrete shielding system are designated Safety-Class SSCs. As noted in Section 3.4.2.7, the Safety-Class designation of the abovegrade portions of process pits, diversion boxes, and valve pits, is not effective until March 30, 2000.

- The transfer system covers, tank level detection systems, salt well flow totalizers, primary tank leak detection systems, service water flow totalizers, abovegrade portions of cleanout boxes, backflow prevention devices, and the 204-AR Waste Unloading Facility structure are designated Safety-Significant SSCs. As noted in Section 3.4.2.7, the Safety-Significant designation of abovegrade portions of cleanout boxes is not effective until March 30, 2000.

- Controls to ensure operability of the transfer leak detection systems, transfer system covers, transfer system supplemental covers, primary tank leak detection

systems, pressure switch interlock systems, and backflow prevention devices (204-AR Waste Unloading Facility only).

- TSR transfer controls to perform material balances, monitor interconnected tanks for level increase, assure double valve isolation on interconnected lines, provide configuration management, perform independent route verification during transfer setup, and provide for concrete shielding or vehicle restrictions around overground transfer lines.

- Emergency preparedness response procedures.

Both the accidents with controls and without controls are in the "anticipated" category. For the bounding consequence accident with failure of controls, a leak develops, a leak detector fails, and at least six material balances fail. Because of the multiple failures involved, the accident is estimated to be in the "extremely unlikely" category. More likely leaks corresponding to a partial failure of controls with smaller pools can also be postulated.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best estimate versus bounding and conservative assumptions as follows:

- If the waste type evaluated were a DST solid-liquid combination instead of an AWF tank solid-liquid combination, the radiological consequences could be reduced by a factor of approximately three. This is currently a reasonable assumption because transfers of aging waste are not performed nearly as often as transfers of DST waste. The toxicological consequences would not be reduced by the same amount because the toxicological source term does not differentiate between DST and AWF tank waste types.

- Further reducing the percentage of solids in the waste mixture from 33 vol% to 5 vol% would reduce the radiological consequences by another factor of five. The percentage of solids in transfers is normally not near one-third, but closer to 5 vol%. The toxicological consequences would similarly be reduced by a factor of 1.3.

- To account for the frequency shift from the "anticipated" category to the "extremely unlikely" category, the onsite toxicological consequences could be further reduced by a minimum factor of approximately 40 using the appropriate frequency-dependent sum-of-fractions values. The offsite toxicological values for the accident scenario without controls were below the risk guidelines.

- Using 50th percentile dispersion coefficients rather than 99.5th percentile coefficients reduces the consequences by a factor of approximately six.

The cumulative effects of these four factors would reduce the radiological consequences of this accident by a factor of approximately 90 and the toxicological consequences by a factor of 312, as illustrated in Table 3.4.3-1. Although not quantified here, if emergency response were credited with limiting or preventing the resuspension of waste particles from the contaminated soil surface by maintaining the contaminated soil in a wetted state or covering the spill area with soil, the offsite radiological consequences could be reduced even further.

3.4.3.1.10 Failure of Controls for Subsurface Leak Resulting in Pool. As discussed in Section 3.4.2.8, "Subsurface Leak Resulting in Pool," the consequences of a catastrophic subsurface leak from an unencased, bermed line resulting in a pool exceed the onsite and offsite radiological guidelines and the onsite toxicological guidelines. The offsite toxicological guidelines are not exceeded. This accident is controlled by the following safety SSCs and TSR controls:

- Pipe encasements and transfer leak detection systems are designated Safety-Class SSCs.

- Tank level detection systems; salt well flow totalizers; transfer system covers; and the abovegrade portions of process pits, diversion boxes, valve pits, and COBs are designated Safety-Significant SSCs. As noted in Section 3.4.2.8, the Safety-Significant designation of the abovegrade portions of process pits, diversion boxes, valve pits, and COBs is not effective until March 30, 2000.

- Controls to ensure operability of the transfer leak detection systems, transfer system covers, and the encasement seal loops.

- Transfer pump administrative lock controls.

- TSR transfer controls to perform material balances, monitor interconnected tanks for level increase, perform radiation surveillance on single-walled, direct-buried/bermed lines during waste transfer operations, assure double-valve isolation on interconnected lines, provide configuration management, perform independent route verification during transfer setup, and ensure that open nozzles physically connected to waste transfer lines are sealed.

- Emergency preparedness response procedures.

Both the accidents with controls and without controls are in the "anticipated" category. For the bounding consequence accident with failure of controls, a leak develops, a leak detector or radiation surveillance is missed or operator fails to take proper corrective action (i.e., shutoff transfer pump), and the leak proceeds to wash out the berm and form a large surface pool. Failure of the cumulative set of controls presented would be expected to reduce the likelihood of an accident producing a large surface pool into the "unlikely" frequency category.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions.

- Reducing the percentage of solids in the SST waste mixture from 33 vol% to 5 vol% would reduce the radiological consequences by a factor of approximately 3.7. The percentage of solids in transfers is normally not near one-third but closer to 5 vol%. The onsite toxicological consequences would similarly be reduced by a factor of 1.8.

- To account for the frequency shift from the "anticipated" category to the "unlikely" category, the onsite toxicological consequences could be further reduced by a minimum factor of approximately 2.6 using the appropriate frequency-dependent sum-of-fractions values.

- Using 50th percentile dispersion coefficients rather than the 99.5th percentile coefficients reduces the consequences by a factor of approximately six.

The cumulative effects of these three factors would reduce the onsite and offsite radiological consequences of this accident by a factor of approximately 22 and the onsite toxicological consequences by a factor of 28. The best-estimate radiological and toxicological consequence estimates for this beyond evaluation basis accident are summarized in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce both the radiological and toxicological consequences.

3.4.3.1.11 Failure of Controls for Spray Leak in Structure or from Waste Transfer Lines. As discussed in Section 3.4.2.9, "Spray Leak in Structure From Waste Transfer System," the consequences without controls of a spray leak in an open valve pit exceed the onsite and offsite radiological guidelines and the onsite toxicological guidelines. This accident is controlled by the following safety SSCs and TSR controls:

- The 204-AR Waste Unloading Facility, transfer system covers, pressure switch interlocks or alarm systems (water service lines), 204-AR Waste Unloading Facility ventilation stack CAM interlock system, backflow prevention devices (204-AR Waste Unloading Facility only), overground transfer encasements, overground encasement leak detectors, and the overground concrete shielding systems are designated safety SSCs.

- Backflow preventers are designated Safety-Significant SSCs.

- TSRs to assure operability and functionality of transfer system covers, pressure switch interlock system, ventilation stack CAM interlock systems, backflow prevention devices (204-AR Waste Unloading Facility only), overground transfer encasement leak detection systems, and encasement seal loops.

- Transfer pump administrative lock controls.

- TSR transfer controls to assure double valve isolation on interconnected lines, provide configuration management, perform independent route verification during

transfer setup, provide for concrete shielding or vehicle restrictions around overground transfer lines, and to ensure that the 204-AR Waste Unloading Facility building doors are closed.

- Excavation controls.

These controls are a combination of preventive and mitigative features. Both the accidents with controls and without controls are in the "anticipated" category. The bounding accident with failed controls would require multiple failures. Because of the complex nature of the transfer systems and the number of controls, the combined frequency of a spray leak and a failure of controls is estimated to be in the "unlikely" category. The accident is summarized in Table 3.4.3-1.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions as follows:

- If the waste type evaluated were a DST solid-liquid combination instead of an AWF tank solid-liquid combination, the radiological consequences could be reduced by a factor of approximately three. This is currently a reasonable assumption because transfers of aging waste are not performed nearly as often as transfers of DST waste. The toxicological consequences would not be reduced by the same amount because the toxicological source term does not differentiate between DST and AWF tank waste types.

- Reducing the pump pressure by 50% would reduce the radiological and toxicological consequences by approximately a factor of three based on a sensitivity study performed with SPRAY computer model (WHC-SD-WM-CN-048, *Calculation Notes in Support of TWRS FSAR Spray Leak Accident Analysis*). This would be a reasonable assumption considering that a bounding pump pressure (the pump shutoff head) was used in the analysis of the accident without controls in WHC-SD-WM-CN-048.

- To account for the frequency shift from the "anticipated" category to the "unlikely" category, the onsite toxicological consequences could be further reduced by a minimum factor of approximately five using the appropriate frequency-dependent sum-of-fractions values. The offsite toxicological values for the accident scenario without controls are below the risk guidelines.

- Using 50th percentile dispersion coefficients rather than 99.5th percentile coefficients reduces the consequences by a factor of approximately six.

The cumulative effects of these factors alone would, at a minimum, reduce the radiological consequences of this accident by a factor of approximately 54 and the toxicological consequences

by a factor of 90, as illustrated in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce both the radiological and toxicological consequences.

3.4.3.1.12 Failure of Controls for Tank Bump. As discussed in Section 3.4.2.11, "Tank Bump," the consequences without controls of a tank bump (thermal roll-over of waste and steam pressurization of the tank headspace) exceed the onsite radiological and toxicological guidelines. This accident is controlled by the following safety SSCs and TSR controls:

- The temperature monitoring systems and tank level detection systems on susceptible tanks are designated Safety-Significant SSCs.
- TSRs to assure control of SST waste temperature, DST waste temperature, and AWF tank waste temperature.
- Controls to ensure the operability of process instrumentation and measuring and testing equipment.
- Transfer controls to ensure that controls for tank bumps are applied to the final state of the tank.

These controls are preventive and reduce the frequency category from "unlikely" (accident without controls) to prevented (accident with controls). Failure of controls would involve faulty temperature monitoring, level monitoring, or human errors in performing waste transfers. Such failures and human errors are anticipated events. However, because of the time required to reach tank bump conditions, recovery from the failures or human errors could prevent the tank bump. The combined likelihood of having the failure of controls and failure to recover is estimated to be in the "extremely unlikely" category. The accident is summarized in Table 3.4.3-1.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions. Because nearly all of the assumptions made in the analysis have already been refined and are considered to be best estimates, only one assumption was identified that may be changed to a more typical or best-estimate value. The assumptions applied are as follows:

- Using 50th percentile dispersion coefficients rather than 99.5th percentile coefficients would reduce the radiological and toxicological consequences by a factor of approximately six.
- To account for the frequency shift from the "unlikely" category to the "extremely unlikely" category, the onsite toxicological consequences could be further reduced by a minimum factor of approximately five using the appropriate frequency dependent sum-of-fraction values. Offsite toxicological values are below the risk guidelines for the accident scenario without controls.

These two factors alone would reduce the radiological consequences of this accident by a factor of six and the toxicological consequences by a factor of 30, as illustrated in Table 3.4.3-1. Credit was not taken for a buoyant plume rise that would further reduce consequences.

3.4.3.2 Accident Conditions Beyond the Evaluation Basis. This section summarizes potential accident scenarios with phenomena or conditions more severe than evaluation basis accidents to determine if there are residual risks with catastrophic consequences as compared to evaluation basis accidents. External events such as aircraft crashes were not considered because they are specifically excluded by DOE-STD-3009-94.

Previously identified accidents were screened to identify phenomena or conditions more severe than the evaluation basis accidents. Most of the natural phenomena accidents can be more severe than the evaluation basis (e.g., wind, ashfall, tornados, and earthquakes). Of these, a beyond evaluation basis seismic event was selected for further analysis because of its potential for more destructive phenomena than considered in the evaluation basis accidents. Two other accidents were identified that had conditions or phenomena that could potentially cause catastrophic failure of certain waste tanks. The two postulated accidents involve (1) a detonation of flammable gases and (2) a larger-than-evaluation-basis organic nitrate-salt reaction that fails the tank dome.

3.4.3.2.1 Beyond Evaluation Basis Natural Phenomena—Seismic. An evaluation basis earthquake with a peak horizontal acceleration of 0.19 *g* and a likelihood of occurrence of 1×10^{-3}/yr was assessed in Section 3.4.2.12.3. For purposes of the beyond evaluation basis accident, an earthquake with a peak horizontal acceleration of 0.43 *g* and a likelihood of occurrence of 1.3×10^{-4}/yr (WHC-SD-W236A-TI-002, *Probabilistic Seismic Hazard Analysis, DOE Hanford Site, Washington*) was selected because it is at the threshold of failure of some underground storage tanks. The likelihood of the overall event corresponds to the "unlikely" frequency category.

For reference, a peak horizontal ground acceleration of 0.43 *g* is larger than the recommended value for existing Performance Category 4 equipment which is 0.37 *g*. A 0.43 *g* acceleration is characteristic of Modified Mercalli Intensity IX which typically destroys nonreinforced masonry walls, damages ordinary foundations, and causes underground pipe breaks (ORNL-NSIC-28, *Earthquakes and Nuclear Power Plant Designs*). The following paragraphs describe the assumed failures for the beyond evaluation basis seismic event. Because electric power service would not be expected after a 0.43 *g* earthquake, spray leaks and pipe breaks with continuing leaks were excluded.

- **Tank Failures Resulting From Natural Phenomena—Seismic**. The median horizontal accelerations for structural failures of SSTs and DSTs are 0.6 *g* and 0.8 *g*, respectively (WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*). However, a 0.43 g acceleration corresponds to the high confidence low probability of failure threshold (LA-UR-95-1900, *Probabilistic Safety Assessment for Hanford High-Level Waste Tanks*). For this assessment, it is conservatively assumed 4 out of 149 SSTs

experience structural failures at 0.43 *g*. The failure mode is gross leakage from the tank from yielding of rebar and crushing of concrete at the lower base of the tank wall (WHC-SD-TWR-RPT-002). Some cracking of concrete on the inside and outside surfaces of the tank dome would also be expected.

The amount of aerosolized waste transported to the atmosphere through the ventilation system, cracks, and other unspecified leak paths was assumed bounded by that released in a hypothetical dome collapse. Based on a conservative assessment of a dome collapse, as much as 0.38 L of aerosolized solid SST waste is released per tank (WHC-SD-WM-CN-051, *The Effects of Load Drop, Uniform Load, and Concentrated Loads on Waste Tanks*). A best-estimate consequence assessment was extrapolated from WHC-SD-WM-CN-051 by examining key consequence analysis assumptions and applying best-estimate rather than bounding and conservative assumptions. For example, using a 50th percentile dispersion coefficient rather than a 99.5th percentile coefficient reduces the onsite and offsite consequences by a factor of about 6. Use of a liquid-solid blend for the released materials rather than SST solids could reduce consequences by at least a factor of five. These factors would reduce the bounding consequences by a factor of at least 30. The resultant best estimate consequences for four tank failures are illustrated in Table 3.4.3-2 along with the contribution from seismically induced flammable gas detonations.

- **Deflagrations Resulting From Natural Phenomena—Seismic**. As in the case of the evaluation basis seismic event, a large seismic event could possibly result in multiple GREs and deflagrations. The seismic excitation of the tank sludge is assumed to result in the release of retained gases to the tank headspace where they ignite because of seismically induced mechanical or electrical sparks. The conditional likelihoods of a GRE above the LFL and an ignition source given a seismic event have not been well characterized and are conservatively assumed to be 1.0. The source terms and consequences for SST and DST deflagrations are developed in Section 3.4.2.2.

Gas release fractions during very large seismic events may exceed 50%. Gas release fractions of this magnitude may result in small releases or large releases depending on the amount of gas retained within the waste in each tank. For tanks with a large amount of retained gas, large releases may occur. As discussed in Section 3.4.2.2, the accident consequences resulting from a headspace deflagration can vary over a large range depending on assumptions regarding combustion phenomena and tank failure modes. Parametric analysis of release fractions and consequences included deflagrations and detonations.

As discussed in Section 3.4.2.2, a detonation resulting from a spontaneous or induced GRE is estimated to be no greater than "extremely unlikely" because of the specific requirements that must be realized concerning the quantity of gas released to attain detonation sensitive concentrations, the timing of the ignition,

and the low likelihood of deflagrations transitioning to detonation in large vessels with little obstruction. Source terms and consequences for a detonation are presented in Section 3.4.2.2 only for DSTs. Mechanisms for very large gas releases in SSTs other than large seismic events have been largely ruled out. Given a large seismic event and the subsequent large possible gas release fraction, detonations in some SSTs and DSTs are postulated for this analysis of very large seismic events. However, the transition of a seismically induced GRE from a deflagration to a detonation is unlikely and, therefore, the combined frequency of a very large earthquake and a detonation is assigned a frequency of "extremely unlikely."

The source term analysis for a detonation, described in Section 3.4.2.2 resulted in a release of 120 L of respirable material. The consequences of a detonation in a SST would be increased over the consequences calculated for a DST because of differences in release material ULDs. In this case changing release material from DST liquids to SST solids results in a factor of 36 increase in calculated radiological consequences, a factor of 4.8 increase for onsite toxicological consequences ("extremely unlikely" frequency category), and a factor of 27 increase for offsite toxicological consequences.

The best-estimate consequences for the detonation releases are reduced from those described in Section 3.4.2.2 by the use of a 50th percentile dispersion coefficient that reduces the consequences by a factor of six.

The consequences for the 0.43 *g* earthquake shown in Table 3.4.3-2 include contributions from a detonation in one DST, a detonation in one SST, and the collapse of four tanks as described above because of the seismic motion without a flammable gas ignition. Credit was not taken for a buoyant plume rise that would further reduce consequences.

3.4.3.2.2 Beyond Evaluation Basis Organic Salt-Nitrate Reaction. The evaluation basis accident for the organic salt-nitrate reaction was computed based on burning 25 m^3 (883 ft^3) of reactive waste. That analysis showed that structural damage was limited to pit riser covers lifting (if any were present), HEPA filter rupture, and dome structural failure via dome cracking. If a significantly larger amount of waste were burned (about 200 m^3 [7,063 ft^3]), significantly higher headspace pressures and temperatures would be generated. If the reactive waste were spread over most of the waste surface, after about 50 min of burning a gradually widening region, heat transfer from the hot gases in the headspace would cause a general surface ignition across all the reactive waste exposed at the surface. This would result in rapid pressure and temperature transients with peak pressures to above 150 kPa (22 lb/in.^{2} gauge) overpressure and temperatures rising above 700 °C (1292 °F) at the dome wall. These conditions could lead to a collapse of all or part of the tank dome. The frequency for the event is qualitatively estimated to be in the "extremely unlikely" category.

Whether the dome collapsed as a result of burning 200 m^3 (7,063 ft^3) of waste, the ensuing radiological and toxicological consequences would be very large. Because 95% of the aerosols generated in burning 25 m^3 (883 ft^3) of waste would be released from the tank and up to 99% of the aerosols generated in burning 200 m^3 (7,063 ft^3) of waste would be released from the tank, the releases and doses are closely proportional. Therefore, the radiological and toxicological doses from burning 200 m^3 (7,063 ft^3) of waste can be computed by simple ratios from 25 m^3 (883 ft^3) dose consequences. The dose consequences of the mechanical dispersion of waste resulting from dome collapse itself are small compared with the consequences of burning 200 m^3 (7,063 ft^3) of waste to cause the collapse. WHC-SD-WM-CN-051 reports that the consequences of a whole dome collapse would be 2.3 Sv (2.3×10^2 rem) onsite and 2.0×10^{-3} Sv (2.0×10^{-1} rem) offsite.

A best-estimate consequence assessment was extrapolated by examining key consequence analysis assumptions and applying best-estimate versus bounding and conservative assumptions. Because nearly all of the assumptions made in the analysis have already been refined and are considered to be best estimates, only one assumption was identified that may be changed to a more typical or best-estimate value. The use of 50th percentile dispersion coefficients rather than 99.5th percentile coefficients would reduce the consequences by a factor of approximately six. The resultant best-estimate consequence is illustrated in Table 3.4.3-2. Credit was not taken for a buoyant plume rise that would further reduce consequences.

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Table 3.4.3-1. Residual Risk: Summary of Beyond Evaluation Basis Accidents with Failure of Controls. (4 sheets)

Accident description	Accident without controls			Accident with failure of controls			
	Frequency category	Bounding consequences[a] rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)	Frequency category	Dose reduction factor	Best estimate consequence[b] rad: Sv (rem) tox: SOF	Risk guideline rad: Sv (rem) tox: SOF (ERPG)
HEPA filter failure-exposure to high temperature	Anticipated	Onsite rad: 5.9 E-03 (5.9 E-01) 7.1 E-02[c] (7.1 E+00)[c]	5.0 E-03 (5.0 E-01)	Unlikely	6 (rad) 6 (tox)	Onsite rad: 9.8 E-04 (9.8 E-02) 1.2 E-02[c] (1.2 E+00[c])	5.0 E-02 (5.0 E+00)
Fire in a contaminated area	Anticipated	Onsite rad: 5.3 E-01 (5.3 E+01) Onsite tox: 1.2 E+00	5.0 E-03 (5.0 E-01) 1 (ERPG-1)	Extremely unlikely	36 (rad) 444 (tox)	Onsite rad: 1.5 E-02 (1.5E+00) Onsite tox: 2.7 E-03	1.0 E-01 (1.0 E+01) 1(ERPG-3)
Mixing of incompatible material-tank pressurization	Anticipated	Onsite rad: 4.0 E-02 (4. E+00) Onsite tox: 3.0 E+01	5.0 E-03 (5.0 E-01) 1 (ERPG-1)	Extremely unlikely	6 (rad) 222 (tox)	Onsite rad: 6.7 E-03 (6.7 E-01) Onsite tox: 1.4 E-01	1.0 E-01 (1.0 E+01) 1 (ERPG-3)
Tank failure due to excessive loads	Unlikely	Onsite tox: 5.0 E+00	1 (ERPG-2)	Extremely unlikely	18 (rad) 90 (tox)	Onsite tox: 5.6 E-02	1 (ERPG-3)
Flammable gas deflagrations-accumulation (SST dome collapse)	Anticipated	Onsite rad: 9.9 E+00 (9.9 E+02) Offsite rad: 6.7 E-03 (6.7 E-01) Onsite tox: 4.2 E+02 Offsite tox: 6.6 E-01	5.0 E-03 (5.0 E-01) 1.0 E-03 (1.0 E-01) 1 (ERPG-1) 1 (PEL-TWA)	Extremely unlikely	2,000 (rad) 80,000 (tox onsite) 10,000 (tox offsite)	Onsite rad: 5.0 E-03 (5.0 E-01) Offsite rad: 3.4 E-06 (3.4 E-04) Onsite tox: 5.3 E-03 Offsite tox: 6.6 E-05	1.0 E-01 (1.0 E+01) 4.0 E-02 (4.0 E+01) 1 (ERPG-3) 1 (ERPG-2)

Table 3.4.3-1. Residual Risk: Summary of Beyond Evaluation Basis Accidents with Failure of Controls. (4 sheets)

Accident description	Accident without controls			Accident with failure of controls			
	Frequency category	Bounding consequences[a] rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)	Frequency category	Dose reduction factor	Best estimate consequence[b] rad: Sv (rem) tox: SOF	Risk guideline rad: Sv (rem) tox: SOF (ERPG)
Flammable gas deflagrations-Gas release event (SST dome collapse)	Anticipated	Onsite rad: 9.9 E+00 (9.9 E+02) Offsite rad: 6.7 E-03 (6.7 E-01) Onsite tox: 4.2 E+02 Offsite tox: 6.6 E-01	5.0 E-03 (5.0 E-01) 1.0 E-03 (1.0 E-01) 1 (ERPG-1) 1 (PEL-TWA)	Unlikely	2,000 (rad) 4,000 (tox onsite) 2,000 (tox offsite)	Onsite rad: 5.0 E-03 (5.0 E-01) Offsite rad: 3.4 E-06 (3.4 E-04) Onsite tox: 1.1 E-01 Offsite tox: 3.3 E-04	5.0 E-02 (5.0 E+00) 5.0 E-03 (5.0 E-01) 1 (ERPG-2) 1 (ERPG-1)
Organic solvent fire	Unlikely	Onsite rad: 6.1 E-02 (6.1 E+00) Onsite tox: 4.0 E+01	5.0 E-02 (5.0 E+00) 1 (ERPG-2)	Unlikely	10 (rad) 10 (tox)	Onsite rad: 6.1 E-03 (6.1 E-01) Onsite tox: 4.0 E+00	5.0 E-02 (5.0 E+00) 1 (ERPG-2)
In-tank fuel fire/deflagration	Unlikely	--	--	Extremely unlikely	--	--	--
Organic salt-nitrate reaction	Unlikely	Onsite rad: 8.8 E+01 (8.8 E+03) Offsite rad: 7.3 E-02 (7.3 E+00) Onsite tox: 1.4 E+05 Offsite tox: 1.6 E+02	5.0 E-02 (5.0 E+00) 5.0 E-03 (5.0 E-01) 1 (ERPG-2) 1 (ERPG-1)	Extremely unlikely	6 (rad) 6 (tox)	Onsite rad: 1.5 E+01 (1.5 E+03) Offsite rad: 1.2 E-02 (1.2 E+00) Onsite tox: 2.3 E+04 Offsite tox: 2.7 E+01	1.0 E-01 (1.0 E+01) 4.0 E-02 (4.0 E+00) 1 (ERPG-3) 1 (ERPG-2)

Table 3.4.3-1. Residual Risk: Summary of Beyond Evaluation Basis Accidents with Failure of Controls. (4 sheets)

Accident description	Accident without controls			Accident with failure of controls			
	Frequency category	Bounding consequences[a] rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)	Frequency category	Dose reduction factor	Best estimate consequence[b] rad: Sv (rem) tox: SOF	Risk guideline rad: Sv (rem) tox: SOF (ERPG)
Surface leak resulting in pool	Anticipated	Onsite rad: 3.3 E+00 (3.3 E+02) Offsite rad: 3.6 E-01 (3.6 E+01) Onsite tox: 5.0 E+00	5.0 E-03 (5.0 E-01) 1.0 E-03 (1.0 E-01) 1 (ERPG-1)	Extremely unlikely	90 (rad) 312 (tox)	Onsite rad: 3.7 E-02 (3.7 E+00) Offsite rad: 4.0 E-03 (4.0 E-01) Onsite tox: 1.6 E-02	1.0 E-01 (1.0 E+01) 4.0 E-02 (4.0 E+00) 1 (ERPG-3)
Subsurface leak resulting in pool	Anticipated	Onsite rad: 3.1 E+00 (3.1 E+02) Offsite rad: 7.1 E-03 (7.1 E-01) Onsite tox: 1.7 E+01	5.0 E-03 (5.0 E-01) 1.0 E-03 (1.0 E-01) 1 (ERPG-1)	Unlikely	22 (rad) 28 (tox)	Onsite rad: 1.4 E-01 (1.4 E+01) Offsite rad: 3.2 E-04 (3.2 E-02) Onsite tox: 6.1 E-01	5.0 E-02 (5.0 E+00) 5.0 E-03 (5.0 E-01) 1 (ERPG-2)
Spray leak in structure or from waste transfer lines	Anticipated	Onsite rad:[d] 7.4 E+00 (7.4 E+02) Offsite rad:[e] 8.3 E-02 (8.3 E+00) Onsite tox: 2.5 E+01	5.0 E-03 (5.0 E-01) 1.0 E-03 (1.0 E-01) 1 (ERPG-1)	Unlikely	54 (rad) 90 (tox)	Onsite rad: 1.4 E-01 (1.4 E+01) Offsite rad: 1.5 E-03 (1.5 E-01) Onsite tox: 2.8 E-01	5.0 E-02 (5.0 E+00) 5.0 E-03 (5.0 E-01) 1 (ERPG-2)

Table 3.4.3-1. Residual Risk: Summary of Beyond Evaluation Basis Accidents with Failure of Controls. (4 sheets)

Accident description	Accident without controls			Accident with failure of controls			
	Frequency category	Bounding consequences[a] rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)	Frequency category	Dose reduction factor	Best estimate consequence[b] rad: Sv (rem) tox: SOF	Risk guideline rad: Sv (rem) tox: SOF (ERPG)
Tank bump	Unlikely	Onsite rad: 2.5 E+00 (2.5 E+02) Onsite tox: 4.9 E+03	5.0 E-02 (5.0 E+00) 1 (ERPG-2)	Extremely Unlikely	6 (rad) 30 (tox)	Onsite rad 4.2 E-01 (4.2 E+01) Onsite tox 1.6 E+02	1.0 E-01 (1.0 E+01) 1 (ERPG-3)

[a]Only the consequences that exceed risk guidelines are listed.
[b]Approximated by dividing radiological and toxicological consequences with controls by the appropriate dose reduction factor.
[c]Annual unfiltered release.
[d]Dose reflects 10-min exposure duration because of assumed self-evacuation (Section 3.4.2.9, "Spray Leak in Structure or From Waste Transfer Lines").
[e]Dose is for 24-hour exposure period (Section 3.4.2.9).
ERPG = Emergency Response Planning Guideline.
HEPA = high-efficiency particulate air (filter).
rad = radiological consequences.
SOF = sum-of-fractions.
tox = toxicological consequences.

Table 3.4.3-2. Summary of Accident Conditions Beyond the Evaluation Basis. (5 sheets)

Accident description	Frequency category	Best estimate consequences rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)
Earthquake with 0.43 *g* peak horizontal acceleration failing 4 single-shell tanks and causing single-shell tank and double-shell tank detonations with dome collapses	Unlikely	Radiological onsite:[a] (1) 3.1 E-01 (3.1 E+01)[c] (2) 5.0 E+01 (5.0 E+03)[g] (3) 1.4 E+00 (1.4 E+02)[k] (4) 5.0 E+01 (5.0 E+03)	5.0 E-02 (5.0 E+00)
		Radiological offsite:[a] (1) 2.7 E-04 (2.7 E-02)[d] (2) 3.4 E-02 (3.4 E+00)[h] (3) 9.3 E-04 (9.3 E-02)[l] (4) 3.5 E-02 (3.5 E+00)	5.0 E-03 (5.0 E-01)
		Toxicological onsite:[a] (1) 5.1 E+01[e] (2) 3.6 E+02[i] (3) 7.5 E+01[m] (4) 3.6 E+02	1 (ERPG-2)
		Toxicological offsite:[a] (1) 3.1 E-03[f] (2) 1.7 E+00[j] (3) 6.2 E-02[n] (4) 1.8 E+00	1 (ERPG-1)

Table 3.4.3-2. Summary of Accident Conditions Beyond the Evaluation Basis. (5 sheets)

Accident description	Frequency category	Best estimate consequences rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)
Organic salt-nitrate reaction of 200 m^3 (7,063 ft^3)	Extremely unlikely	Radiological onsite: 1.2 E+02 (1.2 E+04)[o]	1.0 E-01 (1.0 E+01)
		Radiological offsite: 9.8 E-02 (9.8 E+00)[p]	4.0 E-02 (4.0 E+00)
		Toxicological onsite:[b] 1.4 E+04[q]	1 (ERPG-3)
		Toxicological offsite:[b] 1.6 E+02[r]	1 (ERPG-2)

[a]Values listed in order of contributions from (1) 4 single-shell tank failures, (2) 1 single-shell tank detonation, (3) 1 double-shell tank detonation, and (4) sum of contributions. For onsite consequences, the sum is considered the highest exposure of any of the accident elements at 100 m (328 ft) because one individual cannot be 100 m (328 ft) from all of the accident elements.

[b]Toxic exposures dominated by mercury.

[c]Value determined by the following calculation: (2.3 Sv/30) x 4 tank failures.

Where:

2.3 Sv is the onsite radiological consequence from WHC-SD-WM-CN-051, *The Effects of Load Drop, Uniform Load, and Concentrated Loads on Waste Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington and 30 is the reduction factor discussed in Section 3.4.3.2.1.

[d]Value determined by the following calculation: [(2.0 x 10^{-3} Sv)/(30)] x 4 tank failures.

Where:

2.0 x 10^{-3} Sv is the offsite radiological consequence from WHC-SD-WM-CN-051 and 30 is the reduction factor discussed in Section 3.4.3.2.1.

[e]Value determined by the following calculation: (380/30) x 4 tank failures.

Where:

380 is the onsite toxicological consequence as calculated in WHC-SD-WM-CN-051 and 30 is the reduction factor discussed in Section 3.4.3.2.1.

[f]Value determined by the following calculation: (2.3 x 10^{-2}/30) x 4 tank failures.

Where:

2.3 x 10^{-2} is the offsite toxicological consequence as calculated in WHC-SD-WM-CN-051 and 30 is the reduction factor discussed in Section 3.4.3.2.1.

Table 3.4.3-2. Summary of Accident Conditions Beyond the Evaluation Basis. (5 sheets)

Accident description	Frequency category	Best estimate consequences rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)

[g]Value determined by the following calculation: [(8.2 Sv x 36)/(6)].

Where:

8.2 Sv is the onsite radiological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table), 36 is the consequence increase factor as discussed in Section 3.4.3.2.1, and 6 is the consequence reduction factor also discussed in Section 3.4.3.2.1.

[h]Value determined by the following calculation: [{(5.6 x 10^{-3} Sv)(36)}/(6)].

Where:

5.6 x 10^{-3} Sv is the offsite radiological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table), 36 is the consequence increase factor as discussed in Section 3.4.3.2.1, and 6 is the consequence reduction factor also discussed in Section 3.4.3.2.1.

[i]Value determined by the following calculation: [{(4.5 x 10^{2})(4.8)}/(6)].

Where:

4.5 x 10^{2} is the onsite toxicological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table), 4.8 is the consequence increase factor as discussed in Section 3.4.3.2.1, and 6 is the consequence reduction factor also discussed in Section 3.4.3.2.1.

[j]Value determined by the following calculation: [{(3.7 x 10^{-1})(27)}/(6)].

Where:

3.7 x 10^{-1} is the offsite toxicological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table), 27 is the consequence increase factor as discussed in Section 3.4.3.2.1, and 6 is the consequence reduction factor also discussed in Section 3.4.3.2.1.

Table 3.4.3-2. Summary of Accident Conditions Beyond the Evaluation Basis. (5 sheets)

Accident description	Frequency category	Best estimate consequences rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)

[k]Value determined by the following calculation: (8.2 Sv/6).

Where:

8.2 Sv is the onsite radiological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table) and 6 is the consequence reduction factor discussed in Section 3.4.3.2.1.

[l]Value determined by the following calculation: (5.6×10^{-3} Sv/6).

Where:

5.6×10^{-3} Sv is the offsite radiological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table) and 6 is the consequence reduction factor discussed in Section 3.4.3.2.1.

[m]Value determined by the following calculation: (4.5×10^{2}/6).

Where:

4.5×10^{2} is the onsite toxicological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table) and 6 is the consequence reduction factor discussed in Section 3.4.3.2.1.

[n]Value determined by the following calculation: (3.7×10^{-1}/6).

Where:

3.7×10^{-1} is the offsite toxicological consequence from Table 3.4.2.2-5 for the DST dome blowout—detonation case (Gas Release Event and Ignition Results in Headspace Deflagrations portion of the table) and 6 is the consequence reduction factor discussed in Section 3.4.3.2.1.

[o]Value determined by the following calculation: [{(8.8×10^{1} Sv)(8) + (2.3 Sv)}/6].

Where:

8.8×10^{1} Sv is the onsite radiological consequence from Table 3.4.2.6-4 for the organic salt-nitrate reaction without controls, 8 is the ratio of burning 200 m^3 in the beyond evaluation accident analysis to the 25 m^3 burned in the evaluation basis accident analysis, 2.3 Sv is the onsite radiological consequence from WHC-SD-WM-CN-051 to include the contribution from a dome collapse, and 6 is the consequence reduction factor discussed in Section 3.4.3.2.2.

Table 3.4.3-2. Summary of Accident Conditions Beyond the Evaluation Basis. (5 sheets)

Accident description	Frequency category	Best estimate consequences rad: Sv (rem) tox: SOF	Risk guidelines rad: Sv (rem) tox: SOF (ERPG)

[p]Value determined by the following calculation: $[\{(7.3 \times 10^{-2}\ Sv)(8) + (2.0 \times 10^{-3}\ Sv)\}/6]$.

Where:

7.3×10^{-2} Sv is the offsite radiological consequence from Table 3.4.2.6-4 for the organic salt-nitrate reaction without controls, 8 is the ratio of burning 200 m^3 in the beyond evaluation accident analysis to the 25 m^3 burned in the evaluation basis accident analysis, 2.0×10^{-3} Sv is the onsite radiological consequence from WHC-SD-WM-CN-051 to include the contribution from a dome collapse, and 6 is the consequence reduction factor discussed in Section 3.4.3.2.2.

[q]Value determined by the following calculation: $[\{(1.0 \times 10^{3})(8) + 380\}/6]$.

Where:

1.0×10^{3} is the onsite toxicological consequence from Table 3.4.2.6-4 for the organic salt-nitrate reaction with controls (to correct for the proper frequency—extremely unlikely), 8 is the ratio of burning 200 m^3 in the beyond evaluation accident analysis to the 25 m^3 burned in the evaluation basis accident analysis, 380 is the onsite toxicological consequence from WHC-SD-WM-CN-051 to include the contribution from a dome collapse, and 6 is the consequence reduction factor discussed in Section 3.4.3.2.2.

[r]Value determined by the following calculation: $[\{(1.2 \times 10^{2})(8) + (2.3 \times 10^{-2})\}/6]$.

Where:

1.2×10^{2} is the offsite toxicological consequence from Table 3.4.2.6-4 for the organic salt-nitrate reaction with controls (to correct for the proper frequency—extremely unlikely), 8 is the ratio of burning 200 m^3 in the beyond evaluation accident analysis to the 25 m^3 burned in the evaluation basis accident analysis, 2.3×10^{-2} is the offsite toxicological consequence from WHC-SD-WM-CN-051 to include the contribution from a dome collapse, and 6 is the consequence reduction factor discussed in Section 3.4.3.2.2.

AWF = Aging Waste Facility.
DST = double-shell tank.
ERPG = Emergency Response Planning Guideline.
SOF = sum-of-fractions.
SST = single-shell tank.

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Revision 1
Volume II

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Volume II:
Chapters 4.0 through 17.0

Prepared for the U.S. Department of Energy

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Richland, Washington

Hanford Management and Integration Contractor for the
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Prepared by
Lockheed Martin Hanford Corporation

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CHAPTER 4.0
SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

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CHAPTER 4.0
SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

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LIST OF TERMS

AWF	Aging Waste Facility
BFP	backflow preventer
CAM	continuous air monitor
CGI	commercial grade item
COB	cleanout box
DACS	Data Acquisition and Control System
DBA	design basis accident
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
EPDM	ethylene-propylene diene monomer
FIC	Food Instrument Corporation
FSAR	Final Safety Analysis Report
FTIR	Fourier Transform Infrared
GRE	gas release event
HEPA	high-efficiency particulate air (filter)
HVAC	heating, ventilation, and air conditioning
IMUST	inactive miscellaneous underground storage tank
LFL	Lower Flammability Limit
MIT	multifunction instrument tree
OGT	overground transfer
ORP	Office of River Protection
PMS	preventive maintenance sheet
RCSTS	replacement cross-site transfer system
SC	Safety Class
SSC	structure, system, and component
SST	single-shell tank
TC	thermocouple
TMACS	Tank Monitoring and Control System
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
WG	water gauge
WRSS	waste retrieval sluicing system

4.0 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

4.1 INTRODUCTION

The Tank Waste Remediation System (TWRS) safety analysis uses a graded approach for the identification of structures, systems, and components (SSCs) that maintain or perform safety functions. This graded process results in selective application of functional requirements to engineered features of the SSCs that maintain or perform safety functions. This chapter provides a description of the attributes of the specific SSCs required to provide the necessary safety functions and, thus, supplies the information needed for derivation of the Technical Safety Requirements (TSRs) for the Final Safety Analysis Report (FSAR). The general design of a safety SSC (e.g., DST ventilation systems) may differ from one TWRS location to another, but the safety function of the safety SSC shall apply at all locations. The operational availability of safety SSCs shall be considered and include factors such as redundancy, diversity, and planned downtimes, as appropriate to satisfy the identified safety function(s). The expected products of this chapter include:

- Descriptions of safety SSCs, including safety function(s)
- Identification of the supporting SSCs that the safety SSCs depend upon to carry out safety functions
- Identification of the functional requirements necessary for the safety SSCs to perform their safety function and the general conditions caused by postulated accidents under which the safety SSCs must operate
- Identification of the performance criteria necessary to provide reasonable assurance that the functional requirements will be met
- Identification of assumptions requiring TSRs to ensure performance of the safety function.

The SSCs included in this report are divided into two categories, Safety-Class SSCs and Safety-Significant SSCs. Safety functions performed by Safety-Class SSCs prevent or mitigate releases to the public that would otherwise exceed the offsite radiological risk guidelines or prevent a nuclear criticality.

Safety functions performed by Safety-Significant SSCs prevent or mitigate releases of radiological materials to onsite workers and toxic chemicals to the offsite public and onsite workers. Safety-Significant SSCs also include those safety SSCs that protect the facility worker from serious injury (or fatality) because of hazards not controlled by institutional safety programs.

Defense-in-Depth, as a fundamental safety philosophy, has an extensive precedent in nuclear safety. It builds in many layers of defense against a release of hazardous materials so that no one layer by itself, no matter how dependable, is relied upon totally. To compensate for potential human and mechanical failures, Defense-in-Depth relies on several layers of protection with successive barriers to prevent the release of hazardous material to the environment. This approach includes protection of the barriers, both to avert damage to the physical plant and damage to the barriers themselves. It also includes other measures to protect the public, the onsite workers, and the environment from harm in case these barriers are not fully effective.

There are typically multiple layers of Defense-in-Depth. The inner layers rely on quality of design and competent staff personnel who are well trained in their facility operations and maintenance procedures. Competent personnel translates into fewer errors, failures, or malfunctions of Defense-in-Depth systems and components and, thus, minimizes challenges to the next layer of defense.

In the event that the inner layer of Defense-in-Depth is compromised by either equipment malfunction (from whatever cause) or operator error and there is a progression from a normal to an abnormal range of operation, the next layer of Defense-in-Depth is relied upon to halt the progression of events toward a more serious accident. This layer can consist of automatic systems and other devices that alert the operators to either take action or manually activate systems that will correct the abnormal situation.

The final, or outer, layers of Defense-in-Depth provide mitigation of the consequences of an accident. Passive, automatically or manually activated features (e.g., filtered exhaust) and safety management system programs (e.g., emergency response procedures) minimize accident consequences in the event that all other layers have been breached. The contribution of emergency response actions in minimizing the consequences of an accident cannot be neglected, as the emergency response actions represent the truly final measure of protection for releases that cannot be prevented.

The Defense-in-Depth philosophy is the primary approach to hazard control for nuclear facilities such as TWRS and specifically addresses Defense-in-Depth and protection of workers and the environment. Facility SSCs that are major contributors to Defense-in-Depth are identified as Safety-Significant SSCs in their representative accident analyses.

The Safety-Class and Safety-Significant SSCs were identified with a disciplined methodology and process using established control decision criteria (described more fully in Section 3.3.1.5). Controls derivation was based on the best available information, the collective expertise and experience of the participating personnel (representing hazard and accident analysis, engineering, operations, and management), and application of the control decision criteria. Control decision criteria were generally qualitative except for comparison of calculated accident analysis results with the risk evaluation guidelines. Three especially important safety SSC criteria (i.e., reliability, availability, and maintainability) were fully considered in the control decision process.

Consistent with the Defense-in-Depth philosophy outlined here and in accordance with the requirements of DOE 5480.23, *Nuclear Safety Analysis Reports*, challenges to the safety SSCs discussed in this chapter (i.e., the defined accident barriers) have been addressed in this safety analysis report. In the "with controls" accident analysis summarized in Chapter 3.0, each identified safety SSC has been evaluated through the control decision process to address and understand its suitability in the performance of the identified safety function(s) during and after postulated accident conditions. This chapter reinforces the safety function(s) identified and further evaluates the safety SSCs and associated systems by including specific functional requirements to confirm its suitability to either mitigate or prevent postulated accident consequences to the facility worker, onsite receptor, offsite public, and the environment.

The TWRS facilities, in their existing condition, are analyzed in the FSAR accident analyses for what can go wrong. As presented in the discussion on accident analysis (Sections 3.3.2.4.x and 3.4.2.x), the necessary set of Safety-Class and Safety-Significant SSCs is identified from the evaluation basis accident analyses. The design of the TWRS safety SSCs is not traceable to these evaluation basis accident analyses, however, unlike the front-end approach for the design of a new nonreactor nuclear facility. The requirements and characteristics of the TWRS safety SSCs are based solely on their attributes (i.e., the functional requirements of the safety SSCs and their associated evaluation criteria) and mark the identified safety SSCs for special treatment as the TWRS equipment that is most important to safety. The safety management system processes, policies, and the programs discussed in Section 17.4 provide the programmatic support to give them that special treatment. It is important to note that the FSAR is focused on identifying functional requirements for the TWRS safety SSCs that, in general, are neither absolute nor subject to precise safety margin resolution. Further, the associated performance criteria are only defined for critical operational aspects of the TWRS safety SSCs and not their general design.

The TWRS safety SSCs identified in the FSAR do not require "retrofit" or "rework" to any upgrading criteria. When the U.S. Department of Energy (DOE) issued DOE 5480.23 (with its safety guide attachment), and DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, it made clear its intent to develop safety analyses that established and evaluated the adequacy of the safety bases for operation of their nonreactor nuclear facilities. The DOE never intended those analyses to force a wave of retrofit or rework to upgrade the newly identified safety SSCs. Using a graded approach, however, the TWRS technical staff should always strive to improve the design of the physical plant with every design opportunity. Modifications that enhance the reliability and performance of the TWRS safety SSCs while maintaining their functional requirements will ultimately decrease the residual risk of TWRS operations.

Safety-Significant, Safety-Class, and Defense-in-Depth SSCs are identified for the set of representative accidents analyzed in Chapter 3.0, "Hazard and Accident Analyses." Their safety functions, with appropriate comments, are captured in the tables that follow each analysis. The TWRS Design Features discussed in Section 5.6 and listed in the TSR document are vital passive SSCs whose uncontrolled alteration, modification, or replacement would have a significant effect on safety. The basic criteria and programmatic requirements for activities affecting the Safety-

Significant, Safety-Class, Defense-in-Depth, and Design Feature SSCs are summarized below. The discipline imposed by these criteria and requirements goes far beyond merely supporting the assumptions identified in the TSRs and the FSAR analyses: it is an integral part of the Defense-in-Depth philosophy.

Defense-in-Depth and Design Feature SSCs are protected by the following disciplines:

- Configuration control and configuration management processes shall be followed. Engineering drawings, documents, and other necessary design media shall be controlled per approved procedures as discussed in Section 17.4.2. Two overall commitments of the FSAR are that (1) the TWRS configuration and physical arrangement underlying the documented safety basis shall not be changed without implementing and completing the Unreviewed Safety Question process presented in Section 17.4.1.1 and (2) that the process used for changing the TWRS plant design shall provide a controlled and auditable interface with the Unreviewed Safety Question process.

- On construction projects many SSC installations are "field fitted" to accommodate the project schedule, an acceptable practice because the installation is not yet part of the operating plant. A formal "as-built" process is performed near the end of construction, and the configuration and arrangement details are verified and reconciled with the facility safety analysis report. Drawing revisions to incorporate Engineering Change Notices prepared during construction activities are permitted at any time.

  Unlike construction projects, however, physical plant modifications to the configuration and physical arrangement of TWRS SSCs affect the operating plant and shall be performed using only approved and released design change documents that have been screened by the Unreviewed Safety Question process presented in Section 17.4.1.1. Drawing revisions to incorporate Engineering Change Notices for physical plant modifications affecting the configuration and physical arrangement of TWRS SSCs shall be performed only after final release of Engineering Change Notices as "Modification Work Complete."

- All design changes shall be verified in accordance with approved procedures, and a graded approach for approval of all engineering documents shall be followed. Design changes shall comply with the requirements provided in 10 CFR 830.120, "Quality Assurance." Design changes affecting the human-machine interface shall receive special attention, shall build on strengths, and shall protect against the susceptibility to human error in operating crews.

- There is a firm FSAR commitment that facility work shall be performed only with proper authorization. As described further in Section 17.4.2, approved work

control processes shall be followed for all physical plant modifications to Defense-in-Depth and Design Feature SSCs. Using a graded approach, the same work control processes shall be applied to all preventive and corrective maintenance performed on facility SSCs.

- The quality assurance processes and procedures described in Chapter 14.0, "Quality Assurance," shall be followed. Appropriate levels of quality control involvement shall be exercised in any physical plant modification, replacement, maintenance, or other work activity which affects Defense-in-Depth and Design Feature SSCs.

- To achieve and sustain safe operations, a comprehensive program of management oversight and assessment covering operations, surveillance and maintenance practices, feedback of operational experience, and overall effectiveness of management controls, as described in Section 17.3.2, shall be maintained. The implementing procedures for TWRS are maintained in HNF-IP-0842, *TWRS Administration*.

- As described in Chapters 11.0, "Operational Safety," and 12.0, "Procedures and Training," the preparation, approval, validation, and use of written procedures to guide operations, testing, surveillance, and maintenance activities shall be required. A competent operating staff shall be well trained in all operations, testing, surveillance, and maintenance procedures.

- Purchasing processes for spare parts and other materials needed for TWRS work activities shall be controlled by approved procedures.

Safety-Significant and Safety-Class SSCs are protected by the following additional disciplines. The above basic criteria and programmatic requirements for Defense-in-Depth and Design Feature SSCs shall also apply:

- For all safety SSCs, engineering drawings, documents, and other necessary design media shall accurately represent the TWRS physical plant configuration and arrangement. A change to the design of a Safety-Significant or Safety-Class SSC shall only be possible after full consideration of the reasons supporting why the SSC was originally identified as a safety SSC. Modifications of safety SSCs shall comply with the requirements of approved procedures. In addition, the attributes of the safety SSC (i.e., functional requirements and associated performance criteria) required to support the safety function(s) provided in Chapter 3.0 shall not be changed without appropriate corresponding changes to the Chapter 3.0 analyses.

- A Safety Equipment List shall be maintained to segregate the individual equipment items, components, and parts of the safety SSCs that perform, or directly support the performance of, the safety function of the parent safety SSC from those that do

not. Groupings of individual equipment items, components, and parts, including essential installation hardware items (e.g., anchor bolts, pressure gauges, concrete footings), shall be captured in the Safety Equipment List, which shall normally be a subset of the facility Master Equipment List. The functional requirements necessary for each individual equipment item, component, or part, and the general environmental conditions caused by the postulated Chapter 3.0 representative accident(s) under which it must operate shall also be provided in the Safety Equipment List.

Segregating and classifying the above individual equipment items, components, and parts in the Safety Equipment List means that each will carry the same safety classification as the parent safety SSC for procurement, inventory control, and maintenance replacement or modification activities; it does not mean that each will now become a new and unique safety SSC. Conversely, individual equipment items, components, and parts whose failure would not impair performance of the safety function by the parent safety SSC shall be assigned a safety classification of General Service, and they may be procured as commercial grade items to the codes and standards of record.

The Safety Equipment List is not required to document SSC operability or field repair status, i.e., it does not need to list compensatory measure-related items nor include notes or references addressing missing or nonfunctional items.

- As described in Chapter 10.0, "Initial Testing, In-Service Surveillance, and Maintenance," enhanced inspection, testing, and maintenance programs shall be prepared and implemented to provide a high degree of assurance that all Safety-Significant and Safety-Class SSCs will perform their safety functions when required.

The following sections are divided into separate subsections for Safety-Class and Safety-Significant SSCs. These subsections include the following information:

- **Summary List**—This list is presented in Tables 4-1 (Section 4.3) and 4-7 (Section 4.4), and identifies (1) the SSCs, (2) the accident names (for Safety-Class and most Safety-Significant SSCs) or rationale (for some Safety-Significant SSCs) for which the safety designation was made, (3) safety functions, (4) functional requirements, and (5) performance criteria judged to require TSR coverage. The remaining subsections provide details that correlate to the summary list.

- **SSC Identification**—The SSC identification is established in this section, such as the Safety-Class SSC primary tank leak detection system for double-shell tanks (DSTs) and Aging Waste Facility (AWF) tanks for the Flammable Gas Deflagrations accident, or the Safety-Significant SSC salt well flow totalizer identified for the Surface Leak Resulting in Pool (Section 3.4.2.7) accident.

- **Safety Function**—The safety function statement is drawn directly from the accident analysis. The safety function is a statement of the reason for identifying a safety SSC as Safety-Class or Safety-Significant with a specific identification of the SSC preventive or mitigative safety functions. For example, the safety function for the primary tank leak detection system for the Surface Leak Resulting in Pool accident is to provide an alarm of tank waste from misroutes or other system leaks into the tank annulus to alert operators to take action to stop the transfer of waste into the DST or AWF tank annulus, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.

- **System Description**—This section gives a brief description of the SSC and provides a basic summation of the physical information and the basic principles by which it performs its safety function. The boundaries and interface points of the safety SSC with other SSCs relevant to the safety function are also presented.

- **Functional Requirements**—The functional requirements are those that are specifically needed to fulfill the identified safety functions for the specific accidents where the safety SSC must function. If a safety SSC were required to function at an elevated temperature to perform its safety function, qualification of the SSC for operation in that temperature range would be a functional requirement.

- **System Evaluation**—The system evaluation provides performance criteria imposed on the SSC to ensure that the SSC can meet its functional requirements and thereby satisfy its safety functions. Performance criteria characterize the specific operational responses and capabilities necessary to meet functional requirements and an evaluation of the capabilities of the safety SSCs to meet performance criteria provided in this section. The manner of verification for these performance criteria is specified and may include required calibration, challenge tests, or other functional test procedures. For safety SSCs that already exist, formal design comparison and compliance with traditional safety SSC performance criteria is not required.

- **Controls (Technical Safety Requirements)**—This subsection identifies those assumptions requiring TSRs to ensure performance of the safety function.

The figures provided in this chapter have been included to aid the reader in visualizing information that is presented in the text. These sketches should not be considered design drawings, and they must not be used to make engineering modifications to any SSCs depicted. Facility modifications are approved in accordance with detailed design information found in established procedures, configuration-controlled drawings, and vendor information.

4.2 REQUIREMENTS

The information presented in Chapter 4.0 will satisfy the requirements of DOE 5480.23 paragraph(s) 8.b.(3)(d) as amplified in Attachment 1, paragraph(s) 4.f.(3)(d)4b and 4.f.(3)(d)4c, of the Order (Topic 4), and paragraph(s) 8.b.(3)(k) as amplified in Attachment 1, paragraph(s) 4.f.(3)(d)11n, of the Order (Topic 11).

The design codes, standards, and regulations for the safety SSCs discussed in Chapter 4.0 are those that existed at the time that the individual safety SSCs were designed, fabricated, and installed and reflect the prevailing health, safety, and environmental requirements of that time. Where applicable, specific design codes, standards, and regulations for a safety SSC that relate directly to the safety function of that safety SSC have been identified, and they are provided in the respective Chapter 4.0 section discussions that cover System Description. This information will partially satisfy the requirements of DOE 5480.23, paragraph(s) 8.b.(3)(b), 8.b.(3)(f), and 8.b.(3)(u), as discussed in detail in the Introduction to DOE-STD-3009-94.

Per agreement with DOE, Office of River Protection (ORP) completion of procedure upgrades associated with performance criteria specified in this chapter are deferred to March 30, 2000.

4.3 SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS

This section provides information for the Safety-Class SSCs identified in Chapter 3.0. Table 4-1 provides a summary list of those SSCs. Details of each Safety-Class SSC correlating to the information in the table follow.

Information on Safety-Class SSCs associated with projects outside the original scope of the FSAR are included in the designated addenda. Addendum 1 provides a description of the Safety-Class SSCs for the waste retrieval sluicing system (WRSS). Addendum 2 provides a description of the Safety-Class SSCs for the replacement cross-site transfer system (RCSTS). Addendum 3 provides a description of the Safety-Class SSCs for the 241-AZ-702 ventilation system. Addendum 4 provides a description of the Safety-Class SSCs for the 241-AZ-101 mixer pump test. Additional information on safety SSCs for Tank 241-SY-101 remediation activities and operations are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

4.3.1 Double-Contained Receiver Tank Ventilation Systems

The double-contained receiver tank (DCRT) ventilation systems are identified as Safety-Class SSCs for the Section 3.4.2.2 accident. This classification is applicable to DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U, and 244-CR TK-003.

4.3.1.1 Safety Function(s). Flammable gases can be introduced into the headspace of a DCRT by being: (1) transferred in with single-shell tank (SST) waste, (2) produced within the waste in the tank, and (3) produced by chemical adjustment. The gases are released to the headspace by bubble migration and waste intrusive activities. The volume of gas released by the waste may be enough to make a portion or all of the tank headspace flammable. The headspace is considered flammable when the concentration of flammable gases exceeds the Lower Flammability Limit (LFL).

The Section 3.4.2.2 accident analysis has identified active ventilation systems as the primary means of maintaining gases in the headspace below the flammability limit. The ventilation flow through each DCRT cannot be verified because of the current configuration of the DCRT ventilation systems. In DCRTs equipped with level dip tubes, the dip tubes are used to inject instrument air into the headspace, which provides a positive inlet flow to each DCRT whenever wastes are present in the tanks. This ventilation flow maintains the gas concentrations in the headspace below 25% of the LFL. Specific requirements for the DCRT ventilation systems to fulfill the safety function are identified in the following sections.

The safety function of the DCRT ventilation systems, including 244-CR TK-003, is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations (Section 3.4.2.2) accident.

4.3.1.2 System Description. For the DCRTs containing waste, a minimum inlet air supply as discussed in Section 4.3.1.3 ensures sufficient ventilation to the DCRT to maintain the flammable gas concentrations below 25% LFL. The DCRT 244-BX currently stores radioactive waste and requires continuous ventilation to maintain flammable gas concentrations below 25% of the LFL. Positive ventilation flow for DCRT 244-BX is provided by injecting instrument air into the installed weight factor dip tubes. The inlet air mixes with and dilutes the flammable gases in the vapor space of the tank. The DCRT 244-BX air/gas mixture is then swept from the tank by an active ventilation system, drawn through high-efficiency particulate air (HEPA) filters to remove radioactive particulate, and exhausted to the environment.

The 244-CR TK-003 ventilation system comprises an ambient air supply with ventilation airflow being directed and controlled through the vault and vault tanks by operation of the 244-CR ventilation system. The 244-CR ventilation system comprises an exhaust air filtration system. The 244-CR Vault is divided into an upper section and a lower section. The upper section comprises the pump pit and riser pit areas, and the lower, or vault, section houses the primary waste tanks, which are separated from the vault by annular spaces. The upper and lower vault sections are connected by exhaust ports and a floor drain that allow airflow between the two sections. Air is removed from the lower vault section at the floor level and routed into a filter plenum. The 244-CR ventilation system also removes air directly from the tanks and routes it to this common filter plenum. The combined airflow is then passed through a double bank of HEPA filters and discharged to the environment through monitored exhaust stack 296-C-05.

The remainder of the DCRTs (244-A, 244-S, 244-TX, and 244-U) will require supplemental ventilation using the level dip tubes when waste is stored in a DCRT. When waste

is to be stored in these tanks, instrument air must be injected into the tank for ventilation, the air injection flow rate must be verified by the flow indicators, and the active ventilation system must be operating.

A source (e.g., compressor, gas bottle) of instrument air is a supporting SSC and is described in Section 4.5.2.

4.3.1.3 Functional Requirements. The active ventilation system for all DCRTs shall maintain a vacuum in the tank vapor space, relative to atmospheric pressure. For DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U, the dip tubes shall provide a minimum total inlet airflow of 0.08 m^3/h (3 ft^3/h) to the tank while waste is stored. The dip tube flow indicators shall have a minimum range of 0.01 m^3/h to 0.04 m^3/h (0.2 ft^3/h to 1.5 ft^3/h).

The DCRT 244-S level dip tubes shall supply a minimum total inlet airflow of 0.14 m^3/h (5.0 ft^3/h) while waste is stored in it for transfers from Tanks 241-SX-104 and 241-SX-105.

4.3.1.4 System Evaluation. The existing DCRT ventilation systems are adequate for the required safety functions. The dip tube flow indicators used to verify ventilation flow for 244-BX DCRT (FI-1, FI-2, and FI-3) shall be calibrated or functionally tested annually. Similarly, the dip tube flow indicators for 244-A, 244-S, 244-TX, and 244-U shall be calibrated or functionally tested and verified to meet the functional requirements stated above before waste can be stored in those tanks.

The performance history of the three dip tube flow indicators for DCRT 244-BX has been satisfactory. Although they are fabricated from relatively fragile material, the flow meters are protected from damage by airborne missiles by locating them inside the associated instrument building. A loss of flow is obvious upon visual inspection, and necessary corrective actions can be taken immediately.

The 244-CR ventilation system contains redundant fans but does not contain redundant filter trains and an alternate supply of electrical power. The backup fan shall be started to restore active ventilation to the DCRT should the primary fan fail or require maintenance. Ventilation will be lost if one or both of the HEPA filter stages should fail as an alternate filtration path does not exist for this system; however, HEPA filter failure is extremely rare and filters can readily be replaced upon failure. Similarly, the active ventilation system will shut down during electrical power outages. The electrical distribution system is reliable, and extended outages are not expected. Once the power has been restored or an alternate power supply has been established, the ventilation system must be manually restarted.

4.3.1.5 Controls (Technical Safety Requirements). The assumption in the Flammable Gas Deflagrations accident is that the ventilation system (including the level dip tubes) and flow

indicators are operable and operating when waste is stored in the DCRTs. The operability assumptions include the following provisions:

- When waste is stored in the DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U, the flow indicators shall be monitored twice a day to verify that a minimum airflow of 0.08 m^3/h (3 ft^3/h) is provided.

- When waste is stored in DCRT 244-S during waste transfers from Tanks 241-SX-104 and 241-SX-105, the flow indicators shall be monitored twice a day to verify that a minimum airflow of 0.14 m^3/h (5 ft^3/h) is provided.

- When waste is stored in 244-CR TK-003, the ventilation system shall be verified operable twice a day.

The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*.

4.3.2 Double-Shell and Aging Waste Facility Tank Ventilation Systems

The DST (Section 2.4.3.7) and AWF tank (Section 2.4.3.7.1) primary tank ventilation systems are identified as Safety-Class SSCs for the Section 3.4.2.2 accident.

4.3.2.1 Safety Function(s). Flammable gases are generated in the tank waste by radiolysis, organic degradation, and corrosion. Gases generated in the settled solids layer of the waste are retained, while the gases generated in the supernatant layer are continuously released. The retained gases can be released naturally (i.e., gas release event [GRE]) or as a result of waste intrusive or waste disturbing activities in the tank.

The vapor space is considered flammable when the concentration of flammable gases exceeds the LFL. The volume of gas released by the waste in a GRE or waste intrusive activity may be enough to make a portion or all of the tank vapor space flammable. After a gas release resulting in a flammable vapor space, the tank vapor space will remain flammable for a short period of time until gas diffusion, convection, and active ventilation systems lower the flammable gas concentrations. The Section 3.4.2.2 accident analysis identified active ventilation systems as the primary means of maintaining the vapor space below the flammability limit. Specific requirements necessary for active ventilation systems to fulfill the safety functions are identified in the following sections.

The safety functions of the DST and AWF tank primary tank ventilation systems are to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations (Section 3.4.2.2) accident.

4.3.2.2 System Description. Primary tank ventilation systems provide a flow of air through all tanks in DST Tank Farms 241-AN, 241-AP, 241-AW, and 241-SY, and all tanks in AWF Tank Farms 241-AY and 241-AZ. The systems draw outside air into the tanks where it mixes with and displaces the flammable gases produced by the waste. The air/gas mixture is then removed from the tanks, filtered to remove radioactive particulates, and exhausted to the environment. Specific details for each system are provided below.

Air enters the 241-AP, 241-AY, and 241-AZ tanks by in-leakage through the central pump pit and enters the tank through the pit drain line. Small gaps exist between the walls of the concrete pump pits and the concrete cover blocks. The quantity of air flowing into the tanks and the tank vacuums are controlled by blocking the gaps and by adjusting the tank outlet butterfly valves. This process is repeated until the pressure and airflow rates are acceptable.

The 241-SY Tank Farm tanks have HEPA-filtered inlet stations that are connected to a primary tank riser. The pressure in the tank and airflow rates are regulated by inlet and outlet butterfly valves, which are adjusted until the pressures and flow rates are within acceptable limits. Additionally, the gaps between the pump pit walls and the cover blocks are sealed to prevent unfiltered leakage.

The tanks in 241-AN and 241-AW tank farms have HEPA-filtered inlet stations that contain constant flow devices. The constant flow devices are passive units that do not require support utilities and maintain a constant flow of air into the tanks. The working mechanism of the device is a floating orifice plate that opens or restricts the air inlet passage. The differential pressure across the orifice plate causes it to float. The orifice plates are interchangeable and calibrated to provide known combinations of pressure difference and flow. Similar to 241-SY Tank Farm, other air in-leakage passages into the primary tank have been sealed, and adjustment of the outlet butterfly valve aids in adjusting airflow and pressure. Unlike in the 241-SY Tank Farm, however, the inlet butterfly valve is normally left in the full open position and is closed only when the inlet HEPA filter is being replaced.

Electrical distribution has been identified as a supporting SSC for active ventilation systems and is described in Section 4.5.1.

4.3.2.3 Functional Requirements. The DST and AWF tank primary ventilation systems shall maintain vapor space pressures of all tanks <0 kPa (<0 in. WG) relative to atmospheric pressure.

4.3.2.4 System Evaluation. The existing DST and AWF tank ventilation systems are adequate for the required safety function. Operability of the primary tank ventilation systems shall be verified daily. To ensure that the standby systems will operate in the event of a primary ventilation system failure, the standby systems are functionally tested. Functional testing frequency of the standby systems is determined by operations.

Active ventilation systems are vulnerable to drive train malfunctions such as loss of electrical power and control system trips from malfunctioning process monitors. Mean time between failures has typically been very short by industrial performance standards. Equipment

upgrades and improved maintenance procedures have proven that mean time between failures can be increased.

4.3.2.5 Controls (Technical Safety Requirements). The assumption in the analysis of the DST Flammable Gas Deflagrations accident is that the ventilation systems are operable and operating during normal waste tank operations and will remain operable and operating during a GRE. This operability assumption includes, but is not limited to, the following provisions:

- The primary tank vapor space pressure is monitored daily and confirmed to be <0 kPa (<0 in. WG). (This is the preferred method.)

  OR

- Ventilation airflow rate is monitored daily

  OR

- Flow monitoring (e.g., constant flow device [floater] position on the inlet to AW tanks) is performed daily.

The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.3 Overground Transfer System

This section does not apply to overground transfers from Tank 241-SY-101 to Tank 241-SY-102 associated with crust growth remediation. Descriptions of the waste transfer system for Tank 241-SY-101 crust growth remediation are provided in HNF-3737.

The accident analyses discussed in Sections 3.4.2.7 and 3.4.2.9 identify two major parts of an overground transfer system as Safety-Class SSCs. The identified parts are as follows:

- Overground transfer encasement and connections
- Overground transfer concrete shielding system.

4.3.3.1 Safety Function(s). An overground transfer system is used to transfer tank waste. Unlike a conventional underground waste transfer system, an overground transfer system is assembled and used only for a preplanned and dedicated transfer campaign. At the end of the campaign, the overground transfer system is disassembled, and its component parts are either discarded or stored for future use. Overground transfer systems are designed, constructed, and assembled for a specific waste transfer campaign when a portion of an existing underground transfer piping system either does not exist or is unavailable as a waste transfer route (e.g., an underground transfer pipe run is plugged). Because they are assembled to fit the facility, no two overground transfer systems are identical, although they share common design concepts and features (e.g., secondary pipe encasements and their interconnections, encasement leak detectors, pit cover plates, and concrete shield covers).

The overground transfer concrete shielding system is installed over the overground transfer encasement and connections. For both accidents (Sections 3.4.2.7 and 3.4.2.9), the safety functions of the two major parts of an overground transfer system are as follows:

- **Sections 3.4.2.7 and 3.4.2.9 Accidents**—The safety function of the overground transfer system encasement and connections is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Surface Leak Resulting in Pool and the Spray Leak in Structures or From Waste Transfer Lines accidents.

- **Section 3.4.2.9 Accident**—The safety function of the overground transfer system encasement and connections is to provide confinement for waste spray leaks from the primary line, thus decreasing the consequences of the Spray Leak in Structures or From Waste Transfer Lines accident.

- **Sections 3.4.2.7 and 3.4.2.9 Accidents**—The safety function of the overground transfer concrete shielding system is to protect the primary line from external events (e.g., vehicle impacts), thus decreasing the frequency of the Surface Leak Resulting in Pool and the Spray Leak in Structures or From Waste Transfer Lines accidents.

4.3.3.2 System Description. Overground transfer systems are temporary assemblies that are designed, built, tested, used, flushed, and then disassembled. Overground transfer systems are described only in general terms in the FSAR, and no listing of overground transfer systems is provided because they are designed and installed as temporary plant modifications. See Section 2.4.10.1.1 for additional information.

The design of every overground transfer system is traceable to engineering design documents, including engineering drawings, which are kept current at least until the system is disassembled into components either to be discarded or stored. Components of an existing overground transfer system may be reused in later overground transfer systems.

One of the principal safety features of an overground transfer system is the secondary encasement pipe assembly, which jackets and provides a confinement volume for the primary waste transfer pipe. The encasement and connections piping assembly is designated as Safety-Class. For corrosion resistance, encasement sections are typically short-length flanged sections fabricated from Schedule 40 stainless steel pipe. Typical encasement sections include straight runs; 90°, 45°, and 22.5° long-radius elbows; and other special pipe bends as needed to complete the piping system for the proposed route.

The primary, or inner, waste transfer pipe is assembled from different materials, depending on its location in the overground transfer system. Those primary line portions that provide connection to permanent waste transfer piping in a pit are fabricated from 2.54-cm (1-in.) Schedule 40 stainless steel pipe and fittings from the point of connection in the pit to the transition section inside of the encasement pipe. At the transition section, a 2.54-cm (1-in.) hose bib adapter

is welded to the 2.54-cm (1-in.) Schedule 40 pipe (Figure 4-1), providing an interface for the clamped attachment of an ethylene-propylene diene monomer (EPDM) hose that serves as the primary waste transfer pipe. The EPDM hose, 2.54 cm (1 in.) nominal inside diameter, is fabricated with braided inner reinforcement and is suitable for transporting Hanford Site tank waste at temperatures up to 82 °C (180 °F) at working pressures up to 1,379 kPa (200 lb/in^2 gauge). The EPDM hose is typically sleeved in a continuous stainless steel braid to protect the hose exterior. This minimizes the risk of abrading, puncturing, or tearing the hose during its installation into the encasement pipe. EPDM hose is used only inside the secondary, or encasement, pipe.

The abovegrade portion of an overground transfer system is provided with pipe supports, and all overground transfer sections are sloped to ensure that waste drains back to either the pit at the inlet end or to the pit at the discharge end. Pipe support assemblies are portable structures with weighted base plates for lateral stability and are adjustable to raise or lower the overground transfer system piping at the point of support.

Pits and their covers at each end of the overground transfer system prevent spray releases of waste to the atmosphere from unencased sections of the primary pipe located inside the pits. Covers for the pits are identified as Safety-Class SSCs and are discussed in more detail in Section 4.3.18. Pit drain lines to adjacent waste tanks vary in design, including some with removable plugs.

Transfer leak detection systems are identified as Safety-Class SSCs and are discussed in Section 4.3.17. Pit leak detectors prevent overflow of waste from pits (with potential offsite consequences) by sounding an alarm when leakage is detected, allowing the associated waste transfer pump to be deenergized.

Both ends of the overground transfer encasement and connection assembly terminate inside pits (below the covers). Each end of the encasement is provided with a drain valve. The encasement drain valves are provided to permit periodic pneumatic testing of the encasement and the encased portion of the primary pipe. After an acceptable pneumatic test, an administrative control requires that the encasement drain valves be open before starting the transfer of waste through the line. Any waste leaking into the overground transfer encasement assembly must flow through the associated encasement drain valve and its seal loop (typically, a short length of EPDM hose), and then fall to the pump pit or receiver pit floor, depending on where the leak occurs with respect to the high point in the overground transfer system.

An overground transfer concrete shielding system is installed over the assembled overground transfer encasement and connection system. The concrete shielding sections are usually quite thick, very heavy, and steel reinforced. The concrete shielding system protects the overground transfer encasement and connection system from vehicle impacts and is identified as a Safety-Class SSC.

An engineered heat tracing system shall be provided for the overground transfer system if freezing temperatures are anticipated during waste transfers. The heat tracing elements are

installed on the outside of the encasement pipe and are covered with thermal insulation to minimize heat losses and help prevent cold spots.

4.3.3.3 Functional Requirements. The overground transfer encasement and connection system shall confine waste leaks from the primary pipe to the annulus between the encasement and the primary pipe and channel the leaked waste to a pit at either end of the system for leak detection.

The overground transfer pipe encasement system pressure boundary shall be designed to withstand the 0.19 *g* evaluation basis earthquake and a 113-km/h (70-mi/h) wind.

The overground transfer concrete shielding sections shall be designed to protect the overground transfer system from damage by vehicles. Exposed portions of the overground transfer piping system shall be protected from freezing during a waste transfer campaign.

4.3.3.4 System Evaluation. The existing overground transfer system encasement and connection system and concrete shielding system are adequate for the required safety functions. The integrity of an overground transfer system's encasement shall be periodically confirmed by a pneumatic pressure test. A hydrostatic test shall be used to confirm the integrity of the primary transfer line inside the encasement pipe.

If a waste transfer is in progress and the concrete shielding sections are not installed over the overground transfer system, access to the overground transfer system by vehicles shall be administratively controlled.

Before the overground transfer concrete shielding sections are set in place, the encasement and connections shall be visually examined for damage or defects that could affect the ability of the encasement and connections to perform the safety function, and the entire overground transfer system assembly shall be visually examined for damage or loss of integrity before waste transfer operations begin. Seal loop (encasement drain) valve positions at both ends of the transfer system shall also be verified before waste transfer operations; the two valves shall be open. The seal loop hoses shall be looped per the design drawings to ensure that enough leaked waste can accumulate in the encasement drain path to reliably trigger the leak detectors.

4.3.3.5 Controls (Technical Safety Requirements). The accident analyses discussed in Sections 3.4.2.7 and Section 3.4.2.9 assume that an overground transfer system is operable before waste transfer and assume that it remains operable and operating throughout the transfer evolution.

The overground transfer system is required to be operable if the safety function is to be provided. The encasement must not leak. The two encasement drain (seal loop) valves shall be open to prevent pressurizing the encasement and to permit leaked waste to drain into a connected pit for leak detection. The specific basis and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.4 Waste Tanks

The DSTs (including the AWF tanks) and SSTs are designated as Safety-Class structures for the Organic Solvent Fire (Section 3.4.2.4), Flammable Gas Deflagrations (Section 3.4.2.2), Organic Salt-Nitrate Reaction (Section 3.4.2.6), and the Natural Phenomena—Seismic (Section 3.4.2.12.3) accidents. (Per agreement with DOE-ORP this Safety-Class designation is not effective until March 30, 2000.)

4.3.4.1 Safety Functions.

4.3.4.1.1 Tank Vacuum or Overpressurization Event. Exceeding a minimum or maximum vapor space pressure could result in structural failure of a tank from dome collapse.

The Section 3.4.2.4 accident could cause a vacuum or an overpressurization of the tank. An organic solvent fire on the waste surface followed by cooling of the high temperature gases inside the tank could cause high pressure followed by a vacuum. The accident analysis shows that tank integrity is maintained for the accident pressures. The heated gases from an organic solvent fire could overpressurize the tank. The accident analysis shows that tank integrity is maintained for the organic solvent fire overpressurization. The tank functions to confine materials sufficiently to mitigate onsite and offsite consequences.

The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during a tank vacuum or overpressurization event, thus decreasing the consequences of the Organic Solvent Fire (Section 3.4.2.4) accident.

4.3.4.1.2 Tank Overpressurization Event. Pressurization above maximum vapor space pressure can result in tank failure. Accidents that could cause overpressurization include the following.

- **Section 3.4.2.2 Accident**—A flammable gas deflagration inside the primary waste tank could result in overpressurization of the tank. The flammable gas accident analysis shows that a dome failure could occur during a flammable gas deflagration. The calculated pressure to fail the tank dome is well above the pressure needed to fail the inlet HEPA filter and the exhaust prefilters and HEPA filters (Section 3.4.2.2.1). The analysis describes the controls necessary to prevent this accident.

- **Section 3.4.2.6 Accident**—Organic salt-nitrate reactions could occur in those SST waste tanks that have been designated as "unsafe," "conditionally safe," or "unassigned" (because of insufficient sample data to categorize the waste tanks), where sufficient organic salts exist as a dry fuel that can heat up to ignition temperature. A list of the SSTs, categorized as above, is provided in Table 3.4.2.6-2. The organic salts would be oxidized by sodium nitrates also present in the waste. The resulting reactions will overpressurize the tank. The accident analysis shows that a bounding 25 m^3 (883.4 ft^3) burn of combustible

waste may collapse the tank dome, but that tank gross structural integrity is maintained for the tank pressurization resulting from the range of Organic Salt-Nitrate Reaction accidents involving lesser amounts of combustible waste. In these cases, the tank structure functions to confine the tank waste materials sufficiently to mitigate onsite and offsite consequences.

The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during a tank overpressurization event, thus decreasing the consequences of the Flammable Gas Deflagrations (Section 3.4.2.2) and Organic Salt-Nitrate Reaction (Section 3.4.2.6) accidents.

4.3.4.1.3 Seismic Event. Section 3.4.2.12.3 shows that a seismic event at the tank farm could damage tank farm facilities. Tank failures or collapse of major structures would not be expected for the evaluation basis earthquake. The tank functions to confine materials sufficiently to mitigate onsite and offsite consequences.

The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during and after the evaluation basis earthquake, thus decreasing the consequences of the Natural Phenomena—Seismic accident (Section 3.4.2.12.3).

4.3.4.2 System Description. Radioactive waste is stored at the Hanford Site in 177 steel-lined, reinforced concrete, underground tanks that are providing interim storage of the waste until further processing and permanent disposal options become available.

The underground tanks are arranged in groups called tank farms in the 200 East and 200 West Areas of the Hanford Site. There are two basic tank designs, DSTs (including the AWF tanks) and SSTs. One hundred and forty-nine SSTs were constructed between 1943 and 1964. The remaining 28 tanks are DSTs, constructed between 1968 and 1986. Many of the first underground waste tanks constructed have exceeded their design lifetimes and by the time that future tank waste disposal options are exercised and completed, the remainder will have exceeded their design lifetimes. Therefore, the structural integrity of the underground waste tanks is a very important subject.

The structural integrity of the TWRS SSTs was evaluated in a 7-yr study, RHO-RE-ST-10 P, *Tank Assessment Studies for Continued In-Tank Storage of Hanford Defense Waste*, which concluded in 1983. Reviews of the original structural design calculations revealed that the design life age was used only to determine corrosion rate for the steel liners.

Waste Tank 241-SX-115 was declared a "leaker" in 1965, and is known to have held about 2,645,000 L (700,000 gallons) of waste for about 8 yr. During that period, the waste is also known to have reached temperatures in the range of 127 to 138°C (260 to 280°F). In 1981, a 7.6-cm (3-in.) -diameter core, 11.8 m (38 ft, 8 in.) in length, was taken vertically from the haunch, wall, and footing of Tank 241-SX-115 and tested for its material properties. The test results, which showed no obvious correlation between degraded concrete properties and concrete

temperature, were reported in RHO-RE-ST-4 P, *Status of Tank Assessment Studies for Continued In-Tank Storage of Hanford Defense Waste*. From the data, it appears that the normal variations between concrete batches may have a more significant effect on concrete material properties than elevated concrete temperatures.

Material properties testing was performed on concrete samples from various TWRS facilities. The test results showed only normal scatter around the nominal predicted strength of 55,160 kPa (8000 lb/in^2) for 28-day 20,680 kPa (3000 lb/in^2) concrete. Many samples tested well over 55,160 kPa (8000 lb/in^2). Photographs of tank domes reviewed at the time of the study also showed no visual signs of concrete degradation. This data suggests that the gross structural integrity of the waste tanks, instead of degrading, is improving as the tanks age.

The more recent tank integrity reviews have shifted their focus to the integrity of DST steel liners, and the inner and outer walls of the liners in some tanks have been ultrasonically examined at selected locations. As directed in McClusky (1997), a Tank Integrity Panel is created and chartered to review plans for future tank integrity evaluations. This program plan complies with the requirements of WAC 173-303-640, "Dangerous Waste Regulations/Tank Systems."

The most important structural function of the waste tanks is to resist dome failure from either excessive positive pressure, excessive negative pressure, or seismic loads. Periodic in-service inspections of DSTs (including AWF Tanks) are conducted to ensure the tanks are capable of performing this safety function. No integrity assessments of SSTs are currently planned or underway.

For complete descriptions of DSTs, AWF tanks, and SSTs, see Section 2.4 and Figures 2-8, 2-9, 2-13, and 2-14. For soil cover depth for DSTs (including AWF tanks) and SSTs refer to Table 4-4 of WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*.

4.3.4.3 Functional Requirements. The tanks shall be designed to maintain structural integrity for confinement of wastes.

4.3.4.4 System Evaluation. The existing waste tanks are adequate for the required safety function.

The accident analysis shows that tank integrity is maintained during and after the negative pressure event. The tank functions to confine materials sufficiently to mitigate onsite and offsite consequences.

The accident analysis shows that tank integrity is maintained for the organic solvent fire overpressurization. The tank functions to confine materials sufficiently to mitigate onsite and offsite consequences.

The Flammable Gas Deflagrations accident analysis shows that a DST dome failure could occur during a flammable gas deflagration. The pressure calculated to fail the tank dome is well above the pressure needed to fail the inlet HEPA filter and the exhaust prefilters and HEPA filters.

The Flammable Gas Deflagrations accident analysis shows that cracking of the SST concrete dome is likely to occur. The cracking would relieve the pressure inside the tank. The ventilation inlet filter also provides pressure release. Because of these mechanisms for pressure release, dome collapse is not expected.

The accident analysis shows that tank integrity is maintained for the Organic Salt-Nitrate Reaction accident overpressurization. The tank structure functions to confine materials sufficiently to mitigate onsite and offsite consequences.

On the basis of the structural analysis presented in WHC-SD-TWR-RPT-002, the waste tank structures are relied upon to maintain their gross structural integrity in an evaluation basis earthquake.

When the DSTs were constructed, the design intent was to provide an annulus (or secondary containment feature) such that if a breach of the primary tank occurred, the leaked waste would be contained and prevented from entering the environmental space immediately below the waste tank. In the case of SSTs, however, no such secondary containment feature is available and numerous tanks have leaked and others have been suspected of leaking waste material to the soil. To mitigate future environmental insult, the current strategy is to rapidly proceed with the established Interim Stabilization (salt well pumping) program. The intent of this program is to remove the free and interstitial liquids from the waste matrix remaining in the tanks and reduce the potential for environmental consequences.

4.3.4.5 Controls (Technical Safety Requirements). Changes to the design of the waste tanks are controlled by approved procedures.

4.3.5 Pipe Encasements

The waste transfer system pipe encasements are identified as Safety-Class SSCs.

4.3.5.1 Safety Function(s). From the accident analysis discussed in Section 3.4.2.8, pipe encasements are identified as Safety-Class SSCs. The accident was analyzed for the worst-case direct buried transfer lines. For the cases where the transfer lines are encased, the encasements are credited with providing a route for leakage from the primary transfer line to the transfer structures where leak detection systems will identify the leak and permit operator action to stop the transfer operation.

The safety function of a pipe encasement is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Subsurface Leak Resulting in Pool (Section 3.4.2.8) accident.

4.3.5.2 System Description. Waste transfer system piping is encased by one of two methods.

- It is fabricated as pipe within a pipe, with an inner or primary pipe surrounded by an encasement or secondary pipe. The encasement pipe forms a sloped annular drain channel, and any leaked waste from a primary pipe will flow by gravity along this annular channel to a leak detector.

- The primary pipe(s) are confined in a concrete encasement. The concrete encasement forms a sloped drain channel, and any leaked waste from a primary pipe will flow by gravity along this channel to a leak detector.

Regardless of the encasement form, leaked waste will be channeled through the loop seals (through an open flow path) and into a transfer-associated structure along the transfer route, where the transfer leak detection system described in Section 4.3.17 will detect the leaked waste. Pipe encasements are vulnerable to damage during excavation activities in the tank farms, particularly when powered equipment is used for digging.

4.3.5.3 Functional Requirements. The pipe encasement shall channel waste leaked from a primary pipe to a transfer-associated structure where the leak can be detected. The encasement shall provide an unobstructed flow path for the movement of leaked waste to a transfer-associated structure.

4.3.5.4 System Evaluation. The existing pipe encasements are adequate for the required safety function. The drain path to a transfer-associated structure from an encased piping system is designed to be free of obstructions (i.e., the loop seal valves provide an unobstructed flow path for leaked waste to reach a waste transfer-associated structure for detection).

4.3.5.5 Controls (Technical Safety Requirements). The Section 3.4.2.8 accident analysis assumes that the encasements are operable before a waste transfer and remain operable throughout the transfer evolution. The operability assumption includes the following provision. Prior to the start of a waste transfer, the drain path into the pit(s) from the annulus of the encased piping system shall be verified to provide an open drain path to the pit, with encasement drain valve positions as applicable to the valve type. The encasement drain valves shall never be left in the "HYDRO" position during a waste transfer. A listing of the seal loop valves in the 200 East and 200 West tank farms is provided in Table 4-2.

4.3.6 Pressure Switch Interlocks or Alarms

The pressure switch interlocks or alarms (service water lines) are identified as Safety-Class SSCs in the accident scenarios discussed in Sections 3.4.2.7 and 3.4.2.9.

4.3.6.1 Safety Function(s). The tank farms contain both radioactive and toxic wastes. Because service water lines are connected to the waste transfer system for flushing, high-pressure switches are used to prevent the tank farm pumps from pressurizing the flush lines and reversing the

direction of flow into these lines because of the higher pressure output of the tank farm transfer pumps. This design protects against misrouting caused by incorrectly aligned valves, leaking valves, or waste backflow during flushing if the waste transfer pumps were to be inadvertently started (Figure 4-2). These scenarios could result in an unmitigated spray leak and contamination of the 200 East and 200 West Area water supply system(s).

Pressure switches, which trip at a preset value on increasing pressure, are provided in the service water incoming line to the flush pits. When the pressure to the switch increases above the preset trip level, the switch changes state. The pressure switch is typically connected into the waste transfer pump control system logic, and will either shut down the waste transfer system pump motor if it is running or inhibit the motor from starting if it is not running.

The safety function of the pressure switch interlock or alarm systems is to limit the volume of tank waste that could backflow into and leak from the service water piping system, thus decreasing the consequences of the Surface Leak Resulting in Pool (Section 3.4.2.7) and Spray Leak in Structure or From Waste Transfer Lines (Section 3.4.2.9) accidents.

4.3.6.2 System Description. A pressure at or above the setpoint of the pressure switch results in a change in condition of a set of control contacts that are connected into the liquid waste transfer pump motor control circuitry. This results in the actuation of an alarm or of an interlock to stop the transfer pump. When the transfer system is being flushed, the pressure of the service water flush is above the pressure switch setpoint, thus ensuring that the transfer pump is in the shutdown condition. During water flushing operations, the pressure switch is valved into the transfer piping system. Prior to waste transfers, the valve lineup is changed. During waste transfer operations, the pressure switch is not normally exposed to waste transfer system pressure; if it were to detect the pressure associated with normal waste transfer operations, the switch would actuate.

A high-pressure switch actuates (i.e., changes the condition of its electrical contacts from open to closed or vice versa, and so completes or interrupts an electric circuit) when a preset pressure has been exceeded. This change in the condition of the contact is a part of the run/permissive logic in the control circuitry of the tank farm transfer pump motor. When actuated, the pressure switch removes the power from the transfer pump motor start circuit. If running, the pump head will decay to zero. The pump cannot automatically restart, because a manual start is always required.

During flush operations (i.e., the removal of waste residue from the transfer piping following the transfer of waste) the pressure switch in the associated flush pit is valved into the flush water piping from the pit service water supply systems (Figure 4-3). This flush water is supplied to the piping system in the flush pit from the Hanford Site service water supply and could be either at the service water supply system pressure or at a reduced pressure from throttled valves in the system. Following completion of the flushing, priming, or hydrostatic testing operation, the valve lineup is changed to allow the tank farm pumps to run in their normal operating mode, and the pressure switch will shut down the transfer pump on increasing pressure (Figure 4-4). Part of this valve lineup change isolates the pressure switch from the waste transfer

route piping. While in this lineup, the pressure switch is unaffected by the operating pressure caused by normal operation of the tank farm transfer pump. Without the pressure switch being subjected to a pressure above its setpoint, the tank farm waste transfer pumps can be operated to transfer waste. The backflow of potentially radioactive or toxic substances from the tank farms waste transfer system is prevented from entering areas of piping not intended for waste flow during the designated transfer operation (i.e., the 200 Area water distribution systems) because of the valve lineup change.

Table 4-3 lists the service water system connections to the tank farms and provides the location of the pressure switches and other information.

Pressure switches in service water supply lines and their interlocks with waste transfer pumps are considered reliable with mean time between failures estimated in years.

Electrical distribution is a supporting SSC for the pressure switch/transfer pump motor control system and is described in Section 4.5.1.

4.3.6.3 Functional Requirements. The pressure switch interlock system shall provide an alarm or actuate an interlock to prevent or stop operation of the associated waste transfer pump when the pressure in the service water piping system reaches 138 kPa (20 lb/in^2 gauge).

The pressure switches in the service water lines connected to the waste transfer system are not automatically interlocked to some waste transfer pumps (e.g., waste transfer pumps in interfacing facilities that transfer waste to tank farms). An acceptable alternative to automatic shutdown of the transfer pump is isolation of the service water line by two closed valves and a pressure switch with an alarm in a continuously monitored area. Pressure switch alarm procedures require the immediate shutdown of the transfer pump on alarm.

4.3.6.4 System Evaluation. The existing pressure switch interlocks or alarms are adequate for the required safety function. The pressure switch is rated for the maximum system pressure expected during operation and is adequate for the required safety function. Pressure switches are provided with ports or injection points that allow a test liquid to be introduced at increasing pressure so that the setpoint of the pressure switch can be verified and adjusted into compliance as necessary. The setpoint verification and adjustments are made by trained and authorized workers in accordance with approved procedures.

Pressure switches shall be calibrated annually. The alarm and interlock functions shall be functionally tested annually.

4.3.6.5 Controls (Technical Safety Requirements). Sections 3.4.2.7 and 3.4.2.9 accident analyses assume that the applicable pressure switch interlocks or alarms associated with the proposed waste transfer route are operable and operating before a waste transfer and remain operable and operating throughout the waste transfer evolution. The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.7 Primary Tank Leak Detection Systems

The primary tank leak detection systems on DSTs and AWF tanks are identified as Safety-Class SSCs for the accident scenarios discussed in Sections 3.4.2.2 and 3.4.2.7.

4.3.7.1 Safety Function(s).

4.3.7.1.1 Flammable Gas Deflagrations. Deflagration of flammable gases in the annulus of a DST could occur if gases such as nitrous oxide, hydrogen, or ammonia build up in the annulus. Tank waste could leak from the primary tank into the annulus and, if undetected, could build up enough inventory in the annulus so that a steady-state buildup of flammable gases could occur. Depending on the temperature, heat load, total organic carbon, and the level of waste in the annulus, the gases could reach the LFL. An accident could then be initiated by a spark, resulting in a deflagration of the flammable gases.

DSTs comprise a primary tank and a secondary tank which forms an annular space around the primary tank. The primary tank rests on a 20.3-cm (8-in.) layer of insulating concrete, which has drain slots through which air is drawn for cooling and leak detection. The detection of radionuclides in the annulus ventilation exhaust flow stream with a continuous air monitor (CAM) is an indication of a potential leak from the primary tank. The slots allow any leakage from the primary tank bottom to drain into the annulus. Tank waste could enter the DST annulus by either a leak from the primary tank or by a mistransfer of waste into the annulus, such as installing a jumper that routes tank waste from the central pump pit to the annulus pump pit. Leak detection conductivity probes located in the annulus provide assurance that waste has not leaked into the secondary tank. These leak detection systems are identified as Safety-Class SSCs.

The safety function of the primary tank leak detection systems is to provide an alarm of tank waste from misroutes or other system leaks into the tank annulus to alert operators to take action to prevent a flammable gas deflagration in the DST or AWF tank annulus, thus decreasing the frequency of the Flammable Gas Deflagrations (Section 3.4.2.2) accident.

4.3.7.1.2 Surface Leak Resulting in Pool. A Surface Leak Resulting in Pool accident could occur if tank waste leaked into the DST annulus, filling and even overflowing the annulus. Surface pools are of safety concern because a small fraction of the waste can be entrained (resuspended) in wind blowing over the surface of the pool or over the surface of the wetted soil should the pool soak back into the ground. Resuspended waste can lead to significant inhalation doses to the onsite receptor over time.

DSTs comprise a primary tank and a secondary tank which forms an annular space around the primary tank. The primary tank rests on a 20.3-cm (8-in.) layer of insulating concrete, which has drain slots through which air is drawn for cooling and leak detection. The slots allow any leakage from the primary tank bottom to drain into the annulus. Tank waste could enter the DST annulus by a leak from the primary tank or by a mistransfer of waste into the annulus, such as installing a jumper that routes tank waste from the central pump pit to the annulus pump pit. Leak detection conductivity probes located in the annulus and a ventilation exhaust CAM provide

assurance that waste has not leaked into the secondary tank. These leak detection systems are identified as Safety-Class systems.

The safety function of the primary tank leak detection systems is to provide an alarm of tank waste from misroutes or other system leaks into the tank annulus to alert operators to take action to stop the transfer of waste into the DST or AWF tank annulus, thus decreasing the consequences of the Surface Leak Resulting in Pool (Section 3.4.2.7) accident.

4.3.7.2 System Description. Each DST and AWF tank primary tank leak detection system includes conductivity probes that detect the presence of liquid in the tank annulus and a CAM that detects the presence of airborne radionuclides in the annulus ventilation exhaust stream (Figure 4-5). The systems are described below.

4.3.7.2.1 Double-Shell Tank Farms 241-AN, 241-AP, 241-AW, and 241-SY Conductivity Probes. Each DST is equipped with reel-mounted flake-box-type adjustable conductivity probes installed in annulus risers. The liquid level is measured from gradations on a steel tape that is lowered into the annulus. The setting on each plummet is 0 to 2.54 cm (0 to 1.0 in.) above the annulus bottom. Liquid waste contact with the probe activates audible alarms, and annunciator panel lights in the corresponding tank farm instrument buildings. See Section 2.4.11.2.1 for added information on the leak detection system.

Electrical distribution is a supporting SSC for the conductivity probes and for the associated alarm and annunciator systems and is described in Section 4.5.1.

4.3.7.2.2 Aging Waste Facility Tank Farms 241-AY and 241-AZ Conductivity Probes. Each AWF tank annulus is equipped with three leak detection probes. Each probe has 17 elements, located from 0.3 cm (0.13 in.) to 182.9 cm (72.0 in.) from the bottom of the annulus. Data is obtained by rotating a selector switch for each tank through each of the 17 positions and manually recording the readings. The indicator lights and selector switches are located in the 241-AY Tank Farm and 241-AZ Tank Farm instrument buildings, and the alarm sounds in the control building. See Section 2.4.11.3 for added information on the leak detection system.

Electrical distribution is a supporting SSC for the conductivity probes and for the associated alarm and annunciator systems and is described in Section 4.5.1.

4.3.7.2.3 Annulus Ventilation Continuous Air Monitors. The annulus ventilation system of each DST and AWF tank is equipped with a CAM. A vacuum pump extracts an air sample from the exhaust flow stream upstream of the HEPA filter housing and provides it to the CAM, where the sample is scanned for radionuclide particles. If a leak from the primary tank occurs, the CAM would detect an increase in radioactive particulate activity; if the radiation level measured by the CAM exceeded a preset level, an alarm would actuate.

The electrical distribution system described in Section 4.5.1 is a supporting SSC for the CAMs, the associated alarm and annunciator systems, the CAM cabinet heaters and fans, and prevention of condensation in the sample line.

4.3.7.3 Functional Requirements. The DST and AWF tank annulus conductivity probes shall be able to detect a 2.54-cm (1.0-in.) deep accumulation of waste in the bottom of the DST annulus and shall provide an audible alarm signal and an annunciator panel light upon detection of waste. The DST and AWF tank annulus ventilation system CAMs shall alarm when radiation levels exceeding a preset level are detected.

4.3.7.4 System Evaluation. The existing primary tank leak detection systems are adequate for the required safety functions. Liquid waste contact with the annulus conductivity leak detector will activate alarms and annunciator panel lights. The CAM will alarm if the radiation level exceeds a preset level. Failure of the CAMs will activate audible and visible local and remote alarms. At least one of the two leak detection systems shall be operable to perform the safety function.

The operability of the liquid waste conductivity leak detectors and the annulus CAM system shall be verified every 6 mo by a system functional test.

Performance history of conductivity probes as annulus leak detectors is still being developed, but conductivity probes have performed reliably as transfer pit leak detectors for many years, with mean time between failures approaching one year. CAMs have not generally performed satisfactorily, with mean time between failures measured in months. CAMs are vulnerable to loss of sample flow; low sample flow rate and other CAM malfunctions are normally detected and alarmed.

The design intent of the primary tank leak detection system was to detect waste leaks from the primary tank into the annulus and to alert operations personnel. Provisions were also included to facilitate removal of waste from the annulus space. These features included annulus pump pits and the availability of annulus waste transfer pumps. The detection of waste leaks, although not part of the current safety function as discussed in Sections 4.3.7.1.1 and 4.3.7.1.2, remains an important environmental protection feature of the DSTs.

4.3.7.5 Controls (Technical Safety Requirements). The assumption in Section 3.4.2.2 is that at least one of the annulus leak detection systems is operable. The operability assumption includes the following provision. Functional testing is performed every 6 mo to ensure that the CAMs and the conductivity probes are operable. The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.8 Single-Shell Tank Ventilation Systems

The SST active and passive ventilation systems are identified as Safety-Class SSCs in Section 3.4.2.2.

4.3.8.1 Safety Function(s). Flammable gases are generated in the tank waste by radiolysis, organic degradation, and corrosion. These gases are retained in the waste and released to the tank vapor space. Gases are released to the vapor space either naturally (bubble migration or buoyancy-induced rollover) or as the result of waste-intrusive activities.

The volume of gas released by the waste may be enough to make a portion or all of the tank vapor space flammable. The vapor space is considered flammable when the concentration of flammable gases exceeds the LFL. The tank vapor space is flammable for a only a short period of time, however, because of gas diffusion, convection, and the diluting action of active and passive ventilation systems. The Section 3.4.2.2 accident analysis has identified active and passive ventilation systems as the primary means of maintaining the vapor space below the flammability limit. Requirements that are specifically needed for active and passive ventilation systems to fulfill the safety functions are identified in the following sections.

The safety function of the SST active and passive ventilation systems is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations (Section 3.4.2.2) accident.

4.3.8.2 System Description. Active ventilation systems remove flammable gases from the following SSTs:

- All tanks in SST Tank Farm 241-SX (except for 241-SX-113 and 241-SX-115)
- SSTs 241-C-105 and 241-C-106.

The following SSTs have passive ventilation systems:

- Tanks 241-SX-113 and 241-SX-115
- All tanks in Tank Farm 241-C (except for 241-C-105 and 241-C-106)
- All tanks in SST Tank Farms 241-A, 241-AX, 241-B, 241-BX, 241-BY, 241-S, 241-T, 241-TX, 241-TY, and 241-U.

Active and passive systems are described on the following pages.

4.3.8.2.1 Active Ventilation. The systems draw outside air into the tanks through HEPA-filtered inlet stations. The air mixes with and displaces the flammable gases produced by the waste. The air/gas mixture is then removed from the tanks, filtered to remove radioactive particulates, and exhausted to the atmosphere.

Electrical distribution has been identified as a supporting SSC for active ventilation systems. If electrical power to an active ventilation system is lost, the ventilation system configuration will still allow the tank to breathe in a fashion similar to that of the passive

ventilation systems. The wastes stored in the actively ventilated SSTs generate flammable gases at a higher rate than the wastes in the passively ventilated SSTs.

4.3.8.2.2 Passive Ventilation. A passive ventilation system consists of a filter housing, a HEPA filter, and an isolation valve. The filter housing is fabricated with a riser adapter that allows the housing to be bolted directly to a 10.2-cm (4-in.) tank riser. The riser adapter contains an isolation valve that is open during normal operation of the breather filter assembly. The isolation valve is occasionally closed to isolate the HEPA filter from the tank so that aerosol testing of the filter can be completed, and then the shutoff valve is reopened. The valve is also used to isolate a filter that has failed the aerosol test, until the filter can be replaced. The HEPA filter prevents the release of airborne radioactive particulates to the environment.

Passive ventilation systems allow flammable gases to be exhausted from the SSTs whenever the tank vapor space pressure exceeds atmospheric pressure. Conversely, the system allows air into the tank when atmospheric pressure exceeds the vapor space pressure. This influx of additional air dilutes the flammable gases in the vapor space.

Supporting SSCs are not required for passive ventilation systems.

4.3.8.3 Functional Requirements.

4.3.8.3.1 Active Ventilation. SST active ventilation systems shall maintain a vacuum in the tank vapor space relative to atmospheric pressure.

4.3.8.3.2 Passive Ventilation. SST passive ventilation shall provide a HEPA-filtered flow path to allow the vapor space pressure to be in equilibrium with atmospheric pressure. For those SSTs without individual risers for breather filter installation, the passive ventilation flow path shall be through other interconnected tanks.

4.3.8.4 System Evaluation.

4.3.8.4.1 Active Ventilation. The existing SST active ventilation systems are adequate for the required safety function. Operability of the active ventilation systems shall be verified weekly.

The ventilation system for Tanks 241-C-105 and 241-C-106 is a nonredundant system that contains one HEPA filter train, one fan, and one source of electrical power. In the event of filter, fan, or electrical power failure, active ventilation will be lost until the failed component is replaced or until electrical power can be restored. Failure of the ventilation system could allow flammable gas concentrations to increase in the vapor spaces and exceed the LFL. The electrical distribution system is very reliable, however, and power outages of sustained duration are not expected.

The 241-SX Tank Farm "sludge cooler" ventilation system contains redundant fans but does not contain isolatable redundant filter trains and an alternate supply of electrical power. In the event of primary fan failure or maintenance, the backup fan is started to restore active

ventilation. Active ventilation will be lost, however, if one HEPA filter train should fail. Failure of one HEPA filter train will shut down the entire ventilation system because the filters cannot be isolated. Once the damaged filter train is replaced, active ventilation can be restored. Failures of HEPA filters are infrequent, and HEPA filters can be readily replaced upon failure.

Active ventilation systems are vulnerable to drive train malfunctions and control system trips because of malfunctioning process monitors. Mean time between failures has typically been very short by common industrial performance standards. Equipment upgrades and improved maintenance procedures have proven that mean time between failures can be increased.

4.3.8.4.2 Passive Ventilation. The existing passive ventilation assemblies are adequate for the required safety function. The breather filter isolation valve shall be verified at least every 10 days to ensure the flow path is unobstructed.

Passive ventilation systems are vulnerable to damage by out-of-control vehicles, rainwater intrusion (at some tanks), and breather filters plugging by airborne dust.

4.3.8.5 Controls (Technical Safety Requirements). The assumption in the Section 3.4.2.2 accident is that the ventilation systems are operable and operating during normal waste tank operations and will remain operable and operating during a gas release.

4.3.8.5.1 Active Ventilation. Operability of the active SST ventilation systems shall be verified weekly. Monitoring tank pressures to verify that a vacuum is being maintained is the preferred method for verifying operability.

The specific bases and controls protecting the operability assumptions for active ventilation systems are developed in Chapter 5.0 and the TSR document.

4.3.8.5.2 Passive Ventilation. The operability assumption for passive ventilation systems is that the airflow path from the tank's vapor space to atmosphere is open. Verification of this assumption shall be performed by inspection at least every 10 days to ensure the flow path is unobstructed. The specific bases and controls protecting the operability assumption for passive ventilation systems are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.9 Section Reserved

4.3.10 Section Reserved

4.3.11 Section Reserved

4.3.12 Section Reserved

4.3.13 Section Reserved

4.3.14 Section Reserved

4.3.15 Section Reserved

4.3.16 244-AR TK-002 Vault Ventilation System

The 244-AR TK-002 ventilation system is identified as a Safety-Class SSC for the Section 3.4.2.2 accident.

4.3.16.1 Safety Function(s). Flammable gases are generated in tank waste by radiolysis and corrosion. The volume of gas released by the waste may be enough to make a portion or all of the tank headspace flammable. The headspace is considered flammable when the concentration of flammable gases exceeds the LFL. To prevent ignition of the gases, intrusive activities are prohibited when the flammable gas concentration exceeds 25% of the LFL.

The Section 3.4.2.2 accident analysis has identified active ventilation systems as the primary means of maintaining the tank headspace below 25% of the LFL. The ventilation flow through 244-AR TK-002 headspace cannot be verified because of the current inoperable status of the 244-AR TK-002 vessel ventilation system (Section 2.4.7.2). To provide headspace ventilation, the level dip tubes are used to inject instrument air into the tank headspace when waste is stored in 244-AR TK-002, providing a positive inlet flow to the tank to maintain the headspace below 25% of the LFL. Specific requirements for the level dip tubes to fulfill the safety function are identified in the following sections.

The safety function of the 244-AR Tank TK-002 ventilation system is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations (Section 3.4.2.2) accident.

4.3.16.2 System Description. Lag storage Tank TK-002 in the 244-AR Vault currently stores radioactive waste and requires continuous ventilation to maintain flammable gas concentrations below 25% of the LFL. Ventilation for Tank TK-002 is provided by injecting instrument air into the installed weight factor dip tubes. The inlet air mixes with and dilutes the flammable gases in the vapor space of the tank. The Tank TK-002 air/gas mixture is then displaced from the tank to the atmosphere in the tank annulus space by natural convection.

A source (e.g., compressor, gas bottle) of instrument air is a supporting SSC and is described in Section 4.5.2.

4.3.16.3 Functional Requirements. The dip tubes shall provide a minimum total inlet airflow of 0.08 m^3/h (3 ft^3/h) to 244-AR TK-002 while waste remains in the tank. The dip tube flow indicators shall have a minimum range of 0 m^3/h to 0.07 m^3/h (0 ft^3/h to 2.5 ft^3/h).

4.3.16.4 System Evaluation. The existing 244-AR TK-002 ventilation system is adequate for the required safety functions. The dip tube flow indicators used to verify ventilation flow for Tank TK-002 shall be calibrated or functionally tested annually. The dip tubes will provide sufficient inlet airflow to maintain the tank headspace below 25% LFL.

The performance history of the three Tank TK-002 dip tube air flow meters has been satisfactory. Although they are fabricated from relatively fragile material, the flow meters are protected from damage by airborne missiles by locating them inside the associated instrument building. A loss of flow is obvious upon visual inspection, and necessary corrective actions can be taken immediately.

4.3.16.5 Controls (Technical Safety Requirements). The assumption in the Section 3.4.2.2 accident is that the dip tubes and flow indicators are operable and operating when waste is stored in 244-AR TK-002. The operability assumptions include the following provision. When waste is stored in 244-AR TK-002, the flow indicators shall be monitored twice a day to verify that a minimum total airflow of 0.08 m^3/h (3 ft^3/h) is provided. The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.17 Transfer Leak Detection Systems

The transfer leak detection systems are identified as Safety-Class SSCs for the accident scenario discussed in Sections 3.4.2.7 and 3.4.2.8.

4.3.17.1 Safety Function(s). Surface pools can be caused by accumulations of waste inside transfer system enclosures (e.g., process pits) that result in overflows of the enclosures. The accumulations may come from a transfer system leak originating within the enclosure or from a leak in an encased line that drains to the enclosure. Surface pools are of safety concern because a small fraction of the waste can be entrained (resuspended) in wind blowing over the surface of the pool or over the surface of the wetted soil should the pool soak back into the ground. Resuspended waste can lead to significant inhalation doses to the onsite receptor over time.

The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures and to either provide an alarm to alert operators to take mitigative action or provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Surface Leak Resulting in Pool (Section 3.4.2.7) and Subsurface Leak Resulting in Pool (Section 3.4.2.8) accidents.

4.3.17.2 System Description. Transfer-associated structures, which include process and valve pits, diversion boxes, and cleanout boxes (COBs), are provided with leak detectors located in the

structure. The leak detectors have electrodes at different electrical potentials that are short-circuited by a conductive medium (e.g., liquid waste) and cause a change in state of the monitoring circuitry. When liquid waste short-circuits the leak detector electrodes, an alarm is generated. In some systems, associated interlock circuitry is actuated and the transfer pump is shut down. The control and alarm functions associated with the leak detector are testable.

Leak detectors are located inside waste transfer-associated structures and are sometimes located in a sump in the pit. In the event of a leak, the smaller floor area of a sump causes a faster level increase for the same volume of leaked waste, thereby providing an earlier alarm signal. The leak detector transmits a signal that creates an audible and visual panel alarm and activates the interlock for transfer pump shutdown; if no interlock is installed, the panel alarm prompts operator action to terminate transfer pump operation.

When alternate leak detection devices such as manual conductivity probes are used as temporary compensatory measures to allow short duration waste transfers to be completed, the alternate leak detection devices (e.g., zip cords) shall be described in released engineering documents and installed as temporary plant modifications.

See Section 2.4.11.3.2 for additional information on the leak detection system.

Electrical distribution is a supporting SSC for alarm and control circuitry associated with the leak detection system and is described in Section 4.5.1.

4.3.17.3 Functional Requirements. The installed location of the leak detector must be near the structure's floor in a manner such that the pit liquid hold-up volume above the leak detector's elevation is greater than or equal to 1,520 gal (203.2 ft^3). The basis for this value is contained in HNF-2204, *Calculation Note to Clarify What Structure Volumes are Bounded by BIO Accident 5.3.2.18*. This requirement is typically met by installing the leak detector at a low point in the pit such that liquid accumulations of 5.08 cm (2 in.) are detected. The leak detection system shall activate an alarm or an interlock to prevent or stop operation of the transfer pump when a leak is detected.

4.3.17.4 System Evaluation. The existing transfer leak detection systems are adequate for the required safety functions. Conductivity probes have performed with reasonable reliability as transfer system leak detectors for many years, with mean time between failures approaching one year. The operability of each process pit, diversion box, valve pit, and COB leak detector (and its associated alarm and control circuitry) that is physically connected to a waste transfer pump not under an administrative lock shall be verified quarterly by a functional test.

4.3.17.5 Controls (Technical Safety Requirements). The assumption in the analyses in Sections 3.4.2.7 and 3.4.2.8 is that the leak detector systems are operable and operating during waste transfer. The operability assumptions include the following provisions:

- During a liquid waste transfer, all of the leak detectors associated with lines PHYSICALLY CONNECTED (as defined in Section 1.1 of

HNF-SD-WM-TSR-006) to the waste transfer pump being actuated must be operable.

- To ensure that the pit leak detection system is operable, the alarm and control functions activated by the leak detector are functionally tested quarterly.

The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.18 Transfer System Covers

The transfer system covers are identified as Safety-Class SSCs in the accident analysis in Section 3.4.2.9.

4.3.18.1 Safety Function(s). Tank waste can be transferred within the TWRS complex by using the waste transfer system. The waste transfer system piping provides an interconnecting network for the planned transfer of tank waste to support TWRS operations. If a component of the transfer system pressure boundary (e.g., a pipe, jumper, or valve) were to be damaged or incorrectly installed, a spray leak of liquid waste could result. An uncontrolled spray leak of waste from the waste transfer piping system will result in both onsite and offsite consequences exceeding the evaluation guidelines.

By design, the waste transfer piping system is routed in confinement structures or components that can prevent most or all of a waste spray stream from reaching the atmosphere. Most of the waste transfer system piping system is underground and is normally accessible only in selected locations (e.g., process pits, diversion boxes, valve pits, and COBs). Confinement for any leakage from the waste transfer piping system as it passes through the pits is provided by the pit structure and its cover(s). This design mitigates the consequences of a spray leak.

The safety functions of the transfer system covers are to provide an impaction surface that prevents a waste leak from jetting directly into the atmosphere and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages between adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or from Waste Transfer Lines (Section 3.4.2.9) accident.

4.3.18.2 System Description. Permanent transfer system covers are typically heavy sections of reinforced concrete, although some covers are made of steel according to their design documentation (Figure 4-6). Temporary covers shall meet the functional requirements of permanent covers. Where temporary transfer system covers are used, they shall be described in released engineering documents and installed as temporary plant modifications.

Table 4-4 lists the waste transfer system pits and COBs. When pits and other transfer-associated structures are on the active transfer route of a waste transfer, their covers are Safety-Class SSCs during the waste transfer operation.

Some pits in Table 4-4 are noted to be "inactive," which is defined as follows:

> Inactive—A component or system that is installed but not used for its design function. An engineering change is required to place the component or system into service to perform its design function.

Inactive pits have been isolated from waste transfer operations and are not subject to the controls discussed here. When an inactive pit is reactivated for waste transfer operations, however, its covers will be Safety-Class SSCs and must be shown to be in full compliance with all controls.

Transfer system covers have demonstrated excellent durability in tank farm service, even though concrete covers are vulnerable to rough handling during removal and replacement. Appropriate lifting equipment is used to remove and replace covers, and all lifts are performed to approved procedures. Damage to a cover or the pit structure support ledge is quite obvious, and damage that could compromise the effectiveness of a transfer system cover in performing its safety function shall be evaluated. Damaged components that cannot meet the functional requirements shall be repaired or replaced before waste transfers are routed through the structure.

4.3.18.3 Functional Requirements. The cover assembly for a waste transfer-associated structure that is physically connected to the transfer route shall confine direct spray leaks to the inside of the structure. Transfer system covers shall be designed to eliminate direct spray leakage paths. Transfer system cover assemblies shall fit their supporting structure so that there are no paths for a direct spray leak of tank waste to the atmosphere.

When transfer system cover penetrations are not in use, they shall be plugged. Holes for valve reach rods are typically sealed with wooden plugs, and inspection ports are typically sealed with concrete or steel plugs.

4.3.18.4 System Evaluation. The transfer system covers are adequate to perform the safety functions when the covers are installed and all cover penetrations are sealed.

Each time a waste transfer-associated structure is opened, the transfer system covers (and the abovegrade waste transfer-associated structure) shall be visually inspected for damage or defects that could affect the cover's ability to perform its safety function. The exterior of the structure and cover assembly shall be visually inspected prior to a waste transfer and once per 10 days thereafter to ensure that the covers, cover plugs, and seals are installed and operable.

In Section 3.4.2.12.3 one of the key accident scenario assumptions is that valve covers are assumed to be in place and undamaged by the evaluation basis earthquake (peak horizontal acceleration of 0.19 *g* or less); however, to conservatively account for all potential sources of waste leaks, the seismic analysis does not credit the covers for mitigating the seismic accident consequences.

4.3.18.5 Controls (Technical Safety Requirements). The Section 3.4.2.9 accident analysis assumes that the transfer system covers and cover assemblies are operable prior to a waste transfer and remain operable throughout the transfer evolution. The operability assumptions include the following provisions:

- Covers are installed and operable
- Cover plugs and seals are installed and operable.

The operability of transfer system covers and cover assemblies shall be verified every 10 days during a waste transfer.

4.3.19 Ventilation Stack Continuous Air Monitor Interlock Systems

The ventilation stack CAM interlock systems on DSTs, AWF tanks, actively ventilated SSTs, DCRTs, and the 204-AR Waste Unloading Facility are identified as Safety-Class SSCs for the spray leak in waste transfer system accident analyzed in Section 3.4.2.9.

4.3.19.1 Safety Function(s). Active ventilation systems are provided for some SSTs, all DCRTs, all DSTs, all AWF tanks, and certain structures associated with tank farms. The exhaust from an active system is typically passed through HEPA filters and then routed to a stack, where it is monitored for radionuclide particles by a CAM before being released to the atmosphere. When the radiation level measured by the CAM exceeds a preset level, an alarm is activated and the exhaust system fan is automatically shut down.

This section discusses the role of the ventilation CAM interlock systems in limiting the release of airborne radionuclides after the HEPA filters are damaged by a spray leak within the tank or structure.

The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines (Section 3.4.2.9) accident.

4.3.19.2 System Description. The CAMs and interlocks on the ventilation exhaust stacks for all DSTs, AWF tanks, all actively ventilated SSTs, all DCRTs, and the 204-AR Waste Unloading Facility are required to perform the above safety function. The following is a list of those stacks:

Stack	Facility
296-A-17	241-AY/AZ Tank Farms exhauster
296-A-25	244-A DCRT exhauster
296-A-26	204-AR Waste Unloading Facility exhauster
296-A-27	241-AW Tank Farm exhauster
296-A-29	241-AN Tank Farm exhauster
296-A-40	241-AP Tank Farm exhauster

Stack	Facility
296-B-28	244-BX DCRT exhauster
296-C-05	244-CR Vault exhauster
296-P-16	241-C-105/106 Tank exhauster
296-P-23	241-SY Tank Farm backup exhauster (K1-4-1)
296-P-26	241-AY/AZ Tank Farms backup exhauster (113 m^3/min [4,000 ft^3/min] portable exhauster)
296-P-28	241-SY Tank Farm (second) backup exhauster
296-S-15	241-SX Tank Farm exhauster
296-S-22	244-S DCRT exhauster
296-S-25	241-SY new tank exhauster
296-T-18	244-TX DCRT exhauster
296-U-11	244-U DCRT exhauster

Temporary or portable ventilation exhaust systems other than those listed above must be separately evaluated prior to their use to ensure that the consequences of an unfiltered release are bounded by the Section 3.4.2.9 accident analysis.

Typically, a vacuum pump pulls a gaseous effluent sample from the exhaust stack through a sample line into the CAM and discharges the sample either back to the stack or through a filter to the atmosphere. If the CAM detects high radionuclide particulate activity in the exhaust stream, an alarm is actuated and a signal is transmitted to a relay that interrupts the electrical power to the exhaust fan motor, causing the ventilation exhaust system to stop operating.

Electrical power for the CAM, the interlock and alarm, the cabinet heaters and fans, and prevention of condensation in the sample line has been identified as a supporting SSC. The electrical distribution system is described in Section 4.5.1.

4.3.19.3 Functional Requirements. The CAM system shall operate continuously while the exhaust systems are operating, maintaining representative sampling conditions as required to perform its safety function. The CAM shall measure the radiation levels of the sampled flow stream and detect levels in excess of a preset level. The CAM shall activate an interlock to shut down the exhauster upon detection of a radiation level that exceeds the preset level. Upon CAM failure, the monitors shall actuate an alarm and an interlock to shut down the ventilation exhaust system. (The requirement for the CAM interlock to shut down upon CAM failure will be reevaluated as part of Phase 2 FSAR implementation. Therefore, this requirement is deferred.)

During the ventilation exhaust sampling process, the sample flow stream from the ventilation system is totally contained by steel tubing and the CAM sample flow path pressure boundary, which has no ignition sources. Because of this, the CAM is exempted from the ignition controls described in TSR Administrative Control 5.10 until the flow path pressure boundary is opened for maintenance or other necessary activities.

4.3.19.4 System Evaluation. The existing ventilation stack CAM interlock systems are adequate for the required safety function. The CAM interlock loop shall be calibrated annually, and the alarms and interlocks shall be functionally tested quarterly. The CAMs shall be source-checked weekly to verify appropriate system response.

The electrical interlock deenergizing the exhaust fan is considered reliable. CAMs are, however, vulnerable to loss of sample flow. CAM malfunctions are normally detected and, as a minimum, actuate an interlock to shut down the ventilation exhaust system and an alarm to alert operators that corrective action is required to restore the CAM to normal operation. (The requirement for the CAM interlock to shut down upon CAM failure will be reevaluated as part of Phase 2 FSAR implementation. Therefore, this requirement is deferred.)

4.3.19.5 Controls (Technical Safety Requirements). The assumptions in the Spray Leak in Structure or From Waste Transfer Lines accident described in Section 3.4.2.9 are that CAMs with interlocks are provided for all ventilation exhaust stacks identified above and that the CAMs and their associated alarms and interlocks are operable and operating during and after a spray leak accident that results in damage to the HEPA filters.

4.3.20 Section Reserved

4.3.21 Section Reserved

4.3.22 204-AR Waste Unloading Facility Structure

The 204-AR Waste Unloading Facility structure is identified as a Safety-Class SSC to mitigate the consequences of the Section 3.4.2.9 accident.

4.3.22.1 Safety Function(s). Low-level liquid radioactive waste is normally delivered to the 204-AR Waste Unloading Facility in rail tank cars or tank trailers. The 204-AR Waste Unloading Facility transfer pumps are used to offload the low-level waste and transfer it from the 204-AR Waste Unloading Facility structure to the 241-A-A valve pit via encased line LIQW-702. Additional information on the 204-AR Waste Unloading Facility is provided in Section 2.4.6, where the Design Features of this unique facility are discussed in detail.

If, however, a high-level tank farm waste transfer were to be misrouted so that it backflowed into the 204-AR Waste Unloading Facility and formed a spray leak in the 204-AR Waste Unloading Facility discharge piping system, the accident could result in offsite and onsite consequences if there were no barrier present. When the 204-AR Waste Unloading Facility structure is credited as this barrier, the accident could result in onsite consequences if the rail tank car unloading canyon doors were to be open. Section 3.4.2.9 identifies the 204-AR Waste Unloading Facility structure as a Safety-Class SSC to mitigate the consequences of this accident.

According to the Section 3.4.2.9 accident analysis, the safety functions of the 204-AR Waste Unloading Facility structure are to provide impaction surfaces that prevent a waste leak from jetting directly into the atmosphere and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages with adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines (Section 3.4.2.9) accident.

4.3.22.2 System Description. The design of the 204-AR Waste Unloading Facility is traceable to the engineering design documents for the structure. The walls of the facility are constructed of reinforced concrete. The only part of the facility that may contain waste is the rail tank car unloading canyon. This room houses the rail tank car or tank trailer, the transfer pumps, the discharge piping system, and the catch tank. Access to the tank car unloading canyon radiation zone from the outside of the facility is through an arrangement similar to an airlock, a rollup door and a pair of hinged doors that are kept in their closed position except when personnel passage is required.

The 204-AR Waste Unloading Facility radiation zone heating, ventilation, and air conditioning (HVAC) system for the 204-AR Waste Unloading Facility rail tank car unloading canyon has two intake points. Canyon air entering the exhaust intakes passes through a 30% filter and the first stage of HEPA filtration prior to entering a common plenum. Gases in the headspace of the catch tank, located belowgrade in a corner of the unloading canyon, also reach this common plenum via a moisture separator, a heating element, and another HEPA filter. This common exhaust plenum is equipped with dampers, another moisture separator, and a final stage of HEPA filtration upstream of the exhaust fan. The exhaust fan discharges the flow stream to atmosphere via stack 296-A-26. The exhaust flow stream to the stack is monitored by a CAM. On detection of radioactive particulate levels above a preset level, the CAM alarms and shuts down the exhaust fan, as discussed in Section 4.3.19. The exhaust ducting is provided with flow measurement, radiation sampling, and radiation monitoring systems. As a Defense-in-Depth activity, the differential pressure across the moisture separators and HEPA filters is monitored, and their associated alarms are annunciated in the 204-AR Waste Unloading Facility control room. Figure 4-7 provides additional details of the 204-AR Waste Unloading Facility radiation zone HVAC system.

The 204-AR Waste Unloading Facility local control room is manned only during the unloading of a rail tank car or tank trailer; the 242-A Evaporator Control Room is continuously manned. All alarms to the 204-AR Waste Unloading Facility control room are repeated as a "204-AR TROUBLE" alarm to the 242-A Evaporator control room.

4.3.22.3 Functional Requirements. The 204-AR Waste Unloading Facility structure shall be designed to confine the tank waste spray leak described in the Section 3.4.2.9 accident analysis.

4.3.22.4 System Evaluation. The existing 204-AR Waste Unloading Facility structure is adequate for the required safety functions. The 204-AR Waste Unloading Facility structure provides the confinement capability required to mitigate the consequences of a spray leak of misrouted high-level tank waste from the waste transfer system into the rail tank car unloading

canyon, which is the only location in the 204-AR Waste Unloading Facility where a high-level waste spray accident can occur. With the large volume of the rail tank car unloading canyon, with closed doors providing a confinement barrier per TSR Administrative Control 5.12 and with the multiple HEPA filters and intermediate moisture separator, the 204-AR Waste Unloading Facility structure design presents a relatively stagnant air volume and fosters agglomeration of and rainout (deposition) of spray leak aerosols within the facility.

4.3.22.5 Controls (Technical Safety Requirements). The assumption in the Section 3.4.2.9 spray leak accident is that the 204-AR Waste Unloading Facility structure serves the same safety function as the transfer system covers serve for a waste transfer system pit in Section 4.3.18. In the Section 4.3.18 discussion, the transfer system covers are not sealed and, thus, do not ensure complete confinement of waste spray leak aerosols; gaps provide leakage paths for some of the aerosol generated in the spray leak to be expelled. Similarly, the rail tank car unloading canyon openings are not sealed, and the gaps provide leakage paths for aerosols.

The implied assumption in the Section 3.4.2.9 spray leak accident is that the position of the 204-AR Waste Unloading Facility rail tank car unloading canyon doors is important to the ability of the building to knock down or confine spray within the facility. It is also a good operational practice to ensure that all doors that open the rail tank car unloading canyon to atmosphere remain closed at all times unless there is an operational need for their temporary opening. The main entry rollup door and hinged doors are the chief vulnerability of the 204-AR Waste Unloading Facility as a confinement structure, since these large doors must be opened to admit a rail tank car or tanker truck. These doors are normally closed when the 204-AR waste transfer pumps are operating to ensure that low-level airborne waste from a spray leak does not escape from the building; therefore, TSR control of the doors to the tank car unloading canyon does not impose an unreasonable restriction on normal facility operations.

All doors that open the rail tank car unloading canyon to atmosphere should remain closed at all times unless there is an operational or maintenance need for their temporary opening. The radiation zone ventilation system shall be operable and operating at all times except when maintenance activities are being performed. The west exterior rollup door and the west exterior personnel access door shall be closed during waste transfers that are physically connected to the 204-AR Waste Unloading Facility.

4.3.23 Abovegrade Portions of Process Pits, Diversion Boxes, Valve Pits, and Cleanout Boxes

The transfer system abovegrade portions of process pits, diversion boxes, valve pits, and COBs are identified as Safety-Class SSCs for the accidents discussed in Sections 3.4.2.7 and 3.4.2.9. (Per agreement with DOE-ORP this Safety-Class designation is not effective until March 30, 2000.)

4.3.23.1 Safety Function(s). From accident analyses in Sections 3.4.2.7 and 3.4.2.9, the transfer system abovegrade portions of process pits, diversion boxes, valve pits, and COBs are identified

as Safety-Class SSCs. Tank waste is transferred within the TWRS complex using the waste transfer system. The waste transfer system piping provides an interconnecting network for the planned transfer of tank waste to support TWRS operations. If a component of the transfer system pressure boundary (e.g., pipe, jumper, valve) were to be damaged or incorrectly installed, a leak of tank waste could result. A pool leak or a spray leak of tank waste from the waste transfer piping system in a waste transfer-associated structure could result in offsite consequences exceeding the evaluation guidelines.

By design, the waste transfer piping system is routed in confinement structures or components that can prevent most or all of a waste leak from reaching the atmosphere. Most of the waste transfer system piping system is underground and is normally accessible only in waste transfer-associated structures. COBs are provided in the waste piping at selected locations in the tank farms and can be used, if required, for the insertion of special tools to clear a blockage in the piping. Confinement for any leakage from the waste transfer piping system as it passes through the pits is provided by the abovegrade portions of pit structures and their cover(s); this design mitigates the consequences of a surface pool or waste spray leak.

The safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and COBs are to provide an intact boundary for the leaked waste and, when leak detector alarms and appropriate operator response times to shut off the transfer pump are credited, to prevent premature waste transfer structure overflow and the formation of a surface pool. This decreases the consequences of the Surface Leak Resulting in Pool (Section 3.4.2.7) accident.

The safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and COBs are to provide an impaction surface that prevents a waste leak from jetting directly into the atmosphere and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages between adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines (Section 3.4.2.9) accident.

4.3.23.2 System Description. Abovegrade portions of process pits, diversion boxes, and valve pits are typically constructed of reinforced concrete and are discussed more fully in Sections 2.4.1.4 and 2.4.3.6. COB covers are constructed in accordance with their design documentation and are commonly fabricated of steel. COBs are described in Section 2.4.10.1.1.

Table 4-4 lists the waste transfer system pits and COBs. When pits and other transfer-associated structures are on the active transfer route of a waste transfer, the abovegrade portions of process pits, diversion boxes, valve pits, and COBs are Safety-Class SSCs during the waste transfer operation.

Some pits in Table 4-4 are noted to be "inactive," which is defined in Section 4.3.18.2.

Inactive pits have been isolated from waste transfer operations and are not subject to the controls discussed here. When an inactive pit is reactivated for waste transfer operations,

however, the abovegrade portions of that inactive pit shall be Safety-Class SSCs, and must be shown to be in full compliance with all controls.

The abovegrade portions of process pits, diversion boxes, and valve pits have demonstrated excellent durability in tank farm service, even though reinforced concrete structures are vulnerable to damage from impacts during cover removal and replacement. Appropriate lifting equipment is used to remove and replace covers, and all lifts are performed to approved procedures; however, the potential for undetected damage exists.

4.3.23.3 Functional Requirements. The abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall confine direct spray leaks to the inside of the structure and shall be designed to eliminate direct spray leakage paths. Transfer system cover assemblies shall fit their supporting structure so that there are no paths for a direct spray leak of tank waste to the atmosphere.

Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall be designed to provide an intact boundary to confine waste leakage within the waste transfer-associated structure until it is completely filled with leaked waste. Unsealed openings in the abovegrade portions of process pits, diversion boxes, and valve pits shall be plugged, and holes in COB covers from previous repairs or uncompleted modifications shall be sealed to prevent premature waste outleakage and the formation of a surface pool of waste.

4.3.23.4 System Evaluation. The design of the existing abovegrade portions of process pits, diversion boxes, valve pits, and COBs is adequate for the required safety functions. Each time a process pit, diversion box, valve pit, or COB is opened, the abovegrade portions shall be visually inspected for damage or defects that could affect the ability of the SSC to perform its safety function. The exterior of the abovegrade portions shall be visually inspected prior to a waste transfer to ensure that the following requirements are satisfied:

- The abovegrade portions are free of defects that could result in the inability to perform the safety functions.

- Existing plugs and seals are installed and operable.

4.3.23.5 Controls (Technical Safety Requirements). The accident analyses discussed in Sections 3.4.2.7 and 3.4.2.9 assume that the abovegrade portions of a process pit, diversion box, valve pit, or COB are operable prior to a waste transfer and remain operable throughout the transfer evolution.

Damage to the abovegrade portions of a process pit, diversion box, valve pit, or COB, especially in the region of support for the covers, is quite obvious. Any damage that could compromise the fit of a cover, and thus the effectiveness of the fit of the transfer system covers to the abovegrade portions of the pit, diversion box, or COB in performing its safety function, shall be evaluated.

COB covers are especially vulnerable to damage when removed, and the closure seal of the COB cover shall be verified when a removed cover is reinstalled. Damaged SSCs that cannot meet the functional requirements shall be repaired or replaced before waste transfers are routed through the affected waste transfer-associated structure.

4.3.24 Temperature Monitoring Systems

The temperature monitoring systems are identified as Safety-Class SSCs for the accident scenario discussed in Section 3.4.2.6. (There is an Authorization Basis amendment pending DOE approval that will eliminate the need to designate the temperature monitoring systems as Safety-Class. Therefore, these systems are identified as Safety-Significant.)

4.3.24.1 Safety Function(s). The safety function of the temperature monitoring systems is to provide tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding waste temperatures at which organic salt-nitrate reaction could proceed, thus decreasing the frequency of the Organic Salt-Nitrate Reaction (Section 3.4.2.6) accident.

4.3.24.2 System Description. Tank waste temperature monitoring systems include thermocouple trees and multifunction instrument trees. Waste temperatures can be read by the Tank Monitoring and Control System, field-mounted panel monitors, or locally by handheld temperature monitoring instrumentation. The thermocouple tree is equipped with temperature detectors placed at 610-mm (2-ft) vertical intervals within the tank (the distance of the lowest detector from the tank bottom varies from tank to tank). The multifunction instrument tree includes temperature detectors as well as vapor probe chambers for vapor sampling. The multifunction instrument tree contains 22 thermocouples evenly spaced at different heights from the bottom of the tank upward into the tank vapor space. The multifunction instrument tree output signals are transmitted automatically to the Tank Monitoring and Control System.

The temperature monitoring system for waste tanks is considered reliable, as multiple thermocouples are installed in each tank. Failure of some of the thermocouples, therefore, does not prevent measurement of waste temperatures. Electrical power interruptions may interfere with data transmission to the Tank Monitoring and Control System but, if required, temperatures can always be read locally by means of calibrated millivoltmeters connected temporarily to the thermocouple wires (Section 2.4.11.4).

4.3.24.3 Functional Requirements. The temperature monitoring systems shall be capable of detecting and displaying the temperature of tank waste over the full range of tank operations, including temperatures resulting from a loss of cooling event.

4.3.24.4 System Evaluation. The existing temperature monitoring systems are adequate for the required safety function. The temperature monitoring systems shall be functionally tested annually to assure that each temperature display is within ±2.8 °C (±5 °F) of the temperature read locally by a handheld temperature monitoring instrument at the thermocouple output signal connection.

Plant monitoring procedures require that weekly temperature readings be taken. Functional testing is performed in accordance with plant operating procedures.

4.3.24.5 Controls (Technical Safety Requirements). The assumption in Section 3.4.2.6 is that the tank temperature monitoring systems for the tanks not categorized as "safe" in Table 3.4.2.6-2 are operable and operating. The waste temperature monitoring systems provide the temperature information needed to maintain the following limits.

- SSTs:

  ≤96.1 °C (≤205 °F) In all waste levels

- For DSTs and AWF tanks:

  ≤90.6 °C (≤195 °F) In all waste levels

  OR

  ≤90.6 °C (≤195 °F) In the top 15 ft of the waste

  AND

  ≤101.7 °C (≤215 °F) In the waste below 15 ft.

The operability assumption includes the following provision: the operability of the waste temperature monitoring system will be verified annually to assure that the temperature values are reasonable and that the displayed temperature is within ±2.8 °C (±5 °F) of that temperature read at the thermocouple outlet. The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.3.25 Transfer System Supplemental Covers

Transfer system supplemental covers are identified as Safety-Class SSCs for transfer structures with volumes smaller than valve pit 241-A-A (15 m^3 [530 ft^3]) in the accident analysis in Section 3.4.2.7. Installation of these supplemental covers is not required on waste transfer structures with volumes equal to or greater than 15 m^3 (530 ft^3).

4.3.25.1 Safety Function(s). Tank waste can be transferred within the TWRS complex by using the waste transfer system. The waste transfer system piping provides an interconnecting network for the planned transfer of tank waste to support TWRS operations. If a component of the transfer system pressure boundary (e.g., pipe, jumper, valve) were to be damaged or incorrectly installed, a leak of tank waste could occur. If this pool leak occurs in a waste transfer-associated structure with a volume smaller than 15 m^3 (530 ft^3), the structure will overflow and potentially produce a spray leak. Thus, a pool leak of tank waste in waste transfer-associated structures with

volumes smaller than 15 m^3 (530 ft^3) could produce both onsite and offsite consequences that exceed the evaluation guidelines.

Most waste transfer-associated structures have sufficient interior volume to prevent most or all of a waste leak or spray stream from reaching the atmosphere. However, waste transfer-associated structures with volumes less than 15 m^3 (530 ft^3) will overflow even when all controls are applied. Because of the potential for inadequate transfer system covers on these small structures, there is also the possibility for a spray release before and after the structure has filled. Supplemental covers are installed on transfer-associated structures smaller than 15m^3 (530 ft^3), including cleanout boxes, to knock down spray leaks that accompany the pool leak. This design mitigates the consequences of a surface waste leak.

The safety function of the transfer system supplemental covers is to limit release of aerosols generated by spray in the COB/pit (following the initial surface leak) by providing an impaction surface that prevents a waste leak from jetting directly into the atmosphere, thus decreasing the consequences of the Surface Leak Resulting in Pool (Section 3.4.2.7) accident.

4.3.25.2 System Description. The supplemental covers for COBs have two basic configurations. One configuration has a one-piece solid top. The second configuration incorporates a two-piece overlapping top to accommodate the vertical leak detector supports.

Table 4-4 lists the waste transfer system pits and COBs. When pits or COBs with volumes less than 15m^3 (530 ft^3) are on the active transfer route of a waste transfer, the supplemental covers are Safety-Class SSCs during the waste transfer.

Some pits in Table 4-4 are noted to be "inactive," which is defined in Section 4.3.18.2.

Inactive pits have been isolated from waste transfer operations and are not subject to the controls discussed here. When an inactive pit with a volume less than 15m^3 (530 ft^3) is reactivated for waste transfer operations, however, the supplemental covers will be Safety-Class SSCs and must be shown to be in full compliance with all controls.

4.3.25.3 Functional Requirements. Transfer system supplemental covers shall knock down spray leaks of up to 861.7 kPa (125 lb/in.^{2} gauge). Supplemental covers shall not be liquid or air tight and shall be designed such that a waste leak of at least 76 L/min (20 gal/min) would be released to the ground (i.e., the waste will not accumulate in the supplemental cover). Supplemental covers shall not be degraded by contact with the waste. Supplemental covers shall be capable of withstanding high winds (145 km/h [90 mi/h]) and snow/ash fall (2.2 kPa [45 lb/ft^2]). Supplemental covers shall extend to the ground and allow for maintenance and surveillance activities on the transfer-associated structure.

4.3.25.4 System Evaluation. The transfer system supplemental covers are adequate for the required safety functions when the supplemental covers are installed.

The exterior of the supplemental cover shall be visually inspected prior to a waste transfer and every 72 hr thereafter (while the waste transfer is ongoing) to ensure that the supplemental covers are installed and operable.

4.3.25.5 Controls. The accident analysis described in Section 3.4.2.7 assumes that, for waste transfer-associated structures with volumes less than $15m^3$ ($530\ ft^3$), transfer system supplemental covers are operable prior to a waste transfer and remain operable throughout the transfer evolution. Operability of transfer system supplemental covers shall be verified every 72 hr during a waste transfer.

4.3.26 Backflow Prevention Devices (204-AR Waste Unloading Facility only)

The backflow prevention devices located in the 204-AR Waste Unloading Facility (waste unloading room) are identified as Safety-Class in the accident analyses in Sections 3.4.2.7 and 3.4.2.9. It is important to note that the Safety-Class designation only applies to the backflow prevention devices located in the 204-AR Waste Unloading Facility. Backflow prevention devices other than those in the 204-AR Waste Unloading Facility are identified as Safety-Significant and are described in Section 4.4.4.

4.3.26.1 Safety Function(s). The raw water system is routed into the 204-AR Mechanical Equipment Room through two separate lines. One line supplies water to the chemical addition tanks which are used to adjust the composition of the waste before or during a transfer. The second line supplies water for the fire protection system and also supports activities such as line flushes, pump priming and sealing, tank sluicing and rinsing, and Unloading Room washdowns.

A non-safety related backflow prevention system is located in the Mechanical Equipment Room and is used to prevent accidental chemical contamination of the raw water systems. The Safety-Class backflow prevention system, located in the Unloading Room, is used to prevent a potential spray or pool leak from occurring in the Mechanical Equipment Room during internal or external transfers.

One safety function of the backflow prevention devices located in the 204-AR Waste Unloading Facility (waste unloading room) is to prevent a backflow of waste into the raw water or other service systems leading to the Mechanical Equipment Room where a leak could form a surface pool, thus decreasing the frequency of the Surface Leak Resulting in Pool (3.4.2.7) accident.

Another safety function of the backflow prevention devices located in the 204-AR Waste Unloading Facility (waste unloading room) is to prevent a backflow of waste into the raw water or other service systems leading to the Mechanical Equipment Room where a spray leak could occur, thus decreasing the frequency of the Spray Leak in Structure or from Waste Transfer Lines (3.4.2.9) accident.

4.3.26.2 System Description. The backflow prevention device is located in the Unloading Room where raw water is supplied. The backflow preventer consists of two check valves that prevent backflow of waste from the 204-AR Waste Unloading Facility into the raw water system. Between the two check valves, there is a differential pressure relief valve that drains the interspace during a backflow condition. The test cocks and shutoff valves permit routine functional testing of the individual check valves and the differential pressure relief valve to ensure that the system is operating correctly.

During operation, the reduced pressure backflow preventer assembly has four distinct modes.

- The system is shut down, and no pressure is applied. In this case, both check valves are closed and the interspace between them is drained to atmosphere. It would be normal for only the downstream shutoff valve to be closed if this condition were expected to exist for any length of time.

- The system is pressurized from the normal 204-AR raw water supply system without water flow. In this case, both check valves are closed and the interspace is at a lower pressure (typically one-third of an atmosphere) than the water supply to the inlet check valve.

- The system is pressurized by the 204-AR raw water supply system with water flowing. In this case, both check valves are open and the pressure drop across the inlet check valve is such that the interspace is maintained at a lower pressure (typically one-third of an atmosphere) than the water supply to the inlet check valve upstream of the differential relief valve.

- The system is pressurized from the downstream side. The reduced pressure backflow preventer protects against back-pressurization and back-siphonage. The check valves provide the first line of defense against either of these two conditions. If a check valve fails and the pressure in the interspace between the two check valves drops lower than one seventh of an atmosphere (2 psi) below the supply pressure, then the pressure relief valve will open and the liquid will spill to the ground. The backflow of a potentially radioactive or hazardous chemical flow stream is thus prevented from entering the piping in the mechanical room where a spray leak could potentially occur.

4.3.26.3 Functional Requirements. Backflow prevention devices shall be installed in accordance with the manufacturer's instructions, including protection from freezing temperatures. The rated pressure of the backflow preventer shall be higher than the maximum pressure of the system in which it is installed.

4.3.26.4 System Evaluation. The existing backflow prevention devices are adequate for the required safety function. The backflow preventers used at the Hanford Site are specifically designed to perform their backflow prevention function. The backflow preventers are protected

from freezing by installation in a nonfreezing environment (e.g., in an underground pit where the heat in the soil prevents temperatures from dropping below freezing level or in a heated structure or other location that maintains temperatures above the freezing level) and are operated within their design limits (e.g., maximum operating pressure) as certified by the manufacturer.

The 204-AR Unloading Room backflow prevention devices shall be functionally tested annually by trained technicians using approved procedures and shall be verified to be operating correctly.

Backflow preventers have a long history of reliable performance, both in TWRS and offsite in public water supply applications. Backflow preventers are failsafe devices.

4.3.26.5 Controls. The accident analyses described in Sections 3.4.2.7 and 3.4.2.9 assume that the 204-AR Waste Unloading Facility backflow prevention device is operable prior to a waste transfer and remains operable throughout the transfer evolution. The operability assumptions include the following provisions:

- The 204-AR Waste Unloading Facility backflow prevention device must be operable when it is PHYSICALLY CONNECTED (as defined in Section 1.1 of HNF-SD-WM-TSR-006) to an active waste transfer pump not under administrative lock.

- A functional test will be performed annually to ensure that the 204-AR Waste Unloading Facility backflow prevention device is operable.

4.4 SAFETY-SIGNIFICANT STRUCTURES, SYSTEMS, AND COMPONENTS

This section provides information about the Safety-Significant SSCs identified in Chapter 3.0. Table 4-7 provides a summary list of those SSCs. Details of each Safety-Significant SSC, correlating to the information in the table, follow.

Information on Safety-Significant SSCs associated with projects outside the original scope of the FSAR are included in the designated addenda. Addendum 1 provides a description of the Safety-Significant SSCs for the WRSS. Addendum 2 provides a description of the Safety-Significant SSCs for the RCSTS. Addendum 3 provides a description of the Safety-Significant SSCs for the 241-AZ-702 ventilation system. Addendum 4 provides a description of the Safety-Significant SSCs for the 241-AZ-101 mixer pump test. Additional information on safety SSCs for Tank 241-SY-101 remediation activities and operations are summarized in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Activities and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

4.4.1 Waste Tanks

The DSTs (including AWF tanks) and SSTs are designated as Safety-Significant structures for load requirements. From Section 3.4.2.1, the load drop is only applicable to the DSTs (including AWF tanks) and the 100 Series SSTs. The uniform and concentrated loads are applicable to 100 and 200 Series SSTs and DSTs (including AWF tanks). (Per agreement with DOE-ORP this Safety-Significant designation is not effective until March 30, 2000.)

4.4.1.1 Safety Function. The safety functions of the waste tanks are to withstand penetration from load drops and to maintain structural integrity for uniform and concentrated loads, vacuum, and degradation, averting tank collapse and preventing the release of waste, thus decreasing the frequency of the Tank Failure Due to Excessive Loads (and tank failure due to vacuum or degradation) accident (Section 3.4.2.1).

4.4.1.1.1 Impact Loads. Section 3.4.2.1 identifies that impact loads may be generated on the soil above the tank or in the pump pit from dropping objects lifted above the surface by a crane or other lifting device. This could result in onsite consequences if the impact loads resulted in local failure of the tank structure.

4.4.1.1.2 Excessive Loads. Section 3.4.2.1 indicates that dead loads (e.g., soil cover to provide radiation shielding) and live loads over the tanks are controlled to prevent overstressing the tanks and possibly causing structural failure of the tanks.

4.4.1.2 System Description. Radioactive waste is stored at the Hanford Site in 177 steel-lined, reinforced concrete, underground tanks that are providing interim storage of the waste until further processing and permanent disposal options become available.

The underground tanks are arranged in groups called tank farms in the 200 East and 200 West Areas of the Hanford Site.

There are two basic tank designs, DSTs (including the AWF tanks) and SSTs. Between 1943 and 1964, 149 SSTs were constructed. The remaining 28 tanks are DSTs, constructed between 1968 and 1986.

The most important structural function of the waste tanks is to resist dome penetration from a load drop or excessive uniform and concentrated loads.

For complete descriptions of DSTs (including AWF tanks) and SSTs, refer to Section 2.4 and Figures 2-8, 2-9, 2-13, and 2-14.

4.4.1.3 Functional Requirements. The tanks shall be able to maintain structural integrity for load drops and uniform and concentrated loads. Load values are specified in HNF-SD-WM-TSR-006, Section 5.16, "Dome Loading Controls."

4.4.1.4 System Evaluation. The existing waste tanks are adequate for the required safety functions. DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*, shall be used for lifts. Operating procedures provide lifting restrictions. Changes to the design of the waste tanks are controlled according to approved procedures. Control of loads, vehicles, and vehicle access and movement within tank farms is maintained by HNF-IP-0842, Volume IV, Section 4.10, "Waste Tank Dome Loading."

The tanks have been shown to have the requisite structural capacities in their current configuration to withstand the analyzed loads and load drops (Section 3.4.2.1).

4.4.1.5 Controls (Technical Safety Requirements). Dome loading controls shall be specified in Section 5.16 of HNF-SD-WM-TSR-006.

4.4.2 204-AR Waste Unloading Facility Structure

The 204-AR Waste Unloading Facility structure is identified as a Safety-Significant SSC to mitigate the consequences of the accident analyzed in Section 3.4.2.7.

4.4.2.1 Safety Function(s). Low-level liquid radioactive waste is normally delivered to the 204-AR Waste Unloading Facility in rail tank cars or tank trailers. The 204-AR Waste Unloading Facility transfer pumps are used to offload the low-level waste and transfer it from the 204-AR Waste Unloading Facility structure to the 241-A-A valve pit via encased line LIQW-702. Additional information on the 204-AR Waste Unloading Facility is provided in Section 2.4.6, where the Design Features of this unique facility are discussed in detail.

If, however, a high-level tank farm waste transfer were to be misrouted so that it backflowed into the 204-AR Waste Unloading Facility and formed a leak in the 204-AR Waste Unloading Facility discharge piping system, the accident could result in onsite consequences if the 204-AR Waste Unloading Facility structure were not there as a barrier or if the rail tank car unloading canyon doors were to be open. Section 3.4.2.7 identifies the 204-AR Waste Unloading Facility structure as a Safety-Significant SSC to mitigate the consequences of this accident.

Per the Section 3.4.2.7 accident analysis, the safety functions of the 204-AR Waste Unloading Facility structure are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.

4.4.2.2 System Description. The design of the 204-AR Waste Unloading Facility is traceable to the engineering design documents for the structure. The walls of the facility are constructed of reinforced concrete. The only part of the facility that normally contains waste is the rail tank car unloading canyon. This room houses the rail tank car or tank trailer, the transfer pumps, the discharge piping system, and the catch tank. Access to the tank car unloading canyon radiation

zone from the outside of the facility is through an arrangement similar to an airlock, a roll-up door and a pair of hinged doors that are kept in their closed position except when personnel passage is required.

The 204-AR Waste Unloading Facility radiation zone HVAC system for the 204-AR Waste Unloading Facility tank car unloading canyon has two intake points. Canyon air entering the exhaust intakes passes through a 30% filter and the first stage of HEPA filtration prior to entering a common plenum. Gases in the headspace of the catch tank, located belowgrade in a corner of the unloading canyon, also reach this common plenum through a moisture separator, a heating element, and another HEPA filter. This common exhaust plenum is equipped with dampers, another moisture separator, and a final stage of HEPA filtration upstream of the exhaust fan. The exhaust fan discharges the flow stream to atmosphere through stack 296-A-26. The exhaust flow stream to the stack is monitored by a CAM. On detection of radioactive particulate levels above a preset level, the CAM alarms and shuts down the exhaust fan, as discussed in Section 4.3.19. The exhaust ducting is provided with flow measurement, radiation sampling, and radiation monitoring systems. As a Defense-in-Depth activity, the differential pressure across the moisture separators and HEPA filters is monitored, and their associated alarms are annunciated in the 204-AR Waste Unloading Facility control room. Figure 4-7 provides additional details of the 204-AR Waste Unloading Facility radiation zone HVAC system.

The 204-AR Waste Unloading Facility local control room is manned only during the unloading of a rail tank car or tank trailer; the 242-A Evaporator Control Room is continuously manned. All alarms to the 204-AR Waste Unloading Facility control room are repeated as a "204-AR TROUBLE" alarm to the 242-A Evaporator Control Room.

4.4.2.3 Functional Requirements. The 204-AR Waste Unloading Facility structure shall be designed to confine the tank waste leak described in the Section 3.4.2.7 accident analysis.

4.4.2.4 System Evaluation. The existing 204-AR Waste Unloading Facility structure is adequate for the required safety functions. The 204-AR Waste Unloading Facility structure provides the confinement capability required to mitigate the consequences of a pool leak of misrouted high-level tank waste from the waste transfer system into the rail tank car unloading canyon, which is the only location in the 204-AR Waste Unloading Facility where a high-level waste pool accident can occur. With the large volume of the rail tank car unloading canyon, with closed doors providing a confinement barrier per TSR Administrative Control 5.12, and with the multiple HEPA filters and intermediate moisture separator, the 204-AR Waste Unloading Facility structure design presents a relatively stagnant air volume and limits the aerosols released by the splattering and splashing action of the waste leak. The 204-AR Waste Unloading Facility structure is designed to shield the facility operators from radioactive material movement in the rail tank car unloading canyon, which limits the shine dose from the pool leak.

4.4.2.5 Controls (Technical Safety Requirements). The assumption in the Section 3.4.2.7 pool leak accident is that the 204-AR Waste Unloading Facility structure serves the same safety function as the transfer system covers serve for a waste transfer system pit in Section 4.3.18. In

the Section 4.3.18 discussion, the transfer system covers are not sealed and, thus, do not ensure complete confinement of waste spray leak aerosols; gaps provide leakage paths for some of the aerosol generated in the pool leak to be expelled. Similarly, the rail tank car unloading canyon openings are not sealed, and the gaps provide leakage paths for a limited quantity of aerosols.

The assumption in the Section 3.4.2.7 pool leak accident is that the position of the 204-AR Waste Unloading Facility rail tank car unloading canyon doors is important to the ability of the building to limit the escape of waste aerosols generated by the leak and to limit the shine to facility workers from the leaked waste pool. It is also a good operational practice to ensure that all doors that open the rail tank car unloading canyon to atmosphere remain closed at all times unless there is an operational or maintenance need for their temporary opening. The main entry rollup door/hinged doors are the chief vulnerability of the 204-AR Waste Unloading Facility as a confinement structure since these large doors must be opened to admit a rail tank car or tanker truck. These doors are closed when the 204-AR waste transfer pumps are operating to ensure that low-level airborne waste from a pool leak does not escape from the building.

Prior to a waste transfer, the west exterior rollup and west exterior personnel access doors shall be verified closed.

4.4.3 2727-W Building

The 2727-W Building is identified as a Safety-Significant SSC for the Sodium Fire accident described in Section 3.3.2.4.10.

4.4.3.1 Safety Function(s). The initiating event for the Sodium Fire accident is assumed to be a high wind that causes major damage to the 2727-W Building. Falling building material is assumed to break off a large pipe connection into a sodium storage tank in such a way that the resultant tank opening faces skyward. After tank damage, the wind is assumed to decrease to a low speed and heavy rain is assumed to begin. The building roof is assumed to have failed in such a way that rain is channeled into the tank opening. The rain causes a vigorous sodium-water reaction that generates large amounts of hydrogen and heat. The hydrogen is assumed to ignite and cause an explosion that further damages and opens the upper half of the tank. The explosion results in a sodium fire that covers the entire upper surface of the sodium in the tank. The rain is then assumed to stop and the wind speed to remain low in order to minimize washout of releases and maximize downwind exposures to the sodium combustion product release, which is assumed to be converted entirely to sodium hydroxide in the moist air.

The ability of the building to withstand winds of up to 113 km/h (70 mi/h) reduces the frequency of the accident described above. A foundation wall height of at least 0.9 m (3 ft) abovegrade eliminates vehicle collision as a credible accident initiator.

The safety functions of the 2727-W Building are to withstand high winds and to protect the stored sodium tanks from vehicle collisions, thus preventing a sodium fire and decreasing the frequency of the Sodium Fire (Section 3.3.2.4.10) accident.

4.4.3.2 System Description. The 2727-W Building, as designed, is a prefabricated metal structure installed on a concrete foundation wall. The building is rated for a 958 Pa (20 lb/ft^2) wind load (WHC-SD-WM-TI-759, *Hazard Evaluations for the Tank Waste Remediation System Final Safety Analysis Report*), which translates to a 113 km/h (70 mi/h) fastest mile wind speed (ASCE-7, *Minimum Design Loads for Buildings and Other Structures*). No supporting SSCs have been identified for the 2727-W Building.

4.4.3.3 Functional Requirements. The 2727-W Building shall be designed to withstand winds up to 113 km/h (70 mi/h), which correlates to a wind loading of 958 Pa (20 lb/ft^2). The top of the foundation wall shall be at least 0.9 m (3 ft) abovegrade.

4.4.3.4 System Evaluation. The existing 2727-W Building is adequate for the required safety functions. The 2727-W Building shall be inspected annually for structural degradation from the configuration shown in design drawings. The height of the foundation wall shall be verified annually to ensure that it extends at least 0.9 m (3 ft) abovegrade. In its current configuration, the foundation wall is 1.2 m (4 ft) abovegrade.

The chief vulnerability of the building is high winds; the building has survived 25 yr without damage from wind forces, including a recorded wind speed of 129 km/h (80 mi/h) measured on two occasions at the Hanford Meteorological Station (Section 1.4.1.1.4). The building foundation wall extends 1.2 m (4 ft) abovegrade, which exceeds the functional requirement.

Control of design changes to the 2727-W Building is maintained by following approved procedures.

4.4.3.5 Controls (Technical Safety Requirements). The assumptions in the Section 3.3.2.4.10 accident analysis are that the building will withstand exposure to a wind load of 958 Pa (20 lb/ft^2), which correlates to a wind speed of 113 km/h (70 mph), and that the height of the foundation wall is at least 0.9 m (3 ft) abovegrade. These assumptions can be verified by an annual inspection of the building to ensure that the building structure has not been modified from the configuration shown in the design drawings.

4.4.4 Backflow Prevention Devices

The backflow prevention devices are identified as Safety-Significant SSCs for the Surface Leak Resulting in Pool (Section 3.4.2.7) accident and for the Spray Leak in Structure or From Waste Transfer Lines (Section 3.4.2.9) accident.

4.4.4.1 Safety Function(s). Reduced pressure backflow preventers (Figure 4-8) are required by the state of Washington to be installed between a potable water supply and any system that has a wetted surface if that system contains toxic material and/or radioisotopes. The specific codes setting these requirements are WAC 246-290, "Group A Public Water Systems," and

WAC 246-490, "Cross Connection Control Systems." The state laws referenced above are driven by the *Safe Drinking Water Act of 1974*, as amended.

Service water is supplied to the tank farms for flushing purposes. By installing state-required reduced-pressure backflow preventers in the service water supply lines to TWRS, the potential backflow of tank waste into the water supply systems is prevented.

The safety function of the backflow prevention devices is to prevent a backflow leak of tank waste from the waste transfer system into the service water piping system, thus decreasing the frequency of the Surface Leak Resulting in Pool (Section 3.4.2.7) and Spray Leak in Structure or From Waste Transfer Lines (Section 3.4.2.9) accidents.

4.4.4.2 System Description. The backflow prevention device is located where service water is supplied to the tank farms. The backflow preventer consists of two check valves that prevent backflow from the tank farms into the service water system. Between the two check valves, there is a differential pressure relief valve that drains the interspace during a backflow condition. The backflow prevention device is required to be approved by the state of Washington, and its installation must be inspected and tested annually by state-certified personnel.

During operation, the reduced pressure backflow preventer assembly has four distinct modes:

- The system is shut down, and no pressure is applied. In this case, both check valves are closed and the interspace between them is drained to atmosphere. It would be normal for the shutoff valves to be closed if this condition were expected to exist for any length of time.

- The system is pressurized from the normal 200 Area service water supply system without water flow. In this case, both check valves are closed and the interspace is at a lower pressure (typically one-third of an atmosphere) than the water supply to the inlet check valve.

- The system is pressurized from the normal 200 Area service water supply system with water flow. In this case, both check valves are open and the pressure drop across the inlet check valve is such that the interspace is maintained at a lower pressure (typically one-third of an atmosphere) than the water supply to the inlet check valve upstream of the differential relief valve.

- The system is pressurized from the downstream side. The reduced pressure backflow preventer protects against back-pressurization and back-siphonage. The check valves provide the first line of defense against either of these two conditions. If a check valve fails and the pressure in the interspace between the two check valves drops lower than one seventh of an atmosphere (2psi) below the supply pressure, then the pressure relief valve will open and the liquid will spill to the ground. The backflow of a potentially radioactive or hazardous chemical flow

stream is thus prevented from reaching the water supply system. The test cocks and shutoff valves permit routine functional testing of the individual check valves and the differential pressure relief valve to ensure that the system is operating correctly.

4.4.4.3 Functional Requirements. Backflow prevention devices shall be installed in accordance with the manufacturer's instructions, including protection from freezing temperatures. The rated pressure of the backflow preventer shall be higher than the maximum pressure of the system in which it is installed. State approval of an installation, provided by the state-certified Site water purveyor or designee, is required before the service water supply valve(s) may be opened.

4.4.4.4 System Evaluation. The existing backflow prevention devices are adequate for the required safety function. The backflow preventers used at the Hanford Site are specifically designed to perform their backflow prevention function and have been selected from the listing of such devices approved by the state of Washington. The backflow preventers are protected from freezing by installation in a nonfreezing environment (e.g., in an underground pit where the heat in the soil prevents temperatures from dropping below freezing level or in a heated structure or other location that maintains temperatures above the freezing level) and are operated within their design limits (e.g., maximum operating pressure) as certified by the manufacturer.

Washington State requires that backflow prevention devices shall be functionally tested annually by trained technicians using approved procedures and requires that backflow prevention devices shall be verified to be operating correctly.

Backflow preventers have a long history of reliable performance, both in TWRS and offsite in public water supply applications. Backflow preventers are failsafe devices.

4.4.4.5 Controls (Technical Safety Requirements). TSR controls are not required to ensure the functionality of the backflow preventers. Water supplies to TWRS (e.g., 204-AR Waste Unloading Facility and the TWRS waste transfer system) are not permitted by Washington State laws except through approved, operable, reduced pressure backflow preventers. These conditions must be verified by qualified personnel who have been certified by the health department of the state. These Washington State requirements are implemented by the industrial hygiene program addressed in Chapter 8.0.

4.4.5 High-Efficiency Particulate Air Filter Units

The HEPA filters in the DCRT ventilation systems are identified as Safety-Significant SSCs for the accident scenario described in Section 3.3.2.4.12.

4.4.5.1 Safety Function. The analysis in Section 3.3.2.4.12 discusses a misrouted facility transfer of concentrated (57 wt%) nitric acid to a DCRT. The accident scenario without controls results in unacceptable consequences to an onsite receptor for both radiological dose and toxicological exposure; consequences to the offsite receptor are acceptable. The accident analysis

identified the HEPA filter units in the DCRT ventilation discharge path to atmosphere as Safety-Significant SSCs as operable HEPA filter units reduce the radiological dose and toxicological exposure to the facility worker from an unfiltered release to below acceptable levels.

The addition of concentrated nitric acid to a DCRT containing an optimum amount of basic tank waste maximizes the resulting neutralization reaction and produces sufficient heat to release both radioactive and toxic materials into the tank vapor space. The waste aerosol in the tank vapor space is drawn from the tank by fans, which continue to run following the acid addition. As the fans draw the aerosol from the tank vapor space through the HEPA filter unit, most of the particulate matter in the ventilation discharge flow stream is trapped on the HEPA filter element.

The safety function of the DCRT ventilation system HEPA filter unit (one stage) is to provide HEPA filtration of DCRT headspace gases before their release to the environment, thus decreasing the consequences of the Mixing of Incompatible Material—Tank Pressurization (Section 3.3.2.4.12) accident.

4.4.5.2 System Description. The HEPA filter unit is a sealed enclosure that houses one or more HEPA filter elements, with suitable connections for monitoring the efficiency of the filter. The HEPA filter unit encloses replaceable filter elements. The enclosure provides the structural pathway for channeling the ventilation system flow stream from the waste tank vapor space to and through the HEPA filter elements. As the ventilation system flow stream passes through the filter elements, most of the particulate matter in the flow stream is deposited on the filter media.

The filter media is fabricated from fibrous materials with a particle-removal efficiency of at least 99.95% for 0.3-μm particles of an approved test aerosol. The fibrous material is mounted and sealed to a frame, and the frame provides sealing faces for installation of the filter element into a mounting enclosure. The HEPA filter unit is provided with connections for measurement of differential pressure across the filter element(s) at normal system flow rates. A high differential pressure is associated with the filter element(s) approaching end of useful life because of plugging, while a low (or near zero) differential pressure usually indicates failed (or punctured) filter element(s).

Hardware is installed to periodically verify the efficiency of the HEPA filter unit. Each unit is provided with a tap upstream of the filter element(s) for injection of a challenge aerosol, another tap for upstream sampling immediately before the filter element(s), and still another tap downstream of the filter element(s) for detection of challenge aerosol that may have escaped capture on the filter element(s). HEPA filter units also have sealed bag-in/bag-out capabilities to confine radiological or toxic material either within the unit or within disposable bags. The HEPA filter unit is also accessible for external radiation monitoring so that the filter element can be replaced before the contact radiation dose rate of the filter element exceeds an administrative limit.

4.4.5.3 Functional Requirements. HEPA filter units shall:

- Remove at least 99.95% of 0.3-μm particles of an approved challenge aerosol
- Resist degradation when exposed to ionizing radiation and caustic vapors
- Resist damage caused by moisture buildup on the filter media
- Resist leakage when exposed to a differential flow stream pressure of ≤2.49 kPa (≤10 in. WG).

4.4.5.4 System Evaluation. The existing DCRT ventilation HEPA filter units are adequate for the required safety function. Operability of the HEPA filter units is verified at the time of installation and annually thereafter using a challenge aerosol. When the active ventilation system is operating, the differential pressure across the HEPA filters is monitored daily.

HEPA filters are purchased from qualified suppliers to the requirements of Hanford Site procurement specification HNF-S-0552, *Procurement Specification for Nuclear Grade High Efficiency Particulate Air (HEPA) Filter*, and are tested to exacting national consensus standards (e.g., ASME AG-1, *Code on Nuclear Air and Gas Treatment*). This procurement program helps to ensure that the filter element will adequately meet sealing, structural, environmental, and filtration efficiency requirements.

4.4.5.5 Controls (Technical Safety Requirements). The assumption in the accident scenario in Section 3.3.2.4.12 is that the HEPA filter units are operable. The operability assumption includes the following provisions:

- At least one HEPA filter element is in place and fully operable.
- Testing of the HEPA filter unit is current (i.e., it was challenge-aerosol tested at the time of its installation and it has been tested annually thereafter by trained staff using approved procedures).
- HEPA filter differential pressure is monitored daily when the active ventilation system is operating.

The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.4.6 Pipe Encasements

The waste transfer system pipe encasements are identified as Safety-Significant SSCs for the accident analyzed in Section 3.3.2.4.7.

4.4.6.1 Safety Function(s). The accident analysis discussed in Section 3.3.2.4.7 identifies waste transfer system pipe encasements as Safety-Significant SSCs. The safety function of the waste transfer system pipe encasement is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface (Section 3.3.2.4.7) accident.

4.4.6.2 System Description. Waste transfer system primary (or inner) piping is encased by one of two methods:

- The piping system is fabricated as pipe within a pipe, with an inner or primary pipe surrounded by an encasement or secondary pipe. The encasement pipe forms a sloped annular drain channel, and any leaked waste from a primary pipe will flow by gravity along this annular channel to a leak detector.

- The primary pipe(s) is confined in a concrete encasement. The concrete encasement forms a sloped drain channel, and any leaked waste from a primary pipe will flow by gravity along this channel to a leak detector.

Regardless of the encasement form, leaked waste will be channeled into a transfer-associated structure along the transfer route, where the transfer leak detection system described in Section 4.4.11 will detect the leaked waste.

Pipe encasements are vulnerable to damage during excavation activities in the tank farms, particularly when powered equipment is used for digging.

4.4.6.3 Functional Requirements. The pipe encasement shall channel waste leaked from a primary pipe to a transfer-associated structure where the leak can be detected. The encasement shall provide an unobstructed flow path for the movement of leaked waste to a transfer-associated structure.

4.4.6.4 System Evaluation. The existing pipe encasements are adequate for the required safety function. The drain path to a transfer-associated structure from an encased piping system is designed to be free of obstructions (i.e., the loop seal valves provide an unobstructed flow path for leaked waste to reach a waste transfer-associated structure for detection).

4.4.6.5 Controls (Technical Safety Requirements). The Section 3.3.2.4.7 accident analysis assumes that the encasements are operable before a waste transfer and remain operable throughout the transfer evolution. The operability assumption includes the following provision. Prior to the start of a waste transfer, the drain path into the pit(s) from the annulus of the encased piping system shall be verified to provide an open drain path to the pit, with encasement drain valve positions as applicable to the valve type. The encasement drain valves shall never be left in the "HYDRO" position during a waste transfer. A listing of the seal loop valves in the 200 East and 200 West tank farms is provided in Table 4-2.

4.4.7 Salt Well Flow Totalizers

The salt well flow totalizers are identified as Safety-Significant SSCs for the accidents discussed in Sections 3.3.2.4.7, 3.4.2.7, and 3.4.2.8.

4.4.7.1 Safety Function(s). The salt well flow totalizers indicate the total volume of liquid waste removed from SSTs. Readings are taken periodically during a waste transfer, the data support the performance of material balance calculations, in which the incremental volume of waste removed from a tank is compared with the volume increase in the tank receiving the waste. Discrepancies between the quantity sent and the quantity received may indicate the occurrence of a Subsurface Leak Remaining Subsurface accident, a Surface Leak Resulting in Pool accident, or a Subsurface Leak Resulting in Pool accident, due either to a leak along the planned transfer route or from a misrouting of waste.

The safety function of the salt well flow totalizers is to provide the total salt well flow parameter used in periodic material balance calculations during waste transfer operations. These calculations enable operators to terminate the waste transfer operation if waste leaks or mistransfers are detected, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface (Section 3.3.2.4.7), Surface Leak Resulting in Pool (Section 3.4.2.7), and Subsurface Leak Resulting in Pool (Section 3.4.2.8) accidents.

4.4.7.2 System Description. The salt well flow totalizer is a nonintrusive device (a magnetic flow element) that measures the quantity of liquid waste transferred by the salt well pump. Each salt well pump system is provided with a flow totalizer, which is read in the field by tank farm operations staff. In some cases, salt well flow totalizers are connected to pen recorders in the control room, but salt well flow totalizers have no interlock or control function.

Electrical distribution for the flow totalizer instrumentation loop has been identified as a supporting SSC. The electrical distribution system is described in Section 4.5.1.

4.4.7.3 Functional Requirements. The salt well flow totalizer shall measure the flow of liquid waste transferred by the salt well pump per the manufacturer's specification within an accuracy of ±5% for defined flow ranges.

4.4.7.4 System Evaluation. The existing salt well flow totalizers are adequate for the required safety function. Salt well flow totalizers have a good performance history in the tank farms, with a mean time between failures measured in years.

4.4.7.5 Controls (Technical Safety Requirements). The assumption in the above three accident analyses in Chapter 3.0 is that the salt well flow totalizers are operable. The operability assumption includes the following provisions:

- A limited calibration consisting of a zero check and functional test will be performed annually for SSTs undergoing active salt well pumping.

- Salt well flow totalizer readings are provided at intervals that will allow early detection of transfer system leaks so that action can be taken to prevent the formation of a surface or subsurface waste accumulation as described in the above three accidents.

4.4.8 Service Water Flow Totalizers

The service water flow totalizers for DCRTs and the tank farms that have service water supplies are identified as Safety-Significant SSCs for the Surface Leak Resulting in Pool accident analyzed in Section 3.4.2.7.

4.4.8.1 Safety Function(s). A leak or rupture in a service water line could release water that may enter a waste storage tank or receiver tank. A large water intrusion into a tank that contains waste could cause dilute waste to fill and overflow the tank, resulting in a waste pool as described in Section 3.4.2.7. A service water line leak or rupture in tank farms can be detected by using service water flow totalizers to monitor water usage.

Service water flow totalizers provide total flow information that is used to track water usage in tank farms. A local reading is taken and compared with the previous reading to determine the amount of water used since the last reading. The amount is compared with expected usage. An unexpected increase in water usage may indicate a pipe leak or rupture.

The safety function of the service water flow totalizers is to alert operators of an excessive service water flow and a potential water intrusion into a waste tank. This information enables operators to terminate the service water flow if water intrusion is confirmed, thus preventing a waste tank overflow and decreasing the frequency of the Surface Leak Resulting in Pool (Section 3.4.2.7) accident.

4.4.8.2 System Description. Typically, the service water flow totalizer is a turbine type flow meter that measures the volume of water flowing through the meter. Total flow volume indication is provided by either a mechanical or electronic readout. Service water flow totalizers at the following locations are required to perform the safety function identified above:

- 241-AN
- 241-AP
- 241-AW
- 241-AX #1
- 241-AX-104 Integrator
- 241-AY
- 241-AZ
- 241-BY
- 241-C (located at 271-CR)
- 241-SY
- 204-AR

- 244-AR
- 244-TX.

(A flow totalizer for DCRT 244-BX is physically installed but is inactive; therefore, it does not perform the above safety function. Detection of service water intrusion into 244-BX depends on the tank level detection system described in Section 4.4.9.) The remaining tank farm facilities do not have service water supplies.

Electrical distribution has been identified as a supporting SSC for the totalizers equipped with electronic readouts. The electrical distribution system is described in Section 4.5.1.

4.4.8.3 Functional Requirements. The service water flow totalizers shall provide local indication of water usage with an accuracy within ±5%.

4.4.8.4 System Evaluation. The existing service water flow totalizers are adequate for the required safety function. The flow totalizers shall be functionally tested annually .

4.4.8.5 Controls (Technical Safety Requirements). The assumption in the Section 3.4.2.7 accident analysis is that the service water flow totalizers are operable. The operability assumption includes the following provisions:

- Annual functional testing of the service water flow totalizers is properly performed.

- Water usage readings are taken at intervals that will allow early detection of water line leaks or ruptures so that action can be taken to prevent tank overflow.

4.4.9 Tank Level Detection Systems

The tank level detection systems are identified as Safety-Significant SSCs for accidents discussed in Sections 3.3.2.4.7, 3.4.2.7, 3.4.2.8, and 3.4.2.11. The applicability for each accident is different and is provided in Section 4.4.9.3.

4.4.9.1 Safety Function(s). Tank level measurements taken before, during, and after transfers to or from a tank are used in the performance of material balance calculations. The calculations are used to detect discrepancies between the volume of waste sent from one tank and the volume received in another tank. Such a discrepancy may indicate the occurrence of a Subsurface Leak Remaining Subsurface (Section 3.3.2.4.7) accident, Surface Leak Resulting in Pool (Section 3.4.2.7) accident, Subsurface Leak Resulting in Pool (Section 3.4.2.8) accident, or a misrouting of waste.

During transfers, level measurements are taken in tanks interconnected with the transfer route to detect level increases that may indicate a misrouting of waste to an interconnected tank. Such misroutings can cause tank overflows as described in the Surface Leak Resulting in Pool (Section 3.4.2.7) accident analysis.

Level measurements are recorded at specified intervals in tanks that are not in intrusion prevention status. An unexpected level increase could indicate a service water intrusion resulting from a water line leak or rupture. An intrusion may cause a tank overflow as described in the Surface Leak Resulting in Pool (Section 3.4.2.7) accident analysis.

The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface (Section 3.3.2.4.7), Surface Leak Resulting in Pool (Section 3.4.2.7), and Subsurface Leak Resulting in Pool (Section 3.4.2.8) accidents.

An additional safety function of the tank level detection systems is to detect a service water leak into a waste tank, enabling the operators to terminate the service water leak, thus decreasing the consequences of the Surface Leak Resulting in Pool (Section 3.4.2.7) accident.

Temperature controls for the Tank Bump (Section 3.4.2.11) accident in DSTs specify a temperature limit for the top 4.6 m (15 ft) of waste in the tank. If this temperature limit cannot be met in all waste levels, the temperature limit for the waste layer below 4.6 m (15 ft) of depth may be relaxed to a higher value. DST level measurements are required for implementation of the tank bump temperature controls.

The safety function of the tank level detection systems is to support the implementation of the level-dependent tank temperature controls, thus decreasing the frequency of the Tank Bump (Section 3.4.2.11) accident.

4.4.9.2 System Description. Each DST, AWF tank, SST, DCRT, and catch tank is equipped with a surface level detection system (Section 2.4.11.2.1). Each system includes at least one level detector, which may be a manual tape, a Food Instrument Corporation (FIC) gauge, an ENRAF gauge, or a set of dip tubes. Each DST has an FIC gauge or an ENRAF gauge and a manual tape backup; most SSTs, DCRTs, and catch tanks have only one level detector. Level data can be locally read and is automatically or manually provided to the Tank Monitoring and Control System. The Tank 241-SY-101 level detection system provides data to the Data Acquisition and Control System as well as to the Tank Monitoring and Control System.

Electrical distribution and instrument air are identified as supporting SSCs for the tank level detection systems. Instrument air is identified as a supporting SSC for the level dip tubes

only. The electrical distribution system is described in Section 4.5.1, and the compressed (instrument) air system is described in Section 4.5.2.

4.4.9.3 Functional Requirements.

4.4.9.3.1 Subsurface Leak Remaining Subsurface. The level detection systems for all DSTs, AWF tanks, DCRTs, and SSTs (except during salt well pumping), shall provide level measurements prior to transfers to or from the tanks and at specified intervals during the transfers to support material balance calculations. When salt well pumps are used to transfer waste from SSTs, data from the salt well flow totalizers are used in the material balance calculations (see Section 4.4.7). The tank level detection systems shall measure waste levels with an accuracy of ±1.3 cm (±0.5 in.).

4.4.9.3.2 Surface Leak Resulting in Pool. The level detection systems for all DSTs, AWF tanks, DCRTs, and SSTs (except during salt well pumping) shall provide level measurements prior to transfers to or from the tanks and at specified intervals during the transfers to support material balance calculations. When salt well pumps are used to transfer waste from SSTs, data from the salt well flow totalizers is used in the material balance calculations (Section 4.4.7).

The level detection systems for all DSTs, AWF tanks, DCRTs, catch tanks, and SSTs that are not in intrusion prevention (interim isolation) status shall provide level measurements to detect waste misroutes prior to and during waste transfers when the tanks are interconnected to the transfer route.

The level detection systems for all DSTs, AWF tanks, DCRTs, catch tanks, and SSTs that are not in intrusion prevention status shall provide level measurements at specified intervals to detect a service water leak into the tank. The tank level detection systems shall measure waste levels with an accuracy of ±1.3 cm (±0.5 in.).

4.4.9.3.3 Subsurface Leak Resulting in Surface Pool. The level detection systems for all DSTs, AWF tanks, DCRTs, and SSTs (except during salt well pumping) shall provide level measurements prior to transfers to or from the tanks and at specified intervals during the transfers to support material balance calculations. When salt well pumps are used to transfer waste from SSTs, data from the salt well flow totalizers also are used in the material balance calculations (see Section 4.4.7). The tank level detection systems shall measure waste levels with an accuracy of ±1.3 cm (±0.5 in.).

4.4.9.3.4 Tank Bump. The level detection systems for all DSTs and AWF tanks are required to measure tank waste levels above 4.6 m (15 ft) and to transmit the data to local or remote level indicator. The tank level detection systems shall measure waste levels with an accuracy of ±1.3 cm (±0.5 in.).

4.4.9.4 System Evaluation. The existing tank level detection systems are adequate for the required safety functions. Tank level detection systems shall be calibrated annually to ensure compliance with the functional requirements stated above.

Four types of tank level detection systems are employed in tank farms. The unreliability of the manual tapes and FIC level gauges led to their ongoing replacement with the more reliable ENRAF gauges. There is an additional reason for switching to ENRAF gauges: their electronic microprocessors can easily transmit additional important-level data to instrument buildings and to the Tank Monitoring and Control System.

4.4.9.5 Controls (Technical Safety Requirements). The assumption in the accident analyses discussed in Sections 3.3.2.4.7, 3.4.2.7, 3.4.2.8, and 3.4.2.11 is that the level monitoring systems are operable and operating when they are needed to perform each safety function. The operability assumption includes the following provisions:

- Calibration of level detection instruments and indicators is properly performed and is current.

- Level readings are taken and recorded at intervals that will allow early detection of transfer leaks or misroutes or service water intrusion into a tank so that action can be taken to prevent the formation of a surface or subsurface waste accumulation as described in the Chapter 3.0 accident analyses.

4.4.10 Temperature Monitoring Systems

The temperature monitoring systems are identified as Safety-Significant SSCs for the accident scenario discussed in Section 3.4.2.11 for the following tanks: 241-C-106, 241-SX-103, 241-SX-107, 241-SX-108, 241-SX-109, 241-SX-110, 241-SX-111, 241-SX-112, 241-SX-114, all DSTs, and all AWF tanks.

4.4.10.1 Safety Function(s). Tank bump is a rapid steam pressurization of a tank resulting from heat buildup. Tank waste material containing sludge with sufficient heat load (7.6 kW [26,000 Btu/h]) allows the sludge to heat up and generate steam. Steam builds up in the sludge and is released upward into the supernate, carrying significant sludge with it and heating the supernate. If the tank supernate is already at or near saturation, the steam will not condense but will travel completely through the supernatant to the tank headspace. This steam volume increase results in a pressure increase of the tank headspace and possible releases to the environment through unfiltered pathways.

A Tank Bump accident can result in excessive radiological and toxicological exposures as described in Section 3.4.2.11. The consequences of this accident can be mitigated by the use of tank temperature monitoring systems. Requirements that are specifically needed for the temperature monitoring systems to fulfill required safety functions are identified in the following sections.

The safety function of the temperature monitoring systems is to provide tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding temperatures at which significant tank bumps or steam release events could occur, thus decreasing the frequency of the Tank Bump (Section 3.4.2.11) accident.

4.4.10.2 System Description. Tank waste temperature monitoring systems include thermocouple trees and multifunction instrument trees. Waste temperatures can be read by the Tank Monitoring and Control System, field-mounted panel monitors, or locally by hand-held temperature monitoring instrumentation. The thermocouple tree is equipped with temperature detectors placed at 610 mm (2 ft) vertical intervals within the tank (the distance of the lowest detector from the tank bottom varies from tank to tank). The multifunction instrument tree includes temperature detectors as well as vapor probe chambers for vapor sampling. The multifunction instrument tree contains 22 thermocouples evenly spaced at different heights from the bottom of the tank upward into the tank vapor space. The multifunction instrument tree output signals are transmitted automatically to the Tank Monitoring and Control System (Table 4-8).

The temperature monitoring system for waste tanks is considered reliable, as multiple thermocouples are installed in each tank. Therefore, failure of some of the thermocouples does not prevent measurement of waste temperatures. Electrical power interruptions may interfere with data transmission to the Tank Monitoring and Control System, but temperatures can always be read locally, if required, by means of calibrated millivoltmeters connected temporarily to the thermocouple wires (Section 2.4.11.4).

4.4.10.3 Functional Requirements. The temperature monitoring systems shall be capable of detecting and displaying the temperature of tank waste over the full range of tank operations, including temperatures resulting from a loss of cooling event.

4.4.10.4 System Evaluation. The existing temperature monitoring systems are adequate for the required safety function. The temperature monitoring systems shall be functionally tested annually to assure that each temperature display is within ±2.8 °C (±5 °F) of the temperature read locally by a hand-held temperature monitoring instrument at the thermocouple output signal connection.

Plant monitoring procedures require weekly temperature readings. Functional testing is performed in accordance with plant operating procedures.

4.4.10.5 Controls (Technical Safety Requirements). The assumption in Section 3.4.2.11 is that the tank temperature monitoring systems for the Safety-Significant tanks are operable and operating. The waste temperature monitoring systems provide the temperature information needed to maintain the following limits:

- SSTs:

  ≤96.1 °C (≤205 °F) In all waste levels

- For DSTs and AWF tanks:

≤90.6 °C (≤195 °F)	In all waste levels
OR	
≤90.6 °C (≤195 °F)	In the top 15 ft of the tank waste
AND	
≤101.7 °C (≤215 °F)	In the tank waste below 15 ft.

The operability assumption includes the following provision. The operability of the waste temperature monitoring system will be verified annually to assure that the temperature values are reasonable and that the displayed temperature is within ±2.8 °C (±5 °F) of that temperature read at the thermocouple outlet. The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.4.11 Transfer Leak Detection Systems

The transfer leak detection systems are identified as Safety-Significant SSCs for the accident discussed in Section 3.3.2.4.7.

4.4.11.1 Safety Function(s). A subsurface leak from a pit or a transfer pipe is an accident with potentially significant onsite consequences. A pit could become damaged because of an equipment drop, such as a pump, and develop a crack that allows waste from a leaking transfer jumper to drain to the subsurface soil. The leaked waste could develop a subsurface plume. A transfer pipe could crack from factors such as the age of the pipe, corrosion, abrasion, and broken or cracked welds. Waste transfer-associated structure leak detectors provide assurance that leaks will be detected so that the waste transfer pumps can be shut down.

The safety functions of the transfer leak detection system are to detect the presence of a leak of tank waste in transfer-associated structures and to either provide an alarm to alert operators to take mitigative action or to provide an interlock to shut down waste transfer pump operation, limiting the volume of the waste leak and thus decreasing the consequences of the Subsurface Leak Remaining Subsurface accident.

4.4.11.2 System Description. Transfer-associated structures, which include process and valve pits, diversion boxes, and COBs, are provided with leak detectors (Section 2.4.11.3.2) located in the structure (Figure 4-9). The leak detectors have electrodes at different electrical potentials that can be short-circuited by a conductive medium (e.g., liquid waste) and cause a change in state of the monitoring circuitry. When liquid waste short-circuits the leak detector electrodes, an alarm is generated. In some systems, associated interlock circuitry is actuated and the transfer pump is shut down. The control and alarm functions associated with the leak detector are testable.

Leak detectors are located inside waste transfer-associated structures and are sometimes located in a sump in the pit. In the event of a leak, the smaller floor area of a sump causes a faster level increase for the same volume of leaked waste and thereby provides an earlier alarm signal. The leak detector transmits a signal that creates an audible and visual panel alarm and activates the interlock for transfer pump shutdown; if no interlock is installed, the panel alarm prompts operator action to terminate transfer pump operation.

When alternate leak detection devices such as manual conductivity probes are used as temporary compensatory measures to allow short duration waste transfers to be completed, the alternate leak detection devices (e.g., zip cords) shall be described in released engineering documents and installed as temporary plant modifications.

Tank Farm Electrical Distribution (Section 4.5.1) is a supporting SSC providing power for alarm and control circuitry associated with the leak detector.

4.4.11.3 Functional Requirements. The installed location of the leak detector must be near the structure's floor in a manner such that the pit liquid hold-up volume above the leak detector's elevation is greater than or equal to 1,520 gal (203.2 ft^3). The basis for this value is contained in HNF-2204. This requirement is typically met by installing the leak detector at a low point in the pit such that liquid accumulations of 5.08 cm (2 in.) are detected. The leak detection system shall activate an alarm or an interlock to prevent or stop operation of the transfer pump when a leak is detected.

4.4.11.4 System Evaluation. The existing transfer leak detection systems are adequate for the required safety functions. Conductivity probes have performed reliably as waste transfer-associated structure leak detectors for many years, with mean time between failures approaching one year. The operability of each process pit, diversion box, valve pit, and COB leak detector (and its associated alarm and control circuitry) that is physically connected to a waste transfer pump not under an administrative lock shall be verified quarterly by a functional test.

4.4.11.5 Controls (Technical Safety Requirements). The assumption in Section 3.3.2.4.7 is that the leak detector systems are operable and operating. The operability assumptions include the following provisions.

- During a liquid waste transfer, all of the leak detectors associated with lines PHYSICALLY CONNECTED (as defined in Section 1.1 of HNF-SD-WM-TSR-006) to the waste transfer pump being actuated must be operable.

- To ensure that the pit leak detection system is operable, the alarm and control functions activated by the leak detector are functionally tested quarterly.

The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0 and HNF-SD-WM-TSR-006.

4.4.12 Transfer System Covers

The transfer system covers are identified as Safety-Significant SSCs for the accidents discussed in Sections 3.4.2.7 and 3.4.2.8.

4.4.12.1 Safety Function(s). Tank waste can be transferred within the TWRS complex by using the waste transfer system. The waste transfer system piping provides an interconnecting network for the planned transfer of tank waste to support TWRS operations. If a component of the transfer system pressure boundary (e.g., pipe, jumper, valve) were to be damaged or incorrectly installed, a leak of tank waste could result. A pool leak of tank waste from the waste transfer piping system in a waste transfer-associated structure could result in onsite consequences exceeding the evaluation guidelines.

By design, the waste transfer piping system is routed in confinement structures or components that can prevent most or all of a waste leak from reaching the atmosphere. Most of the waste transfer system piping system is underground and is normally accessible only in selected locations (e.g., process pits, diversion boxes, valve pits, and COBs). Confinement for any leakage from the waste transfer piping system as it passes through the pits is provided by the pit structure and its cover(s); this design mitigates the consequences of a surface or subsurface waste leak.

The safety functions of the transfer system covers are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool (Section 3.4.2.7) and Subsurface Leak Resulting in Pool (Section 3.4.2.8) accidents.

4.4.12.2 System Description. Permanent transfer system covers are typically heavy sections of reinforced concrete, although some covers are made of steel according to their design documentation. Temporary covers shall meet the functional requirements of permanent covers. When temporary transfer system covers are used, they shall be described in released engineering documents and installed as temporary plant modifications.

Table 4-4 lists the waste transfer system pits and COBs. When pits and other transfer-associated structures are on the active transfer route of a waste transfer, their covers are Safety-Significant SSCs during the waste transfer operation.

Some pits in Table 4-4 are noted to be "inactive," which is defined in Section 4.3.18.2.

Inactive pits have been isolated from waste transfer operations and are not subject to the controls discussed here. When an inactive pit is reactivated for waste transfer operations, however, its covers will be Safety-Significant SSCs and must be shown to be in full compliance with all controls.

Transfer system covers have demonstrated excellent durability in tank farm service, even though concrete covers are vulnerable to rough handling during removal and replacement. Appropriate lifting equipment is used to remove and replace covers, and all lifts are performed to

approved procedures. Damage to a cover or the pit structure support ledge is quite obvious, and damage that could compromise the effectiveness of a transfer system cover in performing its safety function shall be evaluated. Damaged components that cannot meet the functional requirements shall be repaired or replaced before waste transfers are routed through the structure.

4.4.12.3 Functional Requirements. The cover assembly for a structure shall limit the escape of aerosol from leaked waste splatter and splashing in the structure. Transfer system covers shall be designed to eliminate direct waste aerosol leakage paths. Transfer system cover assemblies shall fit their supporting structure so that there are no paths for a direct stream of leaked waste to the atmosphere. Transfer system cover assemblies shall function as radiological shields to limit the shine dose to the facility worker from waste leaks.

When transfer system cover penetrations are not in use, they shall be plugged. Holes for valve reach rods are typically sealed with wooden plugs, and inspection ports are typically sealed with concrete or steel plugs.

4.4.12.4 System Evaluation. The transfer system covers are adequate for the required safety functions when the covers are installed and all cover penetrations are sealed.

Each time a waste transfer-associated structure is opened, the transfer system covers (and the abovegrade waste transfer-associated structure) shall be visually inspected for damage or defects that could affect the cover's ability to perform its safety function. The exterior of the structure and cover assembly shall be visually inspected prior to a waste transfer and once per 10 days thereafter to ensure that the covers, cover plugs, and seals are installed and operable.

In Section 3.4.2.12.3, one of the key accident scenario assumptions is that valve covers are assumed to be in place and undamaged by the evaluation basis earthquake (peak horizontal acceleration of 0.19 *g* or less); however, to conservatively account for all potential sources of waste leaks, the seismic analysis does not credit the covers for mitigating the seismic accident consequences.

4.4.12.5 Controls (Technical Safety Requirements). The accident analyses discussed in Sections 3.4.2.7 and 3.4.2.8 assume that the transfer system covers and cover assemblies are operable prior to a waste transfer and remain operable throughout the transfer evolution. The operability assumptions include the following provisions:

- Covers are installed and operable.
- Cover plugs and seals are installed and operable.

The operability of transfer system covers and cover assemblies shall be verified every 10 days during a waste transfer.

4.4.13 Ventilation Stack Continuous Air Monitor Interlock Systems

The ventilation stack CAM interlock systems on DSTs, AWF tanks, and actively ventilated SSTs are identified as Safety-Significant SSCs for the accident analyzed in Section 3.3.2.4.2.

4.4.13.1 Safety Function(s). Active ventilation systems are provided for some SSTs and for all DSTs and AWF tanks. The exhaust from an active ventilation system is typically passed through HEPA filters and then routed to a stack, where it is monitored for radionuclide particles by a CAM before being released to the atmosphere. When the radiation level measured by the CAM exceeds a preset level, an alarm is activated and the exhaust system fan is automatically shut down.

This section discusses the role of the ventilation CAM interlock systems in limiting the release of airborne radionuclides after the HEPA filters are damaged by a fire. The most likely source of a fire in or around the filter train is a malfunctioning electric heater; external fires were also considered.

The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the HEPA Filter Failure—Exposure to High Temperature or Pressure (Section 3.3.2.4.2) accident.

4.4.13.2 System Description. The CAMs and interlocks on the primary ventilation system exhaust stacks for all DSTs, AWF tanks, and actively ventilated SSTs are required to perform the above safety function. The following is a list of those stacks:

- 296-A-17 at 241-AY/AZ Tank Farms exhauster
- 296-A-27 at 241-AW Tank Farm exhauster
- 296-A-29 at 241-AN Tank Farm exhauster
- 296-A-40 at 241-AP Tank Farm exhauster
- 296-P-16 at 241-C-105/106 Tank exhauster
- 296-P-23 at 241-SY Tank Farm backup exhauster (K1-4-1)
- 296-P-26 at 241-AY/AZ Tank Farms backup exhauster (113 m^3/min [4,000 ft^3/min] portable exhauster)
- 296-P-28 at 241-SY Tank Farm (second) backup exhauster

- 296-S-15 at 241-SX Tank Farm exhauster

- 296-S-25 at 241-SY new tank exhauster.

Temporary or portable ventilation exhaust systems other than those listed above must be separately evaluated prior to their use to ensure that the consequences of an unfiltered release are bounded by the Section 3.3.2.4.2 accident analysis.

Typically, a vacuum pump pulls a gaseous effluent sample from the exhaust stack through a sample line into the CAM and discharges the sample either back to the stack or through a filter to the atmosphere. If the CAM detects high radionuclide particulate activity in the exhaust stream, an alarm is actuated and a signal is transmitted to a relay that interrupts the electrical power to the exhaust fan motor, causing the ventilation exhaust system to stop operating.

Electrical distribution for the CAM, the interlock and alarm, the cabinet heaters and fans, and the prevention of condensation in the sample line is identified as a supporting SSC. The electrical distribution system is described in Section 4.5.1.

4.4.13.3 Functional Requirements. The CAM system shall operate continuously while the exhaust systems are operating, maintaining representative sampling conditions as required to perform its safety function. The CAM shall measure the radiation level in the sampled flow stream and detect levels in excess of a preset level. The CAM shall activate an interlock to shut down the exhauster upon detection of a radiation level that exceeds a preset level. Upon CAM failure, the monitors shall actuate an alarm and an interlock to shut down the exhaust system. (The requirement for the CAM interlock to shut down upon CAM failure will be reevaluated as part of Phase 2 of FSAR implementation. Therefore, this requirement is deferred.)

During the ventilation exhaust sampling process, the sample flow stream from the ventilation system is totally contained by steel tubing and the CAM sample flow path pressure boundary, which has no ignition sources. Because of this, the CAM is exempted from the ignition controls described in TSR Administrative Control 5.10 until the flow path pressure boundary is opened for maintenance or other necessary activities.

4.4.13.4 System Evaluation. The existing ventilation stack CAM interlock systems are adequate for the required safety function. The CAM interlock loop shall be calibrated annually, and the alarms and interlocks shall be functionally tested once a quarter.

The electrical interlock deenergizing the exhaust fan is considered reliable. CAMs are vulnerable to loss of sample flow. CAM malfunctions are normally detected and, as a minimum, actuate an interlock to shut down the ventilation exhaust system and an alarm to alert operators that corrective action is required to restore the CAM to normal operation. (The requirement for the CAM interlock to shut down upon CAM failure will be reevaluated as part of Phase 2 of FSAR implementation. Therefore, this requirement is deferred.)

4.4.13.5 Controls (Technical Safety Requirements). The assumptions in the HEPA Filter Failure accident described in Section 3.3.2.4.2 are that CAMs with interlocks are provided on all ventilation exhaust stacks identified above and that the CAMs and their associated alarms and interlocks are operable and operating during and following a fire that damages the HEPA filters.

4.4.14 Abovegrade Portions of Process Pits, Diversion Boxes, Valve Pits, and Cleanout Boxes

The transfer system abovegrade portions of process pits, diversion boxes, valve pits, and COBs are identified as Safety-Significant SSCs for the accidents discussed in Sections 3.4.2.7 and 3.4.2.8. (Per agreement with DOE-ORP this Safety-Significant designation is not effective until March 30, 2000.)

4.4.14.1 Safety Function(s). From accident analyses in Sections 3.4.2.7 and 3.4.2.8, the transfer system abovegrade portions of process pits, diversion boxes, valve pits, and COBs are identified as Safety-Significant SSCs. Tank waste is transferred within the TWRS complex using the waste transfer system. The waste transfer system piping provides an interconnecting network for the planned transfer of tank waste to support TWRS operations. If a component of the transfer system pressure boundary (e.g., pipe, jumper, valve) were to be damaged or incorrectly installed, a leak of tank waste could result. A pool leak of tank waste from the waste transfer piping system in a waste transfer-associated structure could result in onsite consequences exceeding the evaluation guidelines.

By design, the waste transfer piping system is routed in confinement structures or components that can prevent most or all of a waste leak from reaching the atmosphere. Most of the waste transfer system piping is underground and is normally accessible only in waste transfer-associated structures. COBs are provided in the waste piping at selected locations in the tank farms and can be used, if required, for the insertion of special tools to clear a blockage in the piping. Confinement for any leakage from the waste transfer piping system as it passes through the pits is provided by the abovegrade portions of pit structures and their cover(s); this design mitigates the consequences of a surface or subsurface waste leak.

The safety functions of the transfer system abovegrade portions of process pits, diversion boxes, valve pits, and COBs are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool and Subsurface Leak Resulting in Pool accidents.

4.4.14.2 System Description. Abovegrade portions of process pits, diversion boxes, and valve pits are typically constructed of reinforced concrete and are discussed more fully in Sections 2.4.1.4 and 2.4.3.6. COB covers are constructed in accordance with their design documentation and are commonly fabricated of steel. COBs are described in Section 2.4.10.1.1.

Table 4-4 lists the waste transfer system pits and COBs. When pits and other transfer-associated structures are on the active transfer route of a waste transfer, the abovegrade portions of process pits, diversion boxes, valve pits, and COBs are Safety-Significant SSCs during the waste transfer operation.

Some pits in Table 4-4 are noted to be "inactive," which is defined in Section 4.3.18.2.

Inactive pits have been isolated from waste transfer operations and are not subject to the controls discussed here. When an inactive pit is reactivated for waste transfer operations, however, the abovegrade portions of that inactive pit shall be Safety-Significant SSCs, and must be shown to be in full compliance with all controls.

The abovegrade portions of process pits, diversion boxes, and valve pits have demonstrated excellent durability in tank farm service, even though reinforced concrete structures are vulnerable to damage from impacts during cover removal and replacement. Appropriate lifting equipment is used to remove and replace covers and all lifts are performed to approved procedures, however, the potential for undetected damage exists.

4.4.14.3 Functional Requirements. The abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall limit the escape of aerosol from leaked waste splatter and splashing in the structure and shall be designed to eliminate direct waste aerosol leakage paths. Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall have covers fitted so that there are no paths for a direct stream of leaked waste to the atmosphere. Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall also function as radiological shields to limit the shine dose to the facility worker from waste leaks.

Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall be designed to provide an intact boundary to confine waste leakage within the waste transfer-associated structure until it is completely filled with leaked waste. Unsealed openings in the abovegrade portions of process pits, diversion boxes, and valve pits shall be plugged, and holes in COB covers from previous repairs or uncompleted modifications shall be sealed to prevent premature waste outleakage and the formation of a surface pool of waste.

4.4.14.4 System Evaluation. The design of the abovegrade portions of process pits, diversion boxes, valve pits, and COBs is adequate for the required safety functions. Each time a process pit, diversion box, valve pit, or COB is opened, the abovegrade portions shall be visually inspected for damage or defects that could affect the ability of the SSC to perform its safety function. The exterior of the abovegrade portions shall be visually inspected prior to a waste transfer to ensure that the following requirements are satisfied:

- The abovegrade portions are free of defects that could result in inability to perform the safety functions.

- Existing plugs and seals are installed and operable.

4.4.14.5 Controls (Technical Safety Requirements). The accident analyses discussed in Sections 3.4.2.7 and 3.4.2.8 assume that the abovegrade portions of a process pit, diversion box, valve pit, or COB are operable prior to a waste transfer and remain operable throughout the transfer evolution.

Damage to the abovegrade portions of a process pit, diversion box, valve pit, or COB, especially in the region of support for the covers, is quite obvious, and any damage that could compromise the fit of a cover and, thus, the effectiveness of the fit of the transfer system covers to the abovegrade portions of the pit, diversion box, or COB in performing its safety function shall be evaluated.

COB covers are especially vulnerable to damage when removed, and the closure seal of the COB cover shall be verified when a removed cover is reinstalled. Damaged SSCs that cannot meet the functional requirements shall be repaired or replaced before waste transfers are routed through the affected waste transfer-associated structure.

4.4.15 Section Reserved

4.4.16 Section Reserved

4.4.17 Section Reserved

4.4.18 Section Reserved

4.4.19 Section Reserved

4.4.20 Section Reserved

4.4.21 Section Reserved

4.4.22 Section Reserved

4.5 OTHER SUPPORT SYSTEMS

4.5.1 Tank Farm Electrical Distribution System

Tank farm electrical distribution is a supporting system for selected Safety-Class and Safety-Significant SSCs.

4.5.1.1 Function. The tank farms electrical distribution system is a supporting SSC for various safety SSCs identified in Chapter 3.0 and is constructed to comply with electrical codes of record. The function of the tank farm electrical distribution system is to provide electrical power with standard commercial reliability to Safety-Class and Safety-Significant SSCs.

4.5.1.2 System Description. Normal electrical power is provided to the Hanford Site by the Bonneville Power Administration. At the A8 substation (the 251-W Building), 230 kV power is transformed to 13.8 kV and distributed to the 200 East and West Areas. Electrical lines supply power to facility substations, which convert the 13.8 kV primary feed to 480/277 volt power for all equipment within the facilities. The boundary line between the electrical utility and the facility is the disconnect switch located at the facility substation (Table 4-5). Diesel generators or other alternate electrical power generators can supply power during an electrical distribution system failure (Section 2.8.4).

4.5.1.3 Functional Requirements. The safety analysis for TWRS has not identified any accidents that could be immediately caused by the loss of electrical power to electrically powered safety SSCs. None of the safety SSCs require continuous electrical power to adequately perform their safety functions. Backup generators are installed in some areas of the TWRS, but are not required to start up immediately upon loss of Site power to protect the safety functions of the safety SSCs. The accident analyses show, instead, that electrical power to electrically powered safety SSCs can be interrupted temporarily without significantly compromising facility safety. The length of time safety SSCs can remain disabled as a result of losing electrical power before safety is compromised depends on the particular safety SSC and its safety function. Approved procedures based on the hazard and accident analyses specify what must be done, and when, in the event that safety SSCs are inoperable because electrical power is not available.

4.5.1.4 System Evaluation. The existing tank farm electrical distribution system is adequate for the required function. Tank farm operating history shows that electrical power outages are infrequent events. A listing of tank farm events (Table 4-6) recorded 23 events since 1973. Power was interrupted once by transformer failure, twice by an electrical storm, and once by a large "bird." The remaining interruptions occurred as a result of personnel errors or unspecified factors.

Electrical power systems in TWRS do not appear to be major contributors to the failures of safety SSCs. In the event of a tank farm power failure and at the discretion of Tank Farms Operations, gasoline- or diesel-powered electrical generators or other alternative electrical

generators can be temporarily connected to the low-voltage bus of the tank farm to restart selected loads.

Several electrical generators may be needed if the electrical power interruption were widespread and likely to be prolonged, which is not an "anticipated" event. The most restrictive accident scenario is the Flammable Gas Deflagration. The most restrictive tank for steady-state flammable gas releases is Tank 241-SY-101 where 25% LFL concentrations can be reached in seven days and 100% LFL concentrations are reached in 32 days. There has never been an electrical outage to a tank farm with a duration longer than one to two days in the entire history of the Hanford Site. Because of the multiplicity of ways that the power grid supplies the TWRS facilities, it is highly unlikely that a power outage could extend to 7 days or longer. Fuel for alternative electrical generators can be trucked in as required. Hanford Utilities performs regular testing on the electrical system.

4.5.1.5 Controls (Technical Safety Requirements). The safety SSCs do not require continuous electrical power to adequately perform their safety functions. The existing tank farms electrical power distribution systems require no equipment upgrades or special maintenance activities, and standard utility maintenance practices are adequate for all anticipated events.

4.5.2 Compressed Air System

Compressed air systems at the DCRTs (244-A, 244-BX, 244-S, 244-TX, and 244-U) and the 244-AR Vault support Safety-Class SSCs identified in Section 4.3.1 and 4.3.16.

Compressed air systems also support the Safety-Significant SSCs identified in Section 4.4.9.

4.5.2.1 Function(s). Instrument air is produced by supporting compressed air systems and routed to the weight factor/specific gravity systems. The air is injected into the headspace of the tanks through the dip tubes (i.e., weight factor/specific gravity tubes). The total amount of air entering the tanks is regulated to maintain a minimum flow of 0.08 m^3/h (3 ft^3/h). Dip tube flow indicators, described in Sections 4.3.1 and 4.3.16, are monitored to ensure sufficient instrument air enters the tanks.

The tank farms compressed air systems are supporting SSCs for various safety SSCs identified in Chapter 3.0. The functions of the tank farm compressed air systems are to provide compressed air with standard commercial reliability for the DCRT ventilation systems (except 244-CR TK-003) and the 244-AR TK-002 ventilation system, and to provide instrument air to waste tank level detection systems that use dip tubes.

4.5.2.2 System Description. Instrument air is produced by compressed air systems (see Section 2.8.3 for details of the compressed air systems). The major components of "instrument air" quality compressed air systems are compressors, air filters, accumulator tanks, dryers, and

control instrumentation. Compressors perform the mechanical work of increasing the pressure of ambient air to system design parameters.

Accumulator tanks are sized to allow continuous delivery of compressed air and yet permit the compressors to operate intermittently. This improves the life of the compressors and increases the time between maintenance activities.

Dryers remove moisture from the compressed air to prevent damage to instrument air lines and instrumentation. Moisture can collect in air lines and cause damage during freezing conditions. Additionally, moisture can cause pneumatic instrumentation to malfunction and fail.

The compressed air systems in TWRS vary in size and configuration from one installation to another. The compressed air systems are permanent installations that are specifically designed and sized for a particular application. The exceptions are the systems supplying air to DCRTs 244-BX and 244-TX.

Instrument air is supplied to DCRTs 244-BX and 244-TX by identical transportable compressed air stations. The entire compressed air system is mounted on a shipping container. The transportable stations can be moved from one location to another with minimal effort. The only assembly and disassembly required is connection to the instrument air distribution lines and electrical power.

Electrical distribution (Section 4.5.1) has been identified as a supporting SSC for the compressed air systems.

4.5.2.3 Functional Requirements. To maintain flammable gas concentrations below 25% LFL, the compressed air systems shall operate continuously while waste is stored in the 244-A, 244-BX, 244-S, 244-TX, and 244-U DCRTs and 244-AR TK-002. Minimum total inlet airflow supplied to the dip tubes shall be 0.08 m^3/h (3 ft^3/h) as measured by the dip tube flow indicators. However, during waste transfers from Tanks 241-SX-104 and 241-SX-105, the inlet air supply shall be $\geq$ 0.14 m^3/h (5 ft^3/h) as measured by the dip tube flow indicators.

The compressed air system for Tank 241-SY-101 is discussed in HNF-3737.

The compressed air system for each tank level detection system that uses dip tubes shall operate continuously before and during waste transfers to or from the tank or for waste transfers routed through a connected path with the tank and shall operate as needed to support the level measurement schedule for detecting service water intrusions (Section 4.4.9.3).

4.5.2.4 System Evaluation. The existing compressed air systems are adequate for the required functions. Proper maintenance includes annual calibration of compressor system control instrumentation (i.e., pressure indicators and pressure switches). Satisfactory operation is verified

by monitoring the 244-A, 244-BX, 244-S, 244-TX, and 244-U DCRTs and 244-AR TK-002 dip tube flow indicators. The compressed air system should be operable and operating prior to and during waste transfers, and waste storage.

Compressed air systems are vulnerable to drivetrain malfunctions such as loss of electrical power and control instrumentation malfunctions. Mean time between failures has typically been very short by industrial performance standards. Equipment upgrades and improved maintenance procedures have proven that mean time between failures can be increased.

4.5.2.5 Controls (Technical Safety Requirements). The compressed air systems require no equipment upgrades or special maintenance activities, and standard industrial maintenance practices are adequate for all anticipated events. TSR controls are identified in the applicable Chapter 4.0 sections for those safety SSCs that require compressed air.

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Figure 4-1. Typical Interface Arrangement of an Overground Transfer System at a Valve Pit.

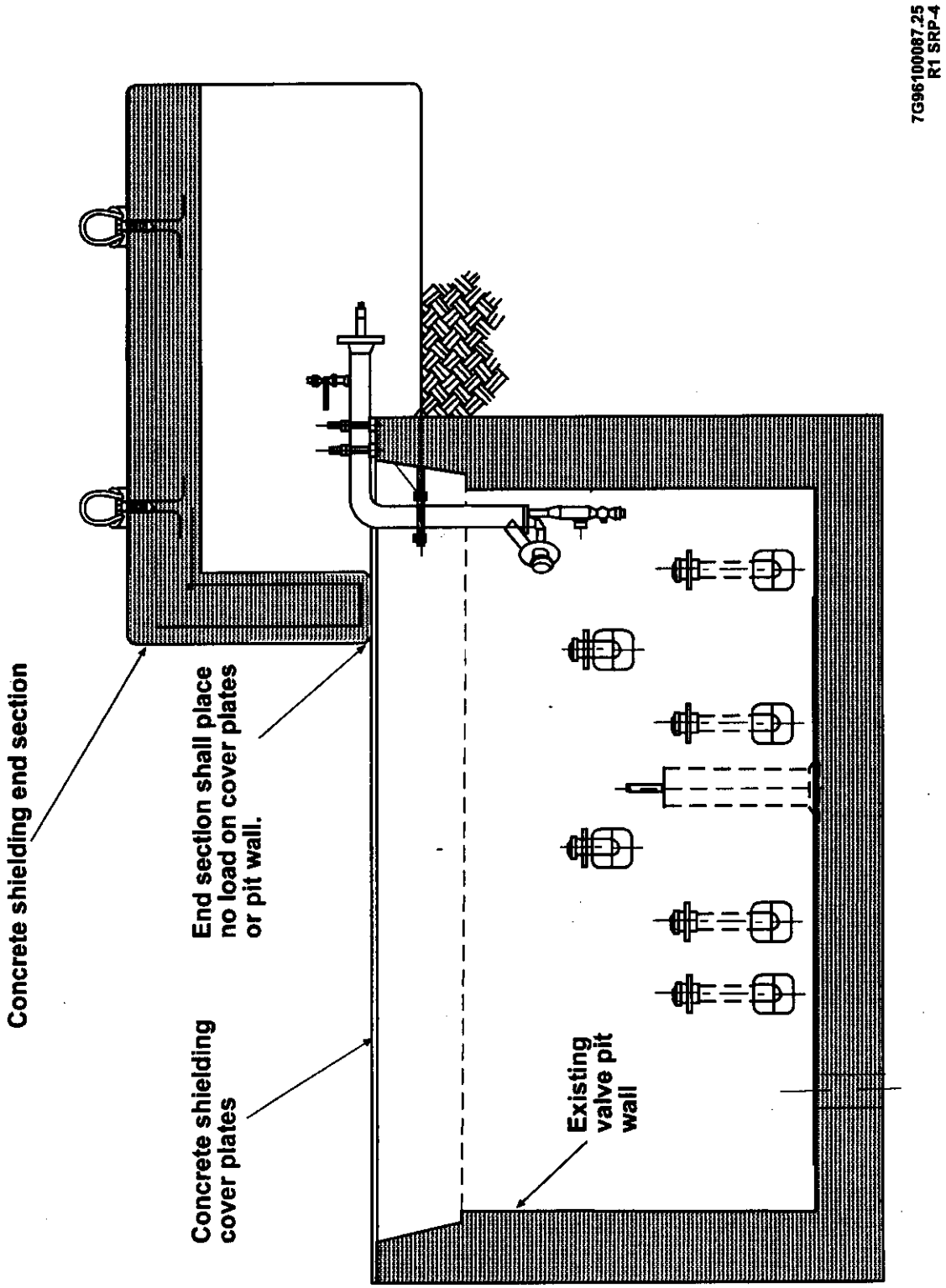
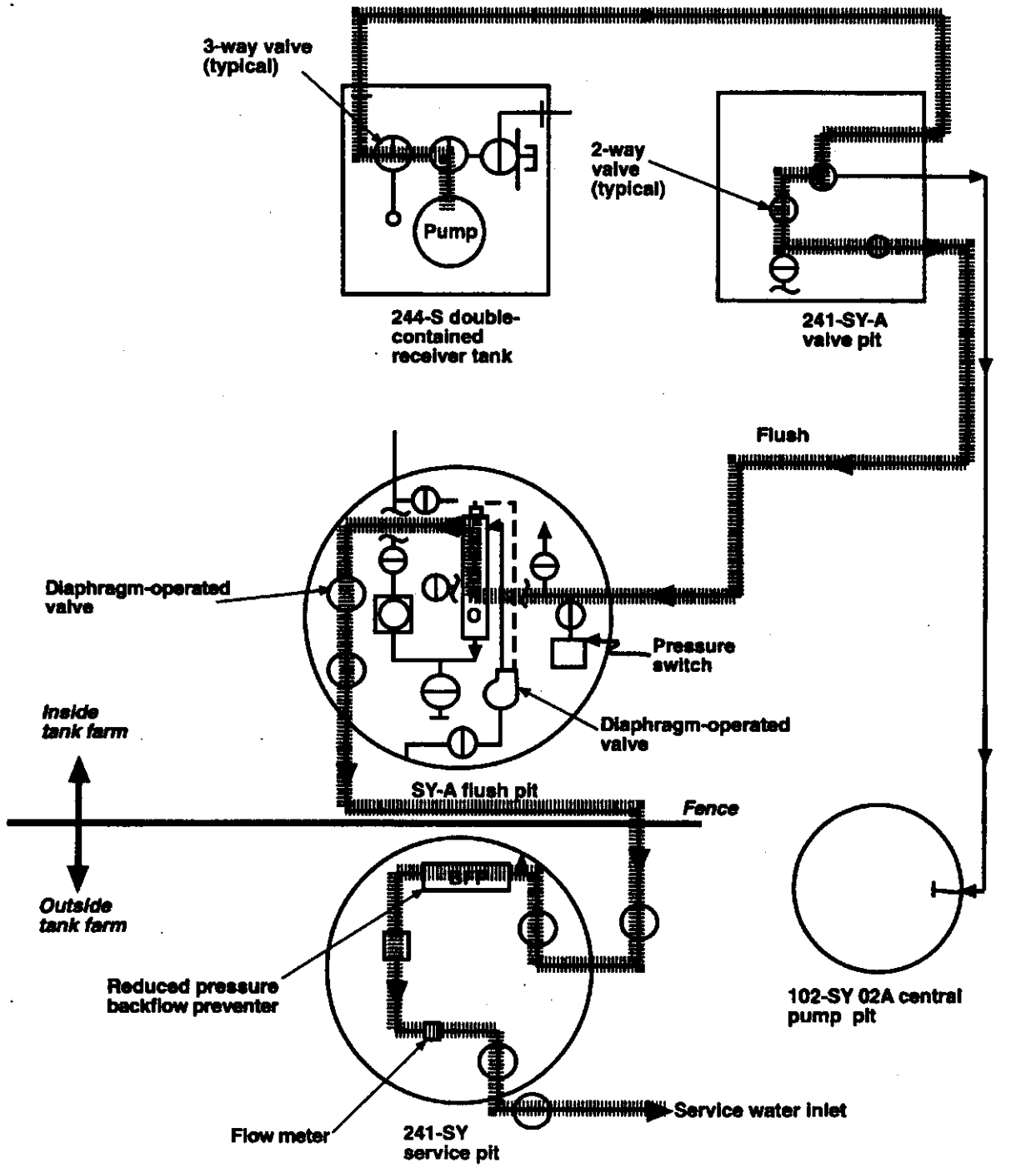


Figure 4-2. Postulated Waste Backflow into Service Water System.



BFP = backflow preventer.

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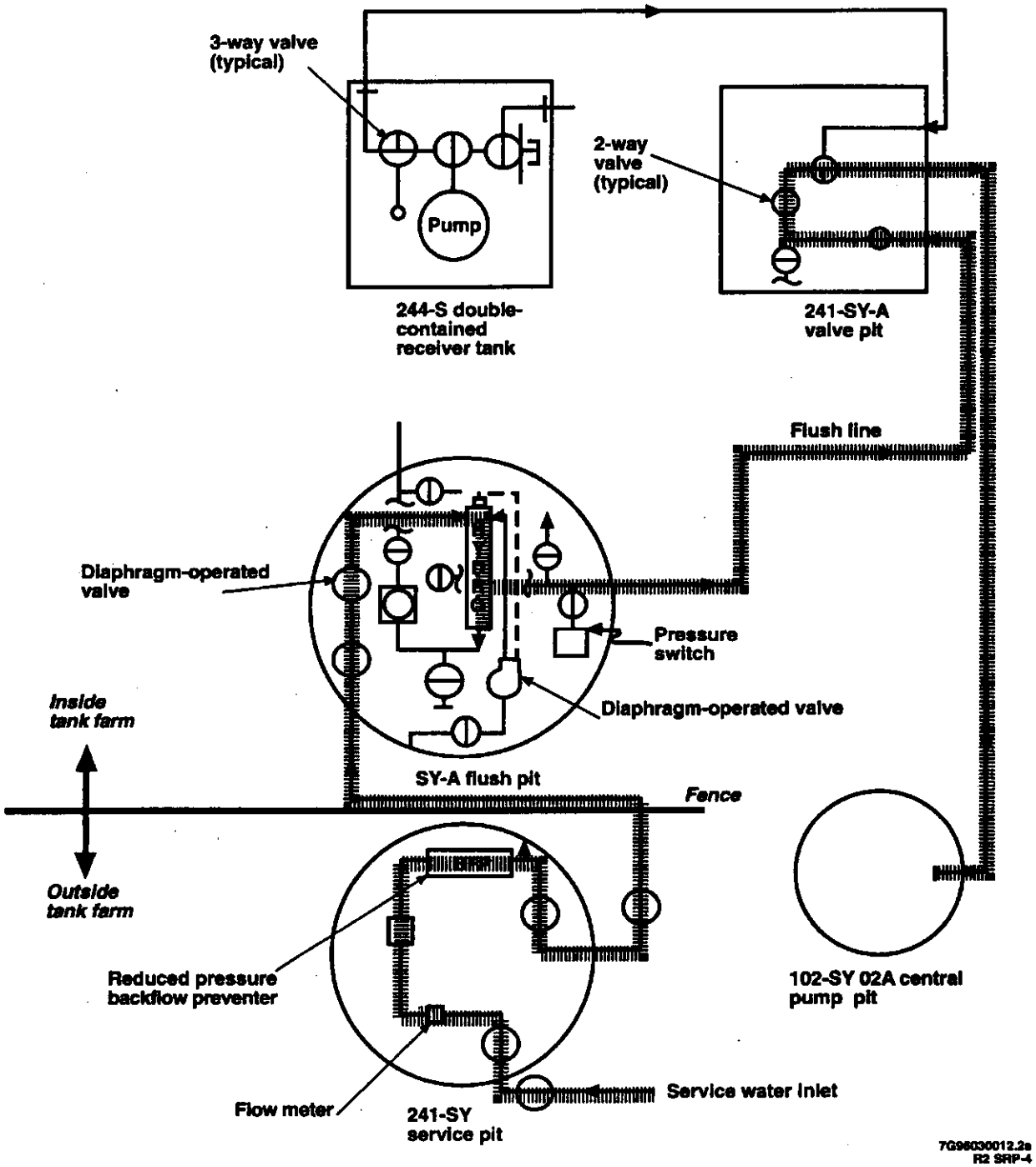
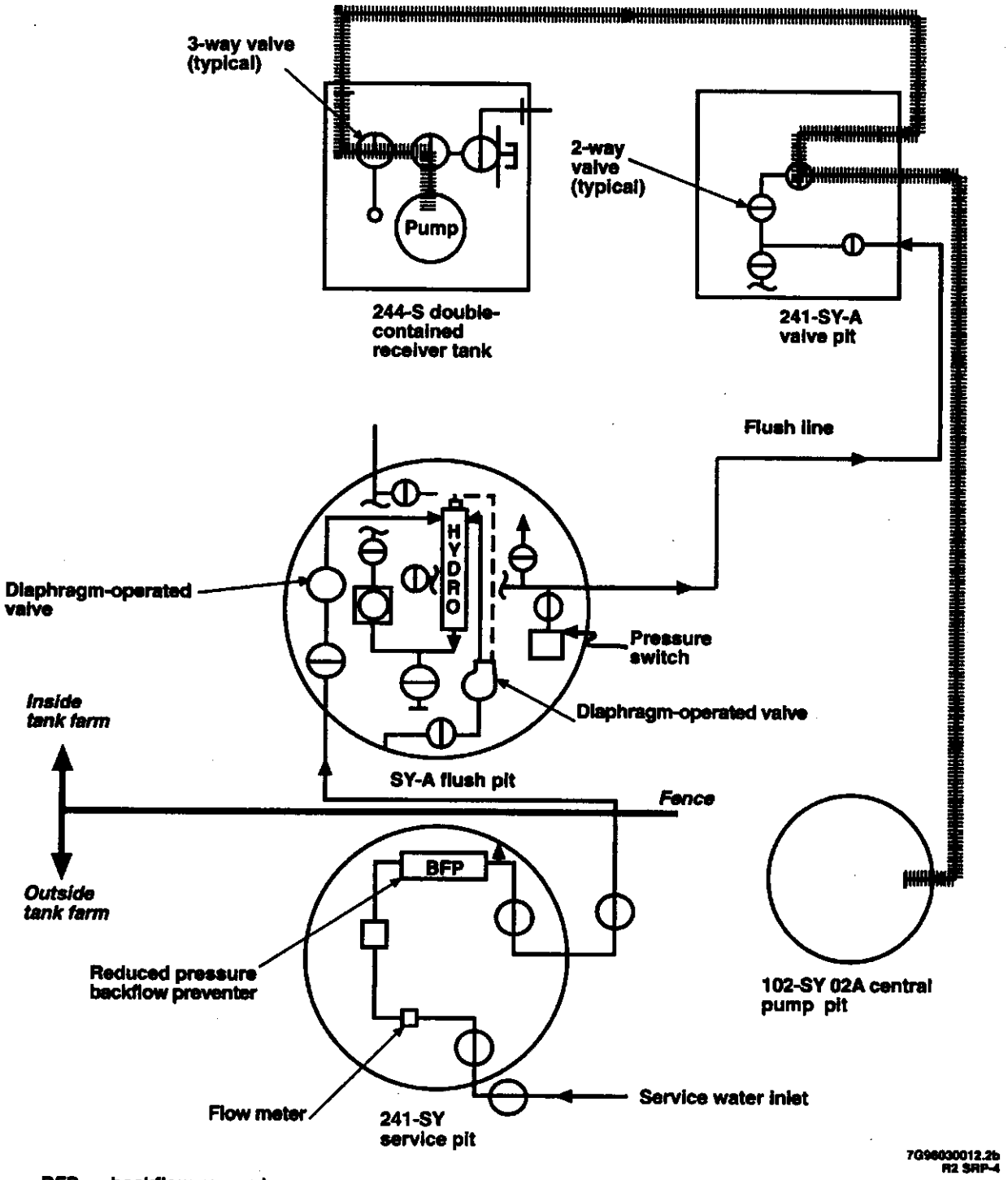
Figure 4-3. Typical Waste Transfer Line Flush Operation with Service Water.



BFP = backflow preventer.

Figure 4-4. Typical Waste Transfer Operation with Flush (Service) Water Isolated.



BFP = backflow preventer.

Figure 4-5. Typical Continuous Air Monitor Flow Path.

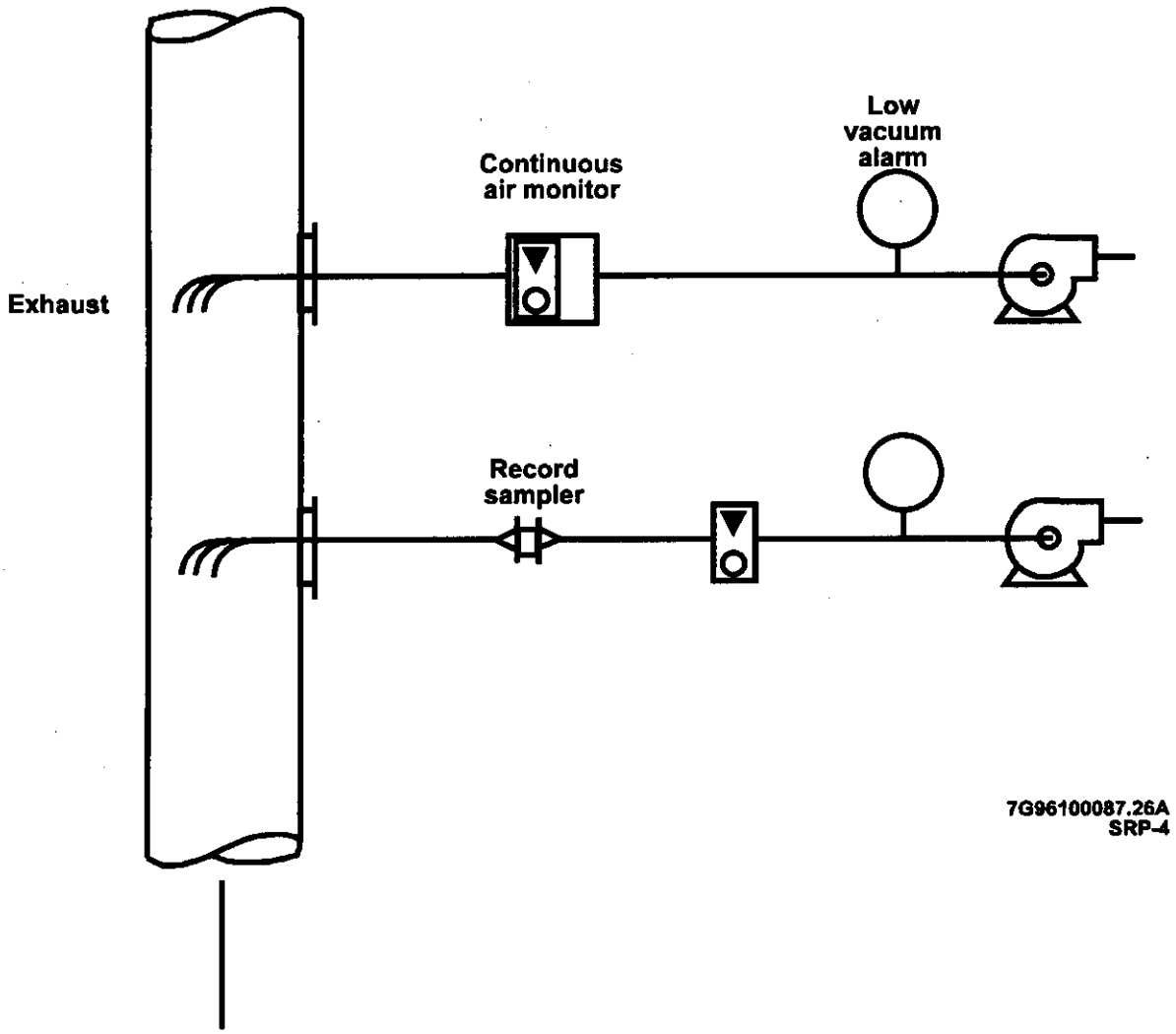


Figure 4-6. Sketch of Transfer System Covers on a Typical Tank Farm Pit.

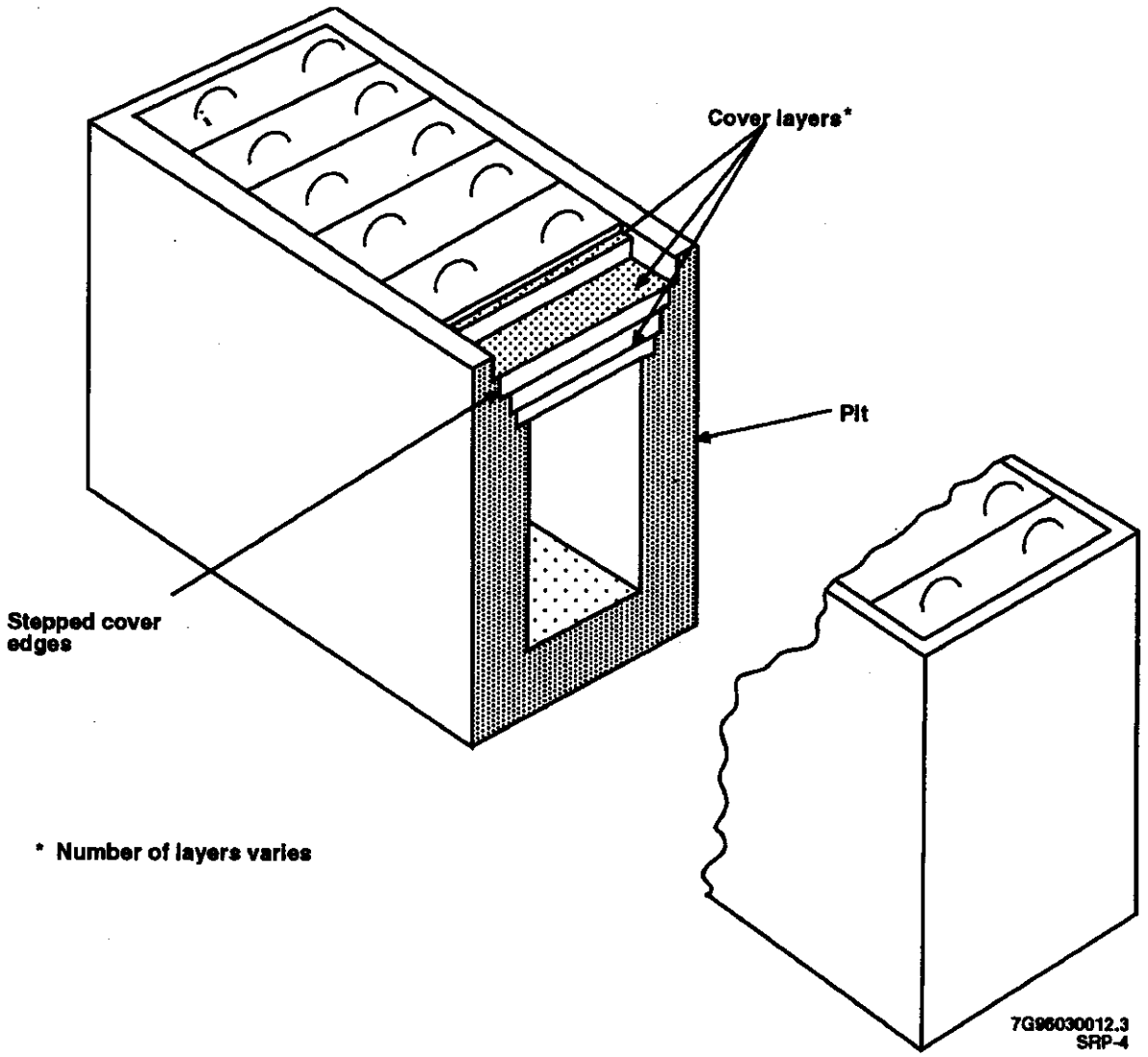


Figure 4-7. 204-AR Waste Unloading Facility Radiation Zone Heating, Ventilation, and Air Conditioning System.

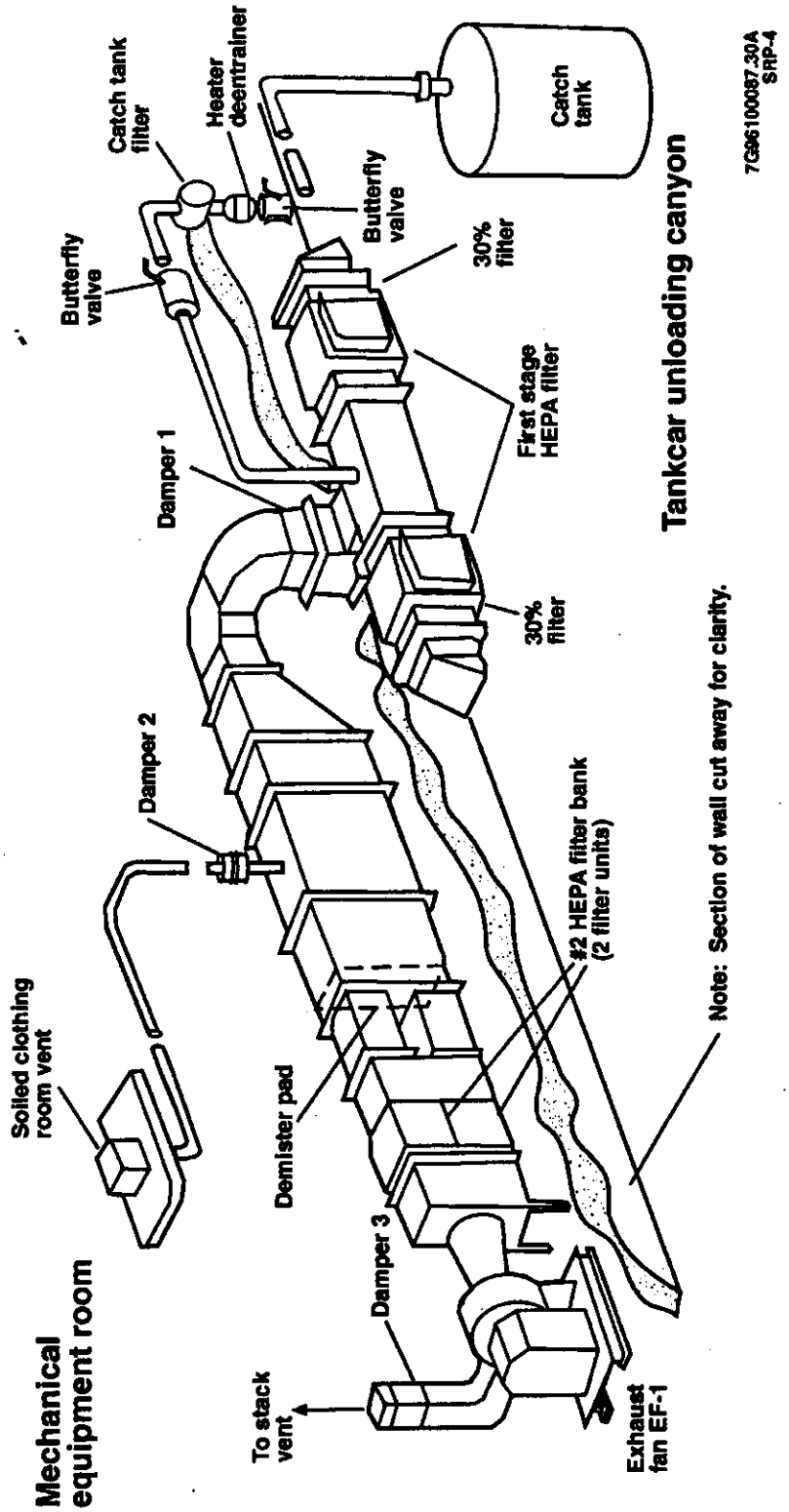


Figure 4-8. Features of a Typical Reduced-Pressure Backflow Preventer.

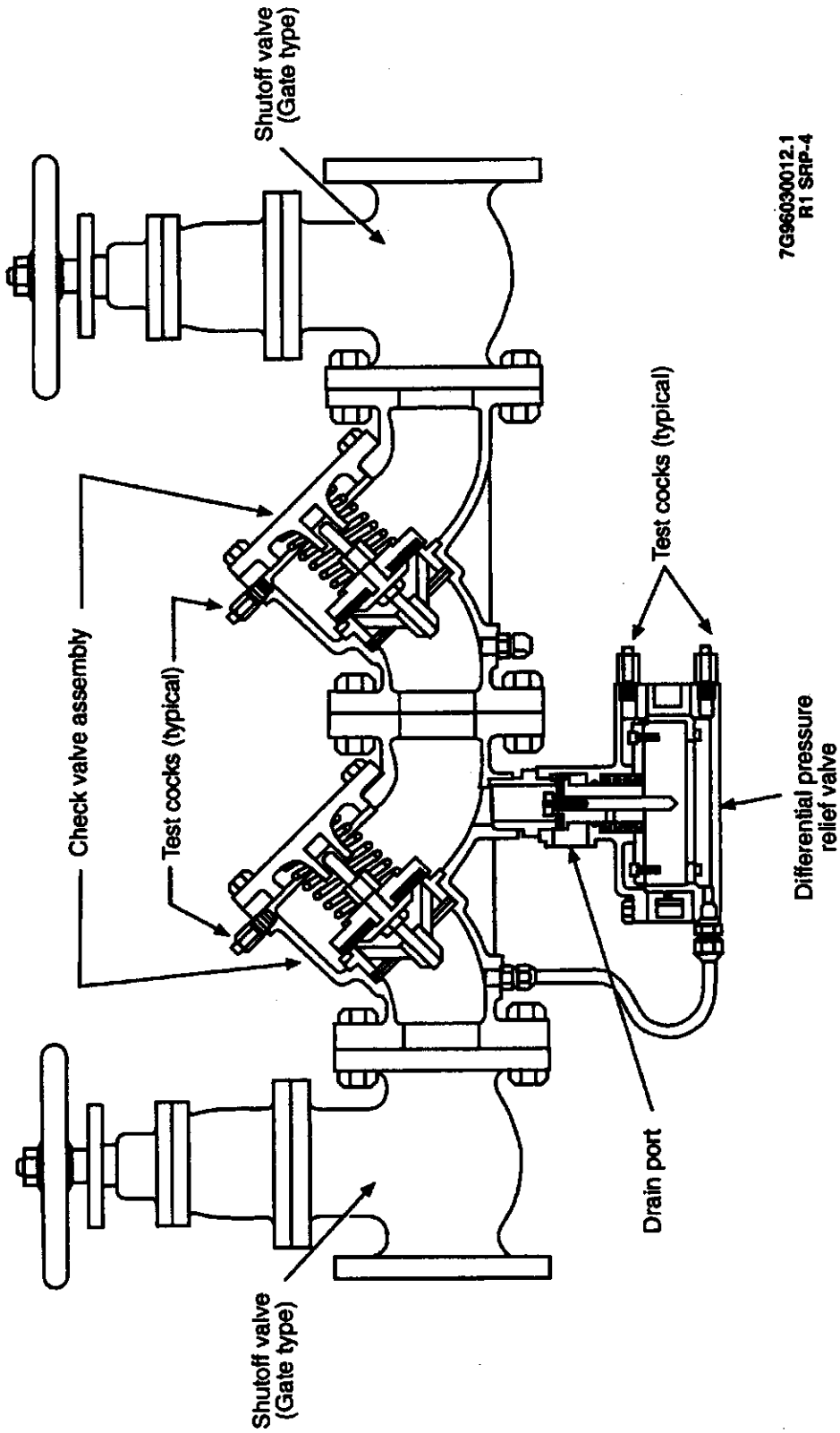


Figure 4-9. Typical Pit Leak Detector Installation.

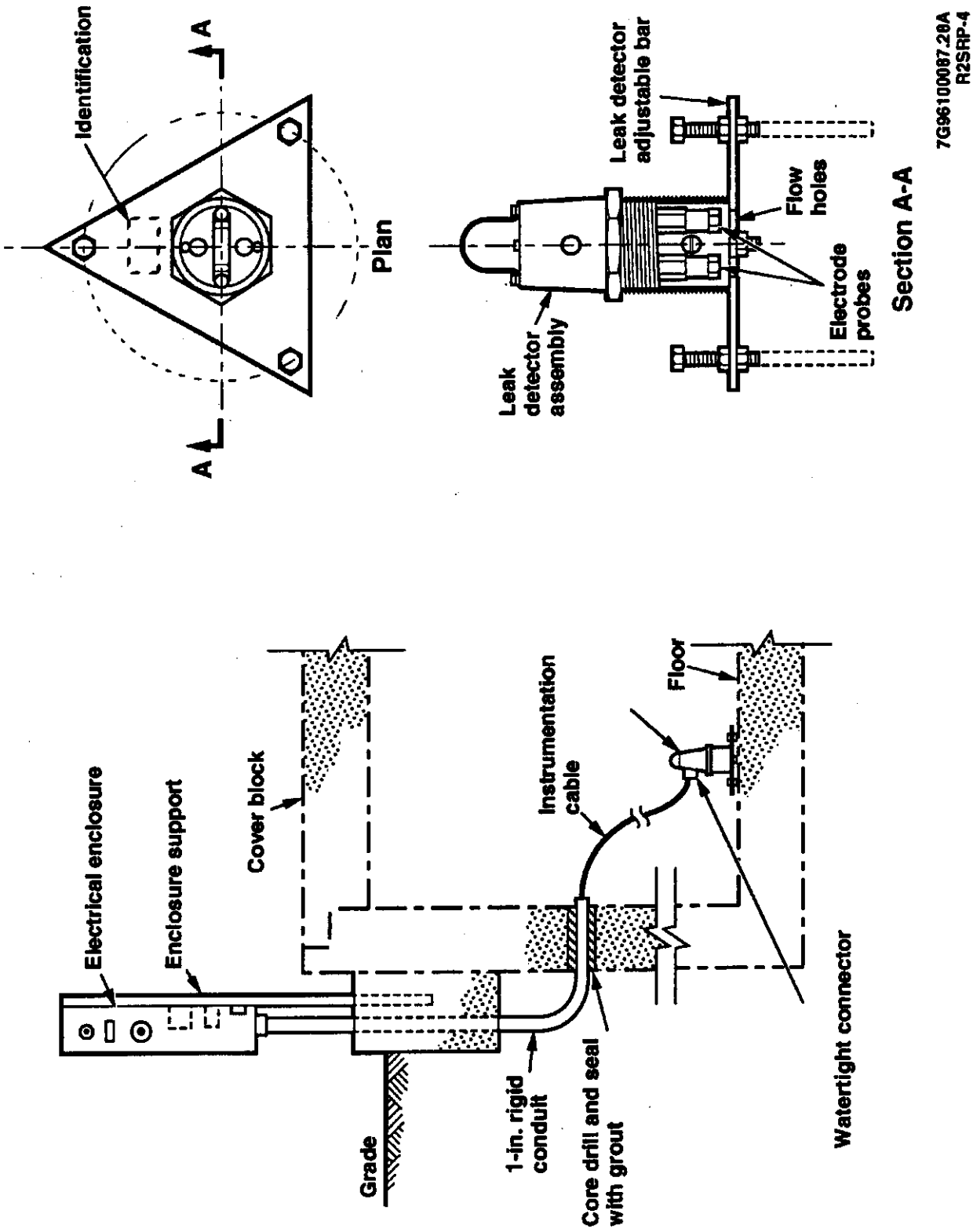
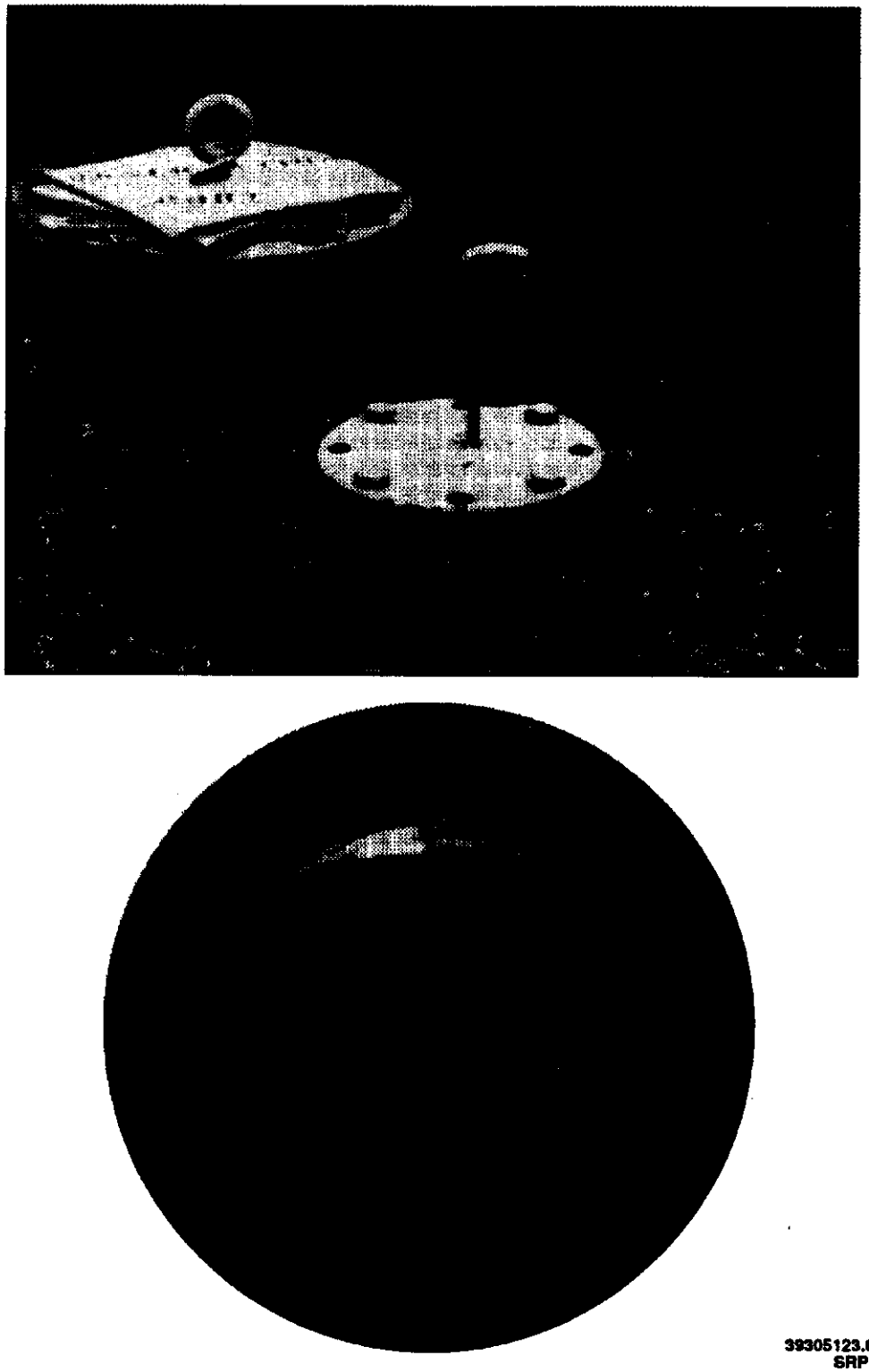


Figure 4-10. Magnehelic Gauge.



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SRP-4

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
DCRT ventilation systems	Flammable Gas Deflagrations (3.4.2.2)	(3.4.2.2) The safety functions of the DCRT ventilation systems are to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident. The safety function of the 244-CR TK-003 ventilation system is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	Active ventilation systems shall maintain a vacuum in the tank vapor space relative to atmospheric pressure. For DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U, dip tubes shall provide a minimum total inlet airflow of 0.08 m^3/h (3 ft^3/h) to the tank while waste is stored. The dip tube flow indicators shall have a minimum range of 0.01 m^3/h to 0.04 m^3/h (0.2 ft^3/h to 1.5 ft^3/h). Only during waste transfers from tanks 241-SX-104 and 241-SX-105, the DCRT 244-S level dip tubes shall supply a minimum total inlet air flow of 0.14 m^3/hr (5.0 ft^3/hr).	The dip tube flow indicators for DCRT 244-BX shall be calibrated or functionally tested annually. The dip tube flow indicators for DCRTs 244-A, 244-S, 244-TX, and 244-U must be calibrated or functionally tested and verified to meet the functional requirements before waste can be stored in those tanks. The 244-CR ventilation system shall be operable and operating when there is waste in the tank.
DST and AWF tank ventilation systems	Flammable Gas Deflagrations (3.4.2.2)	(3.4.2.2) The safety functions of the DST and AWF primary tank ventilation systems are to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	The DST and AWF tank primary ventilation systems shall maintain vapor space vacuums of all tanks from <0 kPa (<0 in. WG) relative to atmospheric pressure.	Operability of the primary tank ventilation systems shall be verified daily to ensure compliance with functional requirements. Standby systems are functionally tested on a periodic basis.

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
OGT system	Surface Leak Resulting in Pool (3.4.2.7) Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)	(3.4.2.7 and 3.4.2.9) The safety function of the OGT system encasement and connections is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Surface Leak Resulting in Pool and the Spray Leak in Structure or From Waste Transfer Lines accidents. (3.4.2.9) The safety function of the OGT system encasement and connections is to provide confinement for waste spray leaks from the primary line, thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines accident. (3.4.2.7 and 3.4.2.9) The safety function of the OGT concrete shielding system is to protect the primary line from external events (e.g., vehicle impacts), thus decreasing the frequency of the Surface Leak Resulting in Pool and the Spray Leak in Structure or From Waste Transfer Lines accidents.	The OGT system shall confine waste leaks from the primary pipe to the annulus between the encasement and the primary pipe and channel the leaked waste to a pit at either end of the system for leak detection. The OGT system pipe encasement shall withstand the evaluation basis earthquake and high wind. The OGT concrete shielding sections shall protect the piping system from vehicle damage. Exposed portions of the OGT piping system shall be protected from freezing during a waste transfer campaign.	OGT system integrity shall be periodically confirmed by pressure testing. The encasement and connections shall be visually examined for damage or defects that could affect the ability of the encasement and connections to perform the safety function before installation of the concrete shielding sections. The entire system assembly shall be examined for damage or loss of integrity before waste transfer operations begin. Seal loop valve positions shall be verified before waste transfer operations to ensure that all valves are open. The seal loop hoses shall be inspected for conformance with design drawings. This section does not apply to overground transfers from Tank 241-SY-101 to Tank 241-SY-102 as associated with crust growth remediation. Description of the waste transfer system for Tank 241-SY-101 crust growth remediation are provided in HNF-3737.

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Waste tanks	Organic Solvent Fire (3.4.2.4) Flammable Gas Deflagrations (3.4.2.2) Organic Salt-Nitrate Reaction (3.4.2.6) Natural Phenomena—Seismic (3.4.2.12.3)	(3.4.2.4) The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during a tank vacuum or overpressurization event, thus decreasing the consequences of the Organic Solvent Fire accident. (3.4.2.2 and 3.4.2.6) The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during a tank overpressurization event, thus decreasing the consequences of the Flammable Gas Deflagrations and Organic Salt-Nitrate Reaction accidents. (3.4.2.12.3) The safety function of the waste tanks is to maintain gross tank structural integrity, which averts tank collapse and limits the release of waste during and after the evaluation basis earthquake, thus decreasing the consequences of the Natural Phenomena—Seismic accident.	The tanks shall be designed to maintain structural integrity for confinement of wastes.	Changes to the design of the waste tanks are controlled according to approved procedures. (Per agreement with DOE-ORP this Safety-Class designation is not effective until March 30, 2000.)
Pipe encasements	Subsurface Leak Resulting in Pool (3.4.2.8)	(3.4.2.8) The safety function of the waste transfer system pipe encasement is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Subsurface Leak Resulting in Pool accident.	The pipe encasement shall channel waste leaked from a primary pipe to a transfer-associated structure where the leak can be detected. The encasement shall provide an unobstructed flow path for the movement of leaked waste to a transfer-associated structure.	Prior to the start of a waste transfer, the drain path into the pit(s) from the annulus of the encased piping system shall be verified to provide an open drain path to the pit, with encasement drain valve positions as applicable to the valve type. The encasement drain valves shall never be left in the "HYDRO" position during a waste transfer.

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Pressure switch interlocks or alarms	Surface Leak Resulting in Pool (3.4.2.7) Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)	(3.4.2.7 and 3.4.2.9) The safety function of the pressure switch interlock or alarm systems is to limit the volume of tank waste that could backflow into and leak from the service water piping system, thus decreasing the consequences of the Surface Leak Resulting in Pool and Spray Leak in Structure or From Waste Transfer Lines accidents.	The pressure switch provides an alarm or is interlocked to prevent or stop operation of the associated waste transfer pump when pressure in the service water piping system reaches 138 kPa (20 lb/in^2 gauge).	Pressure switches shall be calibrated annually. The alarm and interlock functions shall be functionally tested annually.
Primary tank leak detection systems	Flammable Gas Deflagrations (3.4.2.2) Surface Leak Resulting in Pool (3.4.2.7)	(3.4.2.2) The safety function of the primary tank leak detection systems is to provide an alarm of tank waste from misroutes or other system leaks into the tank annulus to alert operators to take action to prevent a flammable gas deflagration in the DST or AWF tank annulus, thus decreasing the frequency of the Flammable Gas Deflagrations accident. (3.4.2.7) The safety function of the primary tank leak detection systems is to provide an alarm of tank waste from misroutes or other system leaks into the tank annulus to alert operators to take action to stop the transfer of waste into the DST or AWF tank annulus, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	The annulus conductivity leak detection system shall be able to detect a 2.54-cm (1.0-in.) deep accumulation of waste in the bottom of the DST annulus and shall provide an audible alarm signal and an annunciator panel light upon detection of waste. The annulus ventilation system CAMs shall operate continuously while the annulus ventilation system is operating and shall alarm when radiation levels exceeding a preset level are detected.	The operability of the liquid waste detectors shall be verified every 6 mo by a system functional test.
SST ventilation	Flammable Gas Deflagrations (3.4.2.2)	(3.4.2.2) The safety function of the SST active and passive ventilation systems is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	SST active ventilation systems shall maintain a vacuum in the tank vapor space relative to atmospheric pressure. SST passive ventilation systems shall provide a HEPA-filtered flow path to allow the vapor space pressure to be in equilibrium with the atmospheric pressure.	Operability of the active ventilation systems shall be verified weekly. The breather filter isolation valve for each passive ventilation system shall be checked every 10 days to ensure the flow path is unobstructed.

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
244-AR TK-002 ventilation system	Flammable Gas Deflagrations (3.4.2.2)	(3.4.2.2) The safety function of the 244-AR TK-002 ventilation system is to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	The dip tubes shall provide a minimum total inlet airflow of 0.08 m^3/h (3 ft^3/h) to 244-AR TK-002 while waste remains in the tank. The dip tube flow indicators shall have a minimum range of 0 m^3/h to 0.07 m^3/h (0 ft^3/h to 2.5 ft^3/h).	The dip tube flow indicators used to verify ventilation flow for 244-AR TK-002 shall be calibrated or functionally tested annually and shall be monitored twice a day to verify operability.
Transfer leak detection systems	Surface Leak Resulting in Pool (3.4.2.7) Subsurface Leak Resulting in Pool (3.4.2.8)	(3.4.2.7 and 3.4.2.8) The safety functions of the transfer leak detection system are to detect the presence of waste transfer system leaks in waste transfer-associated structures and to either provide an alarm to alert operators to take mitigative action, or provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leak and decreasing the consequences of the Surface Leak Resulting in Pool and Subsurface Leak Resulting in Pool accidents.	The installed location of the leak detector must be near the structure's floor in a manner such that the pit liquid hold-up volume above the leak detector's elevation is greater than or equal to 1,520 gal (203.2 ft^3). The basis for this value is contained in HNF-2204. This requirement is typically met by installing the leak detector at a low point in the pit such that liquid accumulations of 5.08 cm (2 in.) are detected. The leak detection system shall activate an alarm or an interlock to prevent or stop operation of the transfer pump when a leak is detected.	The operability of each process pit, diversion box, valve pit, and cleanout box leak detector (and its associated alarm or control circuitry) that is physically connected to a waste transfer pump not under an administrative lock shall be verified quarterly by a functional test.
Transfer system covers	Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)	(3.4.2.9) The safety functions of the transfer system covers are to provide an impaction surface that prevents a waste leak from jetting directly into the atmosphere, and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages between adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines accident.	The cover assembly for a waste transfer-associated structure that is physically connected to the transfer route shall confine direct spray leaks to the inside of the structure. Transfer system covers shall be designed to eliminate direct spray leakage paths. Cover assemblies shall fit their supporting structure so that there are no paths for a direct spray leak of tank waste to the atmosphere. Cover penetrations shall be plugged when they are not in use.	Each time a waste transfer-associated structure is opened, the transfer system covers (and the abovegrade waste transfer-associated structure) shall be visually inspected for damage or defects that could affect the cover's ability to perform its safety function. The exterior of the structure and cover assembly shall be visually inspected prior to a waste transfer and once per 10 days thereafter to ensure that the covers, cover plugs, and seals are installed and operable.

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Ventilation stack CAM interlock systems	Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)	(3.4.2.9) The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines accident.	The CAMs shall operate continuously while the exhaust systems are operating. The CAMs shall measure the radiation levels of the sampled flow stream and activate an interlock to shut down the exhauster when a preset radiation level is exceeded. Upon CAM failure, the monitors shall actuate an alarm and an interlock to shut down the exhaust system.	The CAM interlock loop shall be calibrated annually, and the alarms and interlocks shall be functionally tested quarterly. (The requirement for the CAM interlock to shut down upon CAM failure will be reevaluated as part of Phase 2 FSAR implementation. Therefore, this requirement is deferred.)
204-AR Waste Unloading Facility Structure	Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)	(3.4.2.9) The safety functions of the 204-AR Waste Unloading Facility structure are to provide impaction surfaces that prevent a waste leak from jetting directly into the atmosphere and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages with adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines accident.	The 204-AR Waste Unloading Facility structure shall be designed to confine the tank waste spray leak accident analysis.	The 204-AR railcar unloading canyon doors shall remain closed at all times per TSR Administrative Control 5.12 unless there is an operational need for their temporary opening. The west exterior rollup door and the west exterior personnel access door shall be closed during waste transfers that are physically connected to the facility.

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Abovegrade portions of process pits, diversion boxes, valve pits, and COBs	Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9) Surface Leak Resulting in Pool (3.4.2.7)	(3.4.2.9) The safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes are to provide an impaction surface that prevents a waste leak from jetting directly into the atmosphere, and to limit the release of waste aerosols to the atmosphere by means of tortuous air passages between adjacent surfaces that promote impingement and condensation, thus decreasing the consequences of the Spray Leak in Structure or From Waste Transfer Lines accident. (3.4.2.7) The safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes are to provide an intact boundary for the leaked waste, and when leak detector alarms and appropriate operator response times to shut off the transfer pump are credited, to prevent waste transfer structure overflow and the formation of a surface pool. This decreases the consequences of the Surface Leak Resulting in Pool accident.	The abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall confine direct spray leaks to the inside of the structure, and shall be designed to eliminate direct spray leakage paths. Transfer system cover assemblies shall fit their supporting structure so that there are no paths for a direct spray leak of tank waste to the atmosphere. Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall be designed to provide an intact boundary to confine waste leakage within the waste transfer-associated structure until it is completely filled with leaked waste. Unsealed openings in the abovegrade portions of process pits, diversion boxes, and valve pits shall be plugged, and holes in COB covers from previous repairs or uncompleted modifications shall be sealed to prevent premature waste outleakage and the formation of a surface pool of waste.	Each time a process pit, diversion box, valve pit, or COB is opened, the abovegrade portions shall be visually inspected for damage or defects that could affect the ability of SSCs to perform their safety function. The exterior of the abovegrade portions shall be visually inspected prior to a waste transfer to ensure that the following requirements are satisfied. 1. The abovegrade portions are free of defects that could result in inability to perform the safety functions. 2. Existing plugs and seals are installed and operable. (Per agreement with DOE-ORP this Safety-Class designation is not effective until March 30, 2000.)

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Temperature monitoring systems	Organic Salt-Nitrate Reaction (3.4.2.6)	The safety function of the temperature monitoring systems is to provide tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding waste temperatures at which organic salt-nitrate reactions could proceed, thus decreasing the frequency of the Organic Salt-Nitrate Reaction accident.	The temperature monitoring systems shall be capable of detecting and displaying the temperature of tank waste over the full range of tank operations, including temperatures resulting from a loss of cooling event.	The temperature monitoring systems shall be functionally tested annually to ensure that each temperature display is within ±2.8 °C (±5 °F) of the temperature read locally by a hand-held temperature-monitoring instrument at the thermocouple output signal connection. (There is an Authorization Basis amendment pending approval that will eliminate the need to designate the temperature monitoring systems as Safety-Class. Therefore, these systems are identified as Safety-Significant.)
Transfer System Supplemental Covers	Surface Leak Resulting in Pool (3.4.2.7)	(3.4.2.7) The safety function of the transfer system supplemental covers is to limit release of aerosols generated by spray in the COB/pit (following the initial surface leak) by providing an impaction surface that prevents a waste leak from jetting directly into the atmosphere, thus decreasing the consequences of the Surface Leak Resulting in Pool accident. Supplemental covers are only required in waste transfer-associated structures with volumes that are less than 15 m^3 (530 ft^3).	Transfer system supplemental covers shall knock down spray leaks of up to 861.7 kPa (125 lb/in.^{2} gauge); shall not be liquid or air tight; shall be designed such that a waste leak of at least 76 L/min (20 gal/min) would be released to the ground (i.e. waste will not accumulate in the supplemental cover); shall not be degraded by contact with the waste; shall be capable of withstanding high winds 145 km/h (90 mi/h]) and snow/ash fall 2.2 kPa (45 lb/ft^2); and shall extend to the ground and allow for maintenance and surveillance activities on the transfer-associated structure.	For waste transfer-associated structures with volumes less than 15m^3 (530 ft^3), operability of the transfer system supplemental covers shall be verified prior to commencing a waste transfer and every 72 hr during the waste transfer.

Table 4-1. Safety-Class Structure, System, and Component Summary. (9 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Backflow Prevention Devices (204-AR only)	Surface Leak Resulting in Pool (3.4.2.7) Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)	(3.4.2.7) The safety function of the backflow prevention devices located in the 204-AR Waste Unloading Facility (waste unloading room) is to prevent a backflow of waste into the raw water or other service systems leading to the Mechanical Equipment Room where a leak could form a surface pool, thus decreasing the frequency of the Surface Leak resulting in Pool accident. (3.4.2.9) The safety function of the backflow prevention devices located in the 204-AR Waste Unloading Area is to prevent a backflow of waste into the raw water or other service systems leading to the Mechanical Equipment Room where a spray leak could occur, thus decreasing the frequency of the Spray Leak in Structure or from Waste Transfer Lines accident.	Backflow prevention devices shall be installed in accordance with the manufacturer's instructions, including protection from freezing temperatures. The rated pressure of the backflow preventer shall be higher than the maximum pressure of the system in which it is installed.	Facility backflow prevention device must be operable when it is physically connected to an active waste transfer pump not under administrative lock. The 204-AR Waste Unloading Facility backflow prevention device shall be functionally tested annually to verify operability.

TSR Administrative Control 5.12
HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Fluor Daniel Hanford, Inc., Richland, Washington.
AWF = aging waste facility.
CAM = continuous air monitor.
COB = cleanout box.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
OGT = overground transfer.
SSC = structure, system, and component.
SST = single-shell tank.
TSR = Technical Safety Requirement.
TWRS = Tank Waste Remediation System.
WG = water gauge.

Table 4-2. Transfer Lines with Encasement Seal Loop Valves.

200 East Tank Farms	
241-A	SL-100, SL-101, SL-104, SL-113, SL-114, SN-200/213, SN-201/214, SN-204, SN-215, SN-216, SN-219, SN-220, LIQW 702, 4001, 4004
241-A-244	SN-232, SN-233 (Inactive), SN-234
241-A-350	PW-481
241-A-417	F100
241-AN	SL-160, SL-167, SL-168, SN-260, SN-267, SN-268, DR-368
241-AP	SL-509, SL-510, SN-609, SN-610, SN-621, SN-650
241-AR-151	DR-717, V-714, TL-716
241-AW	SL-167, SL-168, SN-267, SN-268, SN-269, SN-270, DR-334, DR-335, DR-361, V-021, V-022, V-023
241-AX	DR-314 (Inactive), DR-326, DR-327 (Inactive), DR-370
241-AX-152	DR-V713, NHW-V714
241-AY	SL-502, SL-503, SL-504, SL-505, V-720
241-AZ	SL-500, SL-501, SN-600, SN-601
241-AZ-152	NHW-V719
241-BX-244	SN-9808
200 West Tank Farms	
241-S-244	V-456, V-522, V-560, V-561, V-562
241-SY	SL-175, SL-176, SL-178, SL-179, SN-275, SN-276, SN-278, SN-279, SN-281, SN-282, SN-283, SN-284, DR-376
241-TX-244	SN-402, SN-406, SN-408, HSW-202, HSW-203

Source: WHC-SD-WM-EV-040, 1990, *Double-Shell Tank Ancillary Equipment—Secondary Containment Evaluation*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Note: Encasement seal loop valves are listed because the potential exists that the primary transfer line may leak into the encasement. Prior to the start of a waste transfer, the drain path into the pit(s) from the annulus of the encased piping system shall be verified to provide an open drain path to the pit, with encasement drain valve positions as applicable to the valve type. The encasement drain valves shall never be left in the "HYDRO" position during a waste transfer.

Table 4-3. High-Pressure Switches in Flush Lines. (2 sheets)

Facility	Location of high-pressure switch	Comments
200 East Area		
241-A	None	No water source; pipe disconnected and flanged.
244-A	None	No water source. Flush water comes from 244-BX.
241-AN	In service pit.	PS-FP-1 and PS-FP-2.
241-AP	In flush pit.	SW-PSH-301.
204-AR	None installed.	Backflow preventers are used.
244-AR	None installed.	Facility is INACTIVE and is not used; isolation of service water is required.
241-AW	In flush pit.	SW-PS-213, SW-PS-214, and SW-PS-215.
241-AX	None	No water source; pipe disconnected and flanged.
241-AY	None	Flush water comes from sending location.
241-AZ	None	Flush water comes from sending location.
241-B	None	No water source; pipe disconnected and flanged. All tanks isolated.
241-BX	None	No water source; pipe disconnected and flanged. All tanks isolated.
244-BX	In flush pit.	PS-BX-1.
241-BY	In central pump pit of each tank.	Pressure switches for salt well pumps.
241-C	In central pump pit of each tank.	Pressure switches for salt well pumps.
241-CR	None	No interconnection between service water and waste transfer piping.
200 West Area		
240-S	None	IMUST 240-S-302 (Inactive).
241-S	None	No water source in S Farm.
244-S	In flush pit.	PS-FP-1.
241-SX	None	No water source in SX Farm.
204-SY	In flush pit 241-SY-A.	PS-SY-A-2. PM/S WT-03141.
241-T	None	No water source in 241-T Farm.
242-T	None	No water source; isolated evaporator.
241-TX	None	No water source; 241-T Farm is interim isolated.
244-TX	In flush pit.	PS-244-TX-5. PM/S WT-0373.
241-TY	None	No water source; TY Farm is interim isolated.

Table 4-3. High-Pressure Switches in Flush Lines. (2 sheets)

Facility	Location of high-pressure switch	Comments
241-U	Pressure switches are located in the jet pump jumper assembly.	PS-241U-102-2/WT-01827 PS-241U-103-2/WT-02008 PS-241U-105-2/WT-01838 PS-241U-106-2/WT-01906 PS-241U-107-2/WT-01844 PS-241U-108-2/WT-02942 PS-241U-109-2/WT-01841 PS-241U-111-2/WT-01882
Salt well jet pump flush lines		
Pump skid	PS-241S-101-2, PMS# WT-01876	
Pump skid	PS-241S-103-2, PMS# WT-01894	
Pump skid	PS-241S-106-2, PMS# WT-04187	
Pump skid	PS-241S-107-2, PMS# WT-01922	
Pump skid	PS-241S-108-2, PMS# WT-04188	
Pump skid	PS-241S-109-2, PMS# WT-04189	
Pump skid	PS-241S-110-2, PMS# WT-04190	
Pump skid	PS-241S-111-2, PMS# WT-04316	

IMUST = inactive miscellaneous underground storage tank.
PMS = preventive maintenance sheet.

Table 4-4. Waste Transfer System Pits. (8 sheets)

Type of pit	Pits			
200 East Area				
Aging waste central/sluice pump pits	241-AY-01A 241-AY-01B 241-AY-01C 241-AY-01D	241-AY-01E 241-AY-02A 241-AY-02B 241-AY-02C	241-AY-02D 241-AY-02E 241-AZ-01A 241-AZ-01B	241-AZ-01C 241-AZ-02A 241-AZ-02B 241-AZ-02C
Aging waste annulus pump pits	241-AY-01F 241-AY-02F	241-AZ-01F 241-AZ-02F		
Aging waste leak detection/ encasement pits	241-AY-101A 241-AY-101B (encasement) 241-AY-102A		241-AZ-101 241-AZ-102 241-AZ-101/102 (encasement)	
DST valve pits	241-AW-A 241-AW-B	241-AP 241-AN-A	241-AN-B	
DST central/feed pump pits	241-AN-01A 241-AN-02A 241-AN-03A 241-AN-04A 241-AN-05A 241-AN-06A 241-AN-07A	241-AW-01A 241-AW-02A 241-AW-02E (242-A feed pump pit) 241-AW-03A 241-AW-04A	241-AW-05A 241-AW-06A 241-AP-01A 241-AP-02A 241-AP-02D (grout feed pump pit)	241-AP-03A 241-AP-04A 241-AP-05A 241-AP-06A 241-AP-07A 241-AP-08A
DST annulus pump pits	241-AN-01B 241-AN-02B 241-AN-03B 241-AN-04B 241-AN-05B 241-AN-06B	241-AN-07B 241-AW-01B 241-AW-02B 241-AW-03B 241-AW-04B 241-AW-05B	241-AW-06B 241-AP-01B 241-AP-02B 241-AP-03B 241-AP-04B 241-AP-05B	241-AP-06B 241-AP-07B 241-AP-08B
DST leak detection pits	241-AN-01C 241-AN-02C 241-AN-03C 241-AN-04C	241-AN-05C 241-AN-06C 241-AN-07C 241-AW-01C	241-AW-02C 241-AW-03C 241-AW-04C 241-AW-05C	241-AW-06C 241-AP-03C 241-AP-05C
DST flush pits	241-AN	241-AW	241-AP	
SST valve pits	241-C 241-AX-A 241-AX-B 241-A-A 241-A-B	241-BY-111A valve box (inactive) 241-BY-111B valve box (inactive) 241-BY-109 valve box, line V305 (inactive) 241-BY-109 valve box, line 812 (inactive)		

Table 4-4. Waste Transfer System Pits. (8 sheets)

Type of pit	Pits	
SST central/sluice pits	241-A-01A (inactive)	241-B-01C (inactive)
	241-A-01B (inactive)	241-B-02A (inactive)
	241-A-01C (inactive)	241-B-02B (inactive)
	241-A-01D (inactive)	241-B-02C (inactive)
	241-A-02A (inactive)	241-B-03A (inactive)
	241-A-02B (inactive)	241-B-03B (inactive)
	241-A-02C (inactive)	241-B-03C (inactive)
	241-A-02D (inactive)	241-B-06A (inactive)
	241-A-03A (inactive)	241-B-08A (inactive)
	241-A-03B (inactive)	241-B-09A (inactive)
	241-A-03C (inactive)	241-B-112A (inactive)
	241-A-03D (inactive)	241-B-202 (inactive)
	241-A-04A (inactive)	241-B-203 (inactive)
	241-A-04B (inactive)	241-B-204 (inactive)
	241-A-04C (inactive)	241-BX-01A (inactive)
	241-A-04D (inactive)	241-BX-01B (inactive)
	241-A-05A (inactive)	241-BX-01C (inactive)
	241-A-05B (inactive)	241-BX-02A (inactive)
	241-A-05C (inactive)	241-BX-02B (inactive)
	241-A-05D (inactive)	241-BX-02C (inactive)
	241-A-06A (inactive)	241-BX-03A (inactive)
	241-A-06B (inactive)	241-BX-03B (inactive)
	241-A-06C (inactive)	241-BX-03C (inactive)
	241-A-06D (inactive)	241-BX-04A (inactive)
	241-AX-01B (inactive)	241-BX-04B (inactive)
	241-AX-01C (inactive)	241-BX-04C (inactive)
	241-AX-01D (inactive)	241-BX-05A (inactive)
	241-AX-02A (inactive)	241-BX-05B (inactive)
	241-AX-02B (inactive)	241-BX-05C (inactive)
	241-AX-02C (inactive)	241-BX-06A (inactive)
	241-AX-02D (inactive)	241-BX-06B
	241-AX-03A (inactive)	241-BX-06C (inactive)
	241-AX-03B (inactive)	241-BX-08A (inactive)
	241-AX-03C (inactive)	241-BX-110A (inactive)
	241-AX-03D (inactive)	241-BX-111A (inactive)
	241-AX-04A (inactive)	241-BX-112A (inactive)
	241-AX-04B (inactive)	241-BY-01A (inactive)
	241-AX-04C (inactive)	241-BY-01C (inactive)
	241-AX-04D (inactive)	241-BY-01D (inactive)
	241-B-01A (inactive)	241-BY-02A
	241-B-01B (inactive)	241-BY-02B (inactive)

Table 4-4. Waste Transfer System Pits. (8 sheets)

Type of pit	Pits	
SST central/sluice pits (cont'd)	241-BY-02C (inactive)	241-BY-112D (inactive)
	241-BY-02D	241-C-01A (inactive)
	241-BY-03A	241-C-01B (inactive)
	241-BY-03C (inactive)	241-C-01C (inactive)
	241-BY-03D (inactive)	241-C-02A (inactive)
	241-BY-04A (inactive)	241-C-02B
	241-BY-04C (inactive)	241-C-02C (inactive)
	241-BY-04D (inactive)	241-C-03A (inactive)
	241-BY-05A	241-C-03B
	241-BY-05C (inactive)	241-C-03C (inactive)
	241-BY-05D (inactive)	241-C-04A (inactive)
	241-BY-06A	241-C-04B (inactive)
	241-BY-06C (inactive)	241-C-04C (inactive)
	241-BY-06D (inactive)	241-C-05A
	241-BY-07A (inactive)	241-C-05B (inactive)
	241-BY-08A (inactive)	241-C-05C (inactive)
	241-BY-09A	241-C-06A
	241-BY-110A (inactive)	241-C-06B
	241-BY-111A (inactive)	241-C-06C
	241-BY-111C (inactive)	241-C-201 (inactive)
	241-BY-111D (inactive)	241-C-202 (inactive)
	241-BY-112A (inactive)	241-C-203 (inactive)
	241-BY-112C (inactive)	241-C-204 (inactive)
	241-A-01H (slurry distributor pit; active for salt well pumping)	
	241-AX-01A (active for salt well pumping)	
	241-B-04 (no pit; covered salt well caisson, inactive)	
	241-B-05 (no pit; covered salt well caisson, inactive)	
	241-B-07 (no pit; covered salt well caisson, inactive)	
	241-B-110 (no pit; covered salt well caisson, inactive)	
	241-B-111 (no pit; covered salt well caisson, inactive)	
	241-B-201 (no pit; covered salt well caisson, inactive)	
	241-BX-07 (no pit; covered salt well caisson, inactive)	
	241-BX-09 (no pit; covered salt well caisson, inactive)	
	241-C-07 (no pit; covered salt well caisson, inactive)	
	241-C-08 (no pit; covered salt well caisson, inactive)	
	241-C-09 (no pit; covered salt well caisson, inactive)	
	241-C-110 (no pit; covered salt well caisson, inactive)	
	241-C-111 (no pit; covered salt well caisson, inactive)	
	241-C-112 (no pit; covered salt well caisson, inactive)	
SST leak detection pits	241-AX-01E 241-AX-02E 241-AX-03E 241-AX-04E	

Table 4-4. Waste Transfer System Pits. (8 sheets)

	Type of pit	Pits			
1	SST flush pits	241-A-A (inactive)		241-AX-A (inactive)	
		241-A-B (inactive)		241-AX-B (inactive)	
2	Diversion boxes	241-A-151		241-BX-153 (inactive)	
		241-A-152 (inactive)		241-BX-154 (inactive)	
		241-A-153 (inactive)		241-BX-155 (inactive)	
		241-AR-151		241-BXR-151 (inactive)	
		241-AX-151 (inactive)		241-BXR-152 (inactive)	
		241-AX-152		241-BXR-153 (inactive)	
		241-AX-153 (inactive)		241-BYR-152 (inactive)	
		241-AX-155		241-BYR-153 (inactive)	
		241-AX-501		241-BYR-154 (inactive)	
		241-AY-151 (inactive)		241-C-151 (inactive)	
		241-AY-152 (inactive)		241-C-152 (inactive)	
		241-AY-501		241-C-153 (inactive)	
		241-AZ-152		241-C-154 (inactive)	
		241-B-151 (inactive)		241-CR-151 (inactive)	
		241-B-152 (inactive)		241-CR-152 (inactive)	
		241-B-153 (inactive)		241-CR-153 (inactive)	
		241-B-154 (inactive)		241-ER-151	
		241-B-252 (inactive)		241-ER-152	
		242-B-151 (inactive)		241-ER-153	
		241-BR-152 (inactive)		241-EW-151 (located in 600 Area)	
3	Vault pits	244-AR		244-BXR (inactive)	
4	DCRT pits	244-A lift station		244-BX	244-CR
5	Catch tank pits	241-A-302A		241-B-301B (inactive)	
		241-A-302B (inactive)		241-B-302B (inactive)	
		241-A-350		241-BX-302A (inactive)	
		241-A-417		241-BX-302B (inactive)	
		241-AX-152		241-BX-302C (inactive)	
		241-AZ-151		241-301C (inactive)	
		241-AZ-154		241-ER-311	
6	Cleanout boxes	241-COB-AN-1	241-COB-AW-1	241-COB-AW-9	241-COB-AZ-3
		241-COB-AN-2	241-COB-AW-2	241-COB-AW-10	241-COB-AZ-4
		241-COB-AN-3	241-COB-AW-3	241-COB-AW-11	241-COB-AZ-5
		241-COB-AN-4	241-COB-AW-4	241-COB-AW-12	241-COB-AZ-6
		241-COB-AN-5	241-COB-AW-5	241-COB-A-30	241-COB-AZ-7
		241-COB-AN-6	241-COB-AW-6	241-COB-AY-1	241-COB-AZ-8
		241-COB-AN-7	241-COB-AW-7	241-COB-AZ-1	241-COB-AZ-9
		241-COB-AN-8	241-COB-AW-8	241-COB-AZ-2	241-COB-AZ-10

Table 4-4. Waste Transfer System Pits. (8 sheets)

Type of pit	Pits	
200 West Area pits		
DST valve pits	241-SY-A	241-SY-B
DST central/feed pump pits	241-SY-01A 241-SY-02A	241-SY-02E (inactive) 241-SY-03A
DST annulus pump pits	241-SY-01B 241-SY-02B	241-SY-03B
DST leak detection pits	241-SY-01C 241-SY-02C	241-SY-03C
DST flush pits	241-SY-A	241-SY-B (inactive)
SST valve pits	241-S-A 241-S-B 241-S-C 241-S-D 241-SX-A 241-SX-B 241-TX-14B (inactive) 241-TX-15X (near 242-115-TX; inactive) 241-TX-15B (near 242-115-TX; inactive) 241-UA 241-UB 241-UC 241-UD 241-S-01A 241-S-02A 241-S-03A 241-S-04A 241-S-05A 241-S-06A 241-S-07A 241-S-08A 241-S-09A 241-S-110A 241-S-111A 241-S-112A 241-SX-01A 241-SX-02A	241-SX-02B 241-SX-03A 241-SX-03B 241-SX-04A 241-SX-05A 241-SX-05B 241-SX-06A 241-SX-07A (inactive) 241-SX-08A (inactive) 241-SX-09A (inactive) 241-SX-110A (inactive) 241-SX-111A (inactive) 241-SX-112A (inactive) 241-SX-113A (inactive) 241-SX-114A (inactive) 241-SX-115A (inactive) 241-T-01A 241-T-01B 241-T-01C (inactive) 241-T-02A (inactive) 241-T-02B (inactive) 241-T-02C (inactive) 241-T-03A (inactive) 241-T-03B (inactive) 241-T-03C (inactive) 241-T-06 (no pit; inactive) 241-T-08 (no pit; inactive) 241-T-112 (no pit; inactive) 241-TX-01A (inactive)

Table 4-4. Waste Transfer System Pits. (8 sheets)

Type of pit	Pits	
SST valve pits (cont'd)	241-TX-01C (inactive)	241-TY-06 (no pit; inactive)
	241-TX-01D (inactive)	241-U-01A (inactive)
	241-TX-02A (inactive)	241-U-01B (inactive)
	241-TX-02C (inactive)	241-U-01C (inactive)
	241-TX-02D (inactive)	241-U-02A
	241-TX-03A (inactive)	241-U-02B
	241-TX-03C (inactive)	241-U-02C
	241-TX-03D (inactive)	241-U-03A
	241-TX-04A (inactive)	241-U-03B
	241-TX-04C (inactive)	241-U-03C
	241-TX-04D (inactive)	241-U-04A (inactive)
	241-TX-05A (inactive)	241-U-04B (inactive)
	241-TX-05C (inactive)	241-U-04C (inactive)
	241-TX-05D (inactive)	241-U-05A
	241-TX-06A (inactive)	241-U-05B
	241-TX-06C (inactive)	241-U-05C
	241-TX-06D (inactive)	241-U-06A
	241-TX-07A (inactive)	241-U-06B
	241-TX-07C (inactive)	241-U-06C
	241-TX-07D (inactive)	241-U-07A
	241-TX-08A (inactive)	241-U-07B
	241-TX-08C (inactive)	241-U-07C
	241-TX-08D (inactive)	241-U-08A
	241-TX-09A (inactive)	241-U-08B
	241-TX-110A (inactive)	241-U-08C
	241-TX-111A (inactive)	241-U-09A
	241-TX-112A (inactive)	241-U-09B
	241-TX-113A (inactive)	241-U-09C
	241-TX-114A (inactive)	241-U-110A (inactive)
	241-TX-115A (inactive)	241-U-110B (inactive)
	241-TX-116A (no pit; inactive)	241-U-111A
	241-TX-117A (inactive)	241-U-111B
	241-TX-118A (inactive)	241-U-201 (inactive)
	241-TY-01A (inactive)	241-U-202 (inactive)
	241-TY-02A (inactive)	241-U-203 (inactive)
	241-TY-03A (inactive)	241-U-204 (inactive)
	241-TY-04A (inactive)	
	241-T-04 (no pit; covered salt well caisson)	
	241-T-05 (no pit; covered salt well caisson, inactive)	
	241-T-07 (no pit; covered salt well caisson)	

Table 4-4. Waste Transfer System Pits. (8 sheets)

Type of pit	Pits	
SST valve pits (cont'd)	241-T-09 (no pit; covered salt well caisson) 241-T-110 (no pit; covered salt well caisson) 41-T-111 (no pit; covered salt well caisson) 241-T-201 (no pit; covered salt well caisson, inactive) 241-T-202 (no pit; covered salt well caisson, inactive) 241-T-203 (no pit; covered salt well caisson, inactive) 241-T-204 (no pit; covered salt well caisson, inactive) 241-TY-05 (no pit; covered salt well caisson, inactive) 241-U-112 (no pit; covered salt well caisson, inactive)	
SST flush pits	241-S-A 241-S-B 241-SX-A 241-SX-B 241-UA 241-UB 241-UC 241-UD 240-S-151 240-S-152 (inactive) 241-S-151 241-S-152 (inactive) 241-T-151 (inactive) 241-T-152 (inactive) 241-T-153 (inactive) 241-T-252 (inactive) 241-TX-152 241-TX-153 (inactive) 241-TX-154	241-TX-155 (inactive) 241-TXR-151 (inactive) 241-TXR-152 (inactive) 241-TXR-153 (inactive) 241-TR-152 (inactive) 241-TR-153 (inactive) 241-TY-153 (inactive) 241-U-151 241-U-152 241-U-153 (inactive) 241-U-252 (inactive) 241-UR-151 (inactive) 241-UR-152 (inactive) 241-UR-153 (inactive) 241-UR-154 (inactive) 241-UX-154 241-WR (inactive) 242-T-151 (inactive)
Vault pits	241-TXR-244 (inactive)	241-UR-244 (inactive)
DCRT pits	244-S 244-TX	244-U
Catch tank pits	241-S-302 (inactive) 241-S-302A (inactive) 241-S-304 241-SX-302A (inactive) 241-T-301B (inactive) 241-TX-302A (inactive)	241-TX-302B (inactive) 241-TX-302C (inactive) 241-TY-302A (inactive) 241-TY-302B (inactive) 241-UX-302A

Table 4-4. Waste Transfer System Pits. (8 sheets)

Type of pit	Pits		
Cleanout boxes	241-COB-SY-1 241-COB-SY-2	241-COB-SY-3 241-COB-SY-4	241-COB-SY-5 241-COB-SY-6

DCRT = double-contained receiver tank.
DST = double-shell tank.
SST = single-shell tank.

Table 4-5. Electrical Supply to Facilities.

Safety component	Supply line	Facility disconnect
241-AN Tank Farm	C8-L6	C8X138
241-AP Tank Farm	C8-L6	C8X167
241-AW Tank Farm	C8-L6	C8X132
241-AY/AZ Tank Farm	C8-L6	C8X508 C8X575 C8X107
244-A DCRT	C8-L6	C5996L
241-A-350 catch tank	C8-L6	C8X554
244-AR Vault	C8-L6	C8X85
204-AR Vault	C8-L6	C8X133
241-B, 241-BX, 241-BY Tank Farms	C8-L6	C8X89
244-BX DCRT	C8-L6	C8X89
241-C Tank Farm 241-C-105 241-C-106	C8-L6	C8X553
244-CR DCRT	C8-L6	C8X544
241-ER-311 catch tank	C8-L6	C5732P C6128P C6130P
241-SX Tank Farm	C8-L4	C8X516
241-SY Tank Farm	C8-L4	C8X556
244-S DCRT	C8-L4	E8X343
244-TX DCRT	C8-L4	C8X487 C8X135
244-U DCRT	C8-L4	H8X108 (MCC#1-A3)

DCRT = double-contained receiver tank.

Table 4-6. Tank Farm Loss-of-Power Events. (2 sheets)

Date	Event description	Event effects
1-08-1973	Vibration and cold weather broke 13.8-kV line.	Not reported.
4-18-1974	Power cable was not in location shown by tank farm drawings; test hole augured to find a piping leak cut cable.	241-S Tank Farm instrument power outage.
3-24-1982	Dirt in relay contacts, failure of the manual/automatic switch, and failure in the automatic start control circuit module.	Loss of emergency power to 204-AR Waste Unloading Facility.
7-21-1986	Miscommunication; Operations told but had forgotten about a scheduled outage; power shut off.	Loss of power in 241-AN Tank Farm.
11-29-1986	Electrical outage at 200 East Area tank farm.	241-AN, 241-AP, and 241-AW Tank Farms tanks pressurized and activated their high-pressure alarms.
12-10-1986	Power trip.	241-AP Tank Farm lost power and disabled the ventilation exhaust systems; tanks pressurized.
12-25-1989	Cable burnt.	Portable transformer failed while normal power was out for routine maintenance.
10-14-1990	Contaminated insulator caused power pole fire.	Section of Hanford Site 230-kV line lost power; 100-B, 100-KE, 100-KW, and 100-N Areas lost power.
11-11-1990	242-A Evaporator monitoring and control system failed.	Some 200 East Area alarms could not be annunciated.
12-12-1990	Wrong circuit breaker opened (breaker was not labeled, and operator failed to verify the correct breaker).	241-SY Tank Farm primary exhauster shut down.
6-29-1991	Electrical storm.	200 East Area power was interrupted.
8-06-1991	Power interruption.	200 East and 200 West Areas lost power momentarily.
11-16-1991	Power interruption for 1 min, blamed on "small mammal."	241-SY Tank Farm and 241-T Evaporator ventilation disrupted.
11-22-1991	Troubleshooting error caused power interruption.	241-AY/AZ Tank Farms backup ventilation class A equipment lost power (a motor reset circuit fault triggered an electrical "chain reaction," the reset button should not have been pressed).
3-16-1992	Not known.	200 East and 200 West Areas lost power; two backup power systems (diesel generators at 204-AR Waste Unloading Facility and 241-SY Tank Farm) failed to start when required.
4-29-1992	Transformer failed.	241-S Tank Farm leak detection and level monitoring instruments inactivated.
6-28-1992	Electrical storm.	200 West Area lost power.

Table 4-6. Tank Farm Loss-of-Power Events. (2 sheets)

Date	Event description	Event effects
8-11-1993	"Large bird" landed on power pole at Gable Mountain.	241-AP, 241-AW, and 241-AN Tank Farms lost power; loss of active ventilation in 241-AP, 241-AW, 241-AN, and 241-C Tank Farms.
8-05-1994	Power cable severed.	241-AN, 241-AP, 241-AW, 241-C Tank Farms and 244-BX DCRT and 244-CR Vault lost active ventilation.
8-19-1994	Feeder breaker opened.	241-AN Tank Farm lost power, disabling the primary and annulus exhausters and causing the tanks to pressurize.
12-08-1994	Main control power breaker tripped.	Primary and annulus exhausters disabled in 241-AN Tank Farm.
2-17-1995	Electrical power tripped during installation of a microwave transfer trip device.	200 East and West Area tank farms lost power.
10-03-1995	Breaker opened in error.	241-SY Tank Farm backup exhauster shut down.

DCRT = double-contained receiver tank.

Table 4-7. Safety-Significant Structure, System, and Component Summary. (7 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Waste Tanks	Tank Failure Due To Excessive Loads (and Tank Failure Due to Vacuum or Degradation) (3.4.2.1)	(3.4.2.1) The safety functions of the waste tanks are to withstand penetration from load drops, and to maintain structural integrity for uniform and concentrated loads, vacuum, and degradation, averting tank collapse and preventing the release of waste, thus decreasing the frequency of the Tank Failure Due to Excessive Loads (and tank failure due to vacuum or degradation) accident.	The tanks shall be able to maintain structural integrity for load drops and uniform and concentrated loads. Load values are specified in HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Section 5.16, "Dome Loading Controls."	Dome Loading Controls are specified in HNF-SD-WM-TSR-006, Administrative Control 5.16. Changes to the design of the waste tanks are controlled according to approved procedures. Lifts shall be performed in accordance with DOE-RL-92-36, *Hanford Site Hoisting and Rigging Manual*. Control of loads, vehicles, and vehicle access and movement within tank farms is maintained in accordance with HNF-IP-1266, Chapter 5.16, "Dome Loading Controls." (Per agreement with DOE-ORP this Safety-Significant designation is not effective until March 30, 2000.)
204-AR Waste Unloading Facility structure	Surface Leak Resulting in Pool (3.4.2.7)	(3.4.2.7) The safety functions of the 204-AR Waste Unloading Facility structure are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident.	The 204-AR Waste Unloading Facility structure shall be designed to confine the tank waste leak described in the Section 3.4.2.7 accident analysis.	The 204-AR railcar unloading canyon doors shall remain closed at all times per TSR Administrative Control 5.12 unless there is an operational need for their temporary opening. Prior to a waste transfer, the west exterior rollup and west exterior personnel access doors shall be verified closed.

Table 4-7. Safety-Significant Structure, System, and Component Summary. (7 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
2727-W Building	Sodium Fire (3.3.2.4.10)	(3.3.2.4.10) The safety functions of the 2727-W Building are to withstand high winds and to protect the stored sodium tanks from vehicle collisions, thus preventing a sodium fire and decreasing the frequency of the Sodium Fire accident.	The 2727-W Building shall be designed to withstand winds up to 113 km/h (70 mi/h), a wind loading of 958 Pa (20 lb/ft^2). The height of the foundation wall shall be at least 0.9 m (3 ft) abovegrade.	The 2727-W Building shall be inspected annually for deviations from the configuration shown in design drawings. The height of the foundation wall shall be verified annually to ensure that it extends at least 0.9 m (3 ft) abovegrade.
Backflow prevention devices	Surface Leak Resulting in Pool (3.4.2.7) Spray Leak in Structure or from Waste Transfer Lines (3.4.2.9)	(3.4.2.7 and 3.4.2.9) The safety function of the backflow prevention devices is to prevent a backflow leak of tank waste from the waste transfer system into the service water piping system, thus decreasing the frequency of the Surface Leak Resulting in Pool and Spray Leak in Structure or From Waste Transfer Lines accidents.	Backflow prevention devices shall be installed in accordance with the manufacturer's instructions, including protection from freezing temperatures. The rated pressure of the backflow preventer shall exceed the maximum pressure of the system in which it is installed. State approval of an installation, provided by the state-certified Site water purveyor or designee, is required before the service water supply valve(s) may be opened.	None. Backflow prevention devices shall be functionally tested annually by trained technicians using approved procedures and shall be verified to be operating correctly. These Washington State requirements are implemented by the industrial hygiene program described in Chapter 8.0.
HEPA filter units	Mixing of Incompatible Material-Tank Pressurization (3.3.2.4.12)	(3.3.2.4.12) The safety function of the DCRT ventilation system HEPA filter unit (one stage) is to provide HEPA filtration of DCRT headspace gases before their release to the environment, thus decreasing the consequences of the Mixing of Incompatible Material-Tank Pressurization accident.	HEPA filter units shall be capable of removing at least 99.95% of 0.3-μm particles of an approved challenge aerosol from the ventilation exhaust flow stream. HEPA filter units shall also resist degradation when exposed to ionizing radiation and caustic vapors, resist damage caused by moisture buildup on the filter media, and resist leakage when exposed to a differential flow stream pressure of $\leq$2.49 kPa ($\leq$10 in. WG).	Operability of the HEPA filter units is verified at the time of installation and annually thereafter using a challenge aerosol.

Table 4-7. Safety-Significant Structure, System, and Component Summary. (7 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Pipe encasements	Subsurface Leak Remaining Subsurface (3.3.2.4.7)	(3.3.2.4.7) The safety function of the waste transfer system pipe encasement is to direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface accident.	The pipe encasement shall channel waste leaked from a primary pipe to a transfer-associated structure where the leak can be detected. The encasement shall provide an unobstructed flow path for the movement of leaked waste to a transfer-associated structure.	The drain path into the pit(s) from the annulus of the encased piping system shall be verified to provide an open drain path to the pit, with encasement drain valve positions as applicable to the valve type. The encasement drain valves shall never be left in the "HYDRO" position during a waste transfer.
Salt well flow totalizers	Subsurface Leak Remaining Subsurface (3.3.2.4.7) Surface Leak Resulting in Pool (3.4.2.7) Subsurface Leak Resulting in Pool (3.4.2.8)	(3.3.2.4.7, 3.4.2.7, and 3.4.2.8) The safety function of the salt well flow totalizers is to provide the total salt well flow parameter used in periodic material balance calculations during waste transfer operations. These calculations enable operators to terminate the waste transfer operation if waste leaks and/or mistransfers are detected, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface, Surface Leak Resulting in Pool, and Subsurface Leak Resulting in Pool accidents.	The salt well flow totalizer shall measure the flow of liquid waste transferred by the salt well pump per the manufacturer's specification within an accuracy of ±5% for defined flow ranges.	A limited calibration comprising a zero check and functional test will be performed annually for SSTs undergoing active salt well pumping. Salt well flow totalizer readings are provided at intervals that will allow early detection of transfer system leaks so that action can be taken to prevent the formation of a surface or subsurface waste accumulation as described in the three Chapter 3.0 accidents.
Service water flow totalizers	Surface Leak Resulting in Pool (3.4.2.7)	(3.4.2.7) The safety function of the service water flow totalizers is to alert operators that an excessive service water flow and a potential water intrusion into a waste tank exists. This information enables operators to terminate the service water flow if water intrusion is confirmed, thus preventing a waste tank overflow and decreasing the frequency of the Surface Leak Resulting in Pool accident.	The service water flow totalizers shall provide local indication of water usage with an accuracy within ±5%.	The flow totalizer shall be functionally tested annually .

Table 4-7. Safety-Significant Structure, System, and Component Summary. (7 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Tank level detection systems	Subsurface Leak Remaining Subsurface (3.3.2.4.7) Surface Leak Resulting in Pool (3.4.2.7) Subsurface Leak Resulting in Pool (3.4.2.8) Tank Bump (3.4.2.11)	(3.3.2.4.7, 3.4.2.7, and 3.4.2.8) The safety functions of the tank level detection systems are to provide tank waste levels for operator monitoring of all tanks physically connected to the transfer route, and to provide the tank waste levels used in periodic material balance calculations during waste transfer operations. This monitoring and these calculations enable operators to detect waste leaks or waste mistransfers and take appropriate action to terminate the waste transfer operation, thus decreasing the consequences of the Subsurface Leak Remaining Subsurface, Surface Leak Resulting in Pool, and Subsurface Leak Resulting in Pool accidents. (3.4.2.7) An additional safety function of the tank level detection systems is to detect a service water leak into a waste tank, enabling the operators to terminate the service water leak, thus decreasing the consequences of the Surface Leak Resulting in Pool accident. (3.4.2.11) The safety function of the tank level detection systems is to support the implementation of the level-dependent tank temperature controls, thus decreasing the frequency of the Tank Bump accident.	The level detection systems for all DSTs, AWF tanks, and DCRTs shall provide level measurements prior to transfers to or from the tanks, and at specified intervals during the transfers to support material balance calculations. The level detection systems for all DSTs, DCRTs, catch tanks, and SSTs that are not in intrusion prevention (interim isolation) status shall provide level measurements prior to waste transfers when the tanks are interconnected to the transfer route and at specified intervals during the transfers to detect misroutes. The systems shall also provide measurements at specified intervals to detect a service water leak into the tank. The tank level detection systems for DSTs and AWF tanks shall measure tank waste levels above 4.6 m (15 ft) and transmit the data to local and remote level indicators. The tank level detection systems shall be capable of measuring waste levels with an minimum accuracy of ±1.3 cm (±0.5 in.)	Tank level detection systems shall be calibrated annually to ensure compliance with the functional requirements.

Table 4-7. Safety-Significant Structure, System, and Component Summary. (7 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Temperature monitoring systems	Tank Bump (3.4.2.11)	(3.4.2.11) The safety function of the temperature monitoring systems is to provide tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding temperatures at which significant tank bumps or steam release events could occur, thus decreasing the frequency of the Tank Bump accident.	The temperature monitoring systems shall be capable of detecting and displaying the temperature of tank waste over the full range of tank operations, including temperatures resulting from a loss of cooling event.	The temperature monitoring systems shall be functionally tested annually to assure that each temperature display is within ±2.8 °C (±5 °F) of the temperature read locally by a handheld temperature monitoring instrument at the thermocouple output signal connection.
Transfer leak detection systems	Subsurface Leak Remaining Subsurface (3.3.2.4.7)	(3.3.2.4.7) The safety functions of the transfer leak detection system are to detect the presence of a leak of tank waste in transfer-associated structures, and to either provide an alarm to alert operators to take mitigative action, or to provide an interlock to shut down waste transfer pump operation, limiting the volume of the waste leak and thus decreasing the consequences of the Subsurface Leak Remaining Subsurface accident.	The installed location of the leak detector must be near the structure's floor in a manner such that the pit liquid hold-up volume above the leak detector's elevation is greater than or equal to 1,520 gal (203.2 ft^3). The basis for this value is contained in HNF-2204. This requirement is typically met by installing the leak detector at a low point in the pit such that liquid accumulations of 5.08 cm (2 in.) are detected. The leak detection system shall activate an alarm or an interlock to prevent or stop operation of the transfer pump when a leak is detected.	The operability of each process pit, diversion box, valve pit, and COB leak detector (and its associated alarm and/or control circuitry) that is physically connected to a waste transfer pump not under an administrative lock shall be verified quarterly by a functional test.
Transfer system covers	Surface Leak Resulting in Pool (3.4.2.7) Subsurface Leak Resulting in Pool (3.4.2.8)	(3.4.2.7 and 3.4.2.8) The safety functions of the transfer system covers are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool and Subsurface Leak Resulting in Pool accidents.	The cover assembly for a structure shall limit the escape of aerosol from leaked waste splatter and splashing in the structure. Transfer system covers shall be designed to eliminate direct waste aerosol leakage paths. Transfer system cover assemblies shall fit their supporting structure so that there are no paths for a direct stream of leaked waste to the atmosphere. Transfer system cover assemblies shall function as radiological shields to limit the shine dose to the facility worker from waste leaks. When pit cover penetrations are not in use, they shall be plugged.	Each time a waste transfer-associated structure is opened, the transfer system covers (and the abovegrade waste transfer-associated structure) shall be visually inspected for damage or defects that could affect the cover's ability to perform its safety function. The exterior of the structure and cover assembly shall be visually inspected before a waste transfer and once per 10 days thereafter to ensure that the covers, cover plugs, and seals are installed and operable.

Table 4-7. Safety-Significant Structure, System, and Component Summary. (7 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria
Ventilation stack CAM interlock systems	HEPA Filter Failure—Exposure to High Temperature or Pressure (3.3.2.4.2)	(3.3.2.4.2) The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the HEPA Filter Failure—Exposure to High Temperature or Pressure accident.	The CAM shall operate continuously while the exhaust systems are operating. The CAM shall measure the radiation level in the sampled flow stream and activate an interlock to shut down the exhauster upon detection of a radiation level that exceeds a preset level. For CAM failure, the monitors shall actuate an alarm and an interlock to shut down the exhaust system.	The CAM interlock loops shall be calibrated annually and the alarms and interlocks shall be functionally tested once a quarter. (The requirement for the CAM interlock to shut down upon CAM failure will be reevaluated as part of Phase 2 FSAR implementation. Therefore, this requirement is deferred.)
Abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes	Surface Leak Resulting in Pool (3.4.2.7) Subsurface Leak Resulting in Pool (3.4.2.8)	(3.4.2.7 and 3.4.2.8) The safety functions of the abovegrade portions of process pits, diversion boxes, valve pits, and COBs are to limit the aerosol release generated by waste leak splattering and splashing in a waste transfer-associated structure, and to limit the shine dose from the waste leak, thus decreasing the consequences of the Surface Leak Resulting in Pool and Subsurface Leak Resulting in Pool accidents.	The abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall limit the escape of aerosol from leaked waste splatter and splashing in the structure and shall be designed to eliminate direct waste aerosol leakage paths. Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall have covers fitted so that there are no paths for a direct stream of leaked waste to the atmosphere. Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall also function as radiological shields to limit the shine dose to the facility worker from waste leaks. Abovegrade portions of process pits, diversion boxes, valve pits, and COBs shall be designed to provide an intact boundary to confine waste leakage within the waste transfer-associated structure until it is completely filled with leaked waste. Unsealed openings in the abovegrade portions of process pits, diversion boxes, and valve pits shall be plugged. Holes in COB covers from previous repairs or uncompleted modifications shall be sealed to prevent waste outleakage and the formation of a surface pool of waste.	Each time a process pit, diversion box, valve pit, or COB is opened, the abovegrade portions shall be visually inspected for damage or degradation in structural integrity. The exterior of the abovegrade portions shall be visually inspected prior to a waste transfer to ensure that the following requirements are satisfied. • The abovegrade portions are free of defects that could result in inability to perform the safety functions. • Existing plugs and seals are installed and operable. (Per agreement with DOE-ORP this Safety-Significant designation is not effective until March 30, 2000.)

Table 4-7. Safety-Significant Structure, System, and Component Summary. (7 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria

DOE/RL-92-36, 1996, *Hanford Site Hoisting and Rigging Manual*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
HNF-IP-0842, 1997, *TWRS Administration*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.
HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

AWF = Aging Waste Facility.
CAM = continuous air monitor.
COB = cleanout box.
DACS = Data Acquisition and Control System.
DCRT = double-contained receiver tank.
DST = double-shell tank.
FTIR = Fourier Transform Infrared.
HEPA = high efficiency particulate air (filter).
LFL = Lower Flammability Limit.
SSC = structure, system, and component
SST = single-shell tank.
TMACS = Tank Monitoring and Control System.
TSR = Technical Safety Requirements.
WG = water gauge.

Table 4-8. Tank Waste Temperature Monitoring Safety Significant Systems. (2 sheets)

Tank	System
Single-shell tanks	
241-C-106	TC Tree (3) TMACS
241-SX-103	TC Tree (1) TMACS
241-SX-107	TC Tree (2) TMACS
241-SX-108	TC Tree (2) TMACS
241-SX-109	TC Tree (2) TMACS
241-SX-110	TC Tree (2) TMACS
241-SX-111	TC Tree (2) TMACS
241-SX-112	TC Tree (2) TMACS
241-SX-114	TC Tree (2) TMACS
Double-shell tanks	
241-AN Tank Farm	
241-AN-101	TC Tree (1) TMACS
241-AN-102	TC Tree (1) TMACS
241-AN-103	TC Tree (1) TMACS MIT (1)
241-AN-104	TC Tree (1) TMACS MIT (1)
241-AN-105	TC Tree (1) TMACS MIT (1)
241-AN-106	TC Tree (1) TMACS
241-AN-107	TC Tree (1) TMACS
241-AP Tank Farm	
241-AP-101	TC Tree (1)
241-AP-102	TC Tree (1)
241-AP-103	TC Tree (1)
241-AP-104	TC Tree (1)
241-AP-105	TC Tree (1)
241-AP-106	TC Tree (1)
241-AP-107	TC Tree (1)
241-AP-108	TC Tree (1)

Table 4-8. Tank Waste Temperature Monitoring Safety Significant Systems. (2 sheets)

Tank	System
241-AW Tank Farm	
241-AW-101	TC Tree (1)
241-AW-102	TC Tree (1)
241-AW-103	TC Tree (1)
241-AW-104	TC Tree (1)
241-AW-105	TC Tree (1)
241-AW-106	TC Tree (1)
241-AY Tank Farm	
241-AY-101	TC Tree (7)
241-AY-102	TC Tree (1)
241-AZ Tank Farm	
241-AZ-101	TC Tree (1)
241-AZ-102	TC Tree (1)
241-SY Tank Farm	
241-SY-101	TC Tree (2) TMACS MIT (2)
241-SY-102	TC Tree (1) TMACS
241-SY-103	TC Tree (2) TMACS MIT (1)

Source: WHC-EP-0182-95, *Waste Tank Summary Report for Month Ending February 29, 1996*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-EL-003, 1995, *Operational Safety Requirements and Operating Specification Documentation Compliance Instrumentation Matrices - 200 East Area Tank Farms*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-HIE-007, 1996, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-553, 1993, *Thermocouple Status for Single-Shell and Double-Shell Waste Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

MIT = multifunction instrument.
TC = thermocouple.
() = number of TC trees.
TMACS = Tank Monitoring and Control System.

Table 4-9. Other Support Systems. (2 sheets)

SSC	Accident(s)	Functions	Functional requirements	Performance criteria
Tank farm electrical distribution	Supporting SSC for: 3.4.2.2 3.4.2.7 3.4.2.8 3.4.2.9 3.4.2.11 3.3.2.4.2 3.3.2.4.7	The tank farms electrical distribution system is a supporting SSC for various safety SSCs identified in Chapter 3.0 and is constructed to comply with electrical codes of record. The function of the tank farm electrical distribution system is to provide electrical power with standard commercial reliability to Safety-Class and Safety-Significant SSCs.	None of the safety SSCs require continuous electrical power to adequately perform their safety functions. The length of time that a safety SSC can remain disabled as a result of losing electrical power before safety is compromised depends on the particular safety SSC and its safety function. Backup generators are installed in some areas of TWRS, but are not required to start up immediately on loss of Site power to protect the safety functions of the safety SSCs.	None. Electrical power systems in TWRS do not appear to be major contributors to the failures of safety SSCs.

Table 4-9. Other Support Systems. (2 sheets)

SSC	Accident(s)	Functions	Functional requirements	Performance criteria-
Compressed air system	Supporting SSC for: 3.4.2.2	The tank farms compressed air systems are supporting SSCs for various safety SSCs identified in Chapter 3.0. The functions of the tank farm compressed air systems are to provide compressed air with standard commercial reliability for the DCRT ventilation systems (except 244-CR TK-003) and the 244-AR TK-002 ventilation system;; and to provide instrument air to waste tank level detection systems that use dip tubes. The compressed air system for Tank 241-SY-101 is discussed in HNF-3737.	The compressed air systems shall operate as needed to support the safety SSCs that require air to perform their safety functions. The compressed air systems shall operate continuously while waste is stored in the 244-A, 244-BX, 244-S, 244-TX, and 244-U DCRTs and 244-AR TK-002. Minimum total inlet airflow supplied to the dip tubes shall be 0.08 m^3/h (3 ft^3/h) as measured by the dip tube flow indicators. However, while waste from tanks 241-SX-104 and 241-SX-105 is stored in DCRT 244-S for transfers, the inlet air supply shall be ≥ 0.14 m^3/h (≥ 5 ft^3/h) as measured by the dip tube flow indicators. The compressed air system for each tank level detection system that uses dip tubes shall operate continuously before and during waste transfers to or from the tank or for waste transfers routed through a connected path with the tank and shall operate as needed to support the level measurement schedule for detecting service water intrusions.	None. The compressed air system should be operable and operating prior to and during waste transfers, waste storage, and Tank 241-SY-101 tank operations and activities.

CHAPTER 5.0
DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

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CHAPTER 5.0
DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

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LIST OF TERMS

AC	Administrative Control
AWF	Aging Waste Facility
CAM	continuous air monitor
CWC	Central Waste Complex
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
ERO	Emergency Response Organization
FSAR	Final Safety Analysis Report
HEPA	high-efficiency particulate air (filter)
LCO	Limiting Condition for Operation
LCS	Limiting Control Setting
LFL	Lower Flammability Limit
ORP	Office of River Protection
OSR	Operational Safety Requirement
PWSF	Purgewater Storage Facility
RL	U.S. Department of Energy, Richland Operations Office
SL	Safety Limit
SSC	structure, system, and component
SST	single-shell tank
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System

5.0 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 INTRODUCTION

The necessary preventive and mitigative features determined to be essential in Chapter 3.0, "Hazard and Accident Analyses," and from the designation of Safety-Class and Safety-Significant features in Chapter 4.0, "Safety Structures, Systems, and Components," are identified in this chapter. Information necessary for preparing the separate Technical Safety Requirement (TSR) document (HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*) required by DOE 5480.22, *Technical Safety Requirements*, is also provided in this chapter.

HNF-SD-WM-TSR-006 has been implemented and is currently in use. The TSR document defines acceptable conditions, safe boundaries, and management, or Administrative Controls (ACs) that ensure safe operation of a nuclear facility and reduce the potential risk to the public and onsite workers from uncontrolled releases of radiological or toxicological material or from radiation exposures caused by inadvertent criticality (DOE 5480.22).

This chapter comprises summaries and references to pertinent sections of the FSAR that describe design and AC features needed to prevent or reduce the consequences of an accident. The Safety Limits, Limiting Control Settings (LCSs), Limiting Conditions for Operation (LCOs), Surveillance Requirements, ACs, and Design Features form the basis of the TSR document and provide the logical link between the TSR controls and the FSAR.

As discussed in Chapter 3.0, a hazard categorization process assessed the Tank Waste Remediation System (TWRS) facilities' radiological and toxicological material inventory. The TSR controls were developed based on the graded approach applied to the hazard and accident analyses and the Hazard Category 2 designation.

Products of this chapter include the following:

- Qualitative and quantitative TSR control selection criteria
- Operational modes that designate distinguishable facility configurations
- Derivation of minimum staffing levels for each operational mode
- Discussion of the derivation of the TSR controls selected
- A list of Design Features for each TWRS facility type
- Identification of TSR interfaces with other TWRS and Hanford Site facilities and controls

- Tables that link the hazard and accident analyses and the TSR controls
- A table that provides cross-references to other FSAR chapters
- A table that identifies TSR interfaces with other facilities.

Derivation of TSRs for projects not within the original scope of the FSAR are included in the designated addenda, as applicable. Derivation of TSRs for the waste retrieval sluicing system are contained in Addendum 1. Derivation of TSRs for the replacement cross-site transfer system are contained in Addendum 2. Derivation of TSRs for the 241-AZ-702 ventilation system are contained in Addendum 3. Derivation of TSRs for the 241-AZ-101 mixer pump test are contained in Addendum 4.

5.2 REQUIREMENTS

The primary requirements specific for this chapter, the hazard and accident analyses, and the TSR document (HNF-SD-WM-TSR-006) are based on the following documents:

- DOE 5480.22, *Technical Safety Requirements*, Change 2 (1996)
- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994).

5.3 TECHNICAL SAFETY REQUIREMENTS COVERAGE

5.3.1 Summary

The suite of TSR controls for analyzed TWRS hazards/accidents is summarized in Table 5-1. Table 5-1 lists TSR controls per the accident analyses in Chapter 3.0 and the evaluation of safety structures, systems, and components (SSCs) in Chapter 4.0. The table also provides a brief derivation basis for each control related to the specific accident. Table 5-1 is written to provide a cross-reference to the respective Chapter 3.0 accident analysis section or to Section 5.5, "Technical Safety Requirements Derivation," where derivation details are arranged by TSR control.

The required TSR controls are considered necessary and sufficient for public safety, significant Defense-in-Depth, significant worker safety, and for maintaining radiological and toxicological consequences below risk guidelines, except for accidents noted in the Executive Summary and Chapter 3.0.

Worker safety at TWRS facilities is covered by integrated safety management programs. These programs reduce the likelihood and potential impacts of operational events and are covered by their respective regulatory and contractual systems of basic requirements. These programs are included by reference in the ACs in the TSR document (HNF-SD-WM-TSR-006).

A cross-reference to the other FSAR chapters is also provided in Table 5-2. DOE 5480.22 requires the TSR document to include AC programs for nuclear criticality safety, organization and management (including minimum staffing), and occurrence reporting.

5.3.2 Criteria

Chapter 3.0, Section 3.3.1.5, "Controls Identification," details the control selection process from initial hazard identification to selection of hardware or administrative programs for controls.

The following elements were considered in selection of TSR controls to the extent practical:

- **Analysis Assumptions**—Controls were selected to protect major analysis assumptions that could be affected by an operating activity or equipment operation.

- **Sensitivity Analysis**—Controls were selected for less significant analysis assumptions if variability of the assumption significantly affected consequences.

- **Reliability**—Controls were selected for equipment systems that have demonstrated high reliability in the tank farm environment.

- **Optimization**—Controls were selected that could address multiple accidents to minimize implementation costs.

- **Priorities**—Controls were selected first to prevent then to mitigate, first to involve passive systems then actively engineered systems, and first to use engineered controls then administrative programs.

- **Practical Safety-Class/Safety-Significant Designation**—Controls (i.e., SSCs) were selected that would have value in being designated Safety-Class or Safety-Significant.

- **Risk Guidelines**—Controls were selected that would bring the likelihood or consequences within risk guideline values when possible. Controls were selected for toxicological hazards for the accidents analyzed in the FSAR where the toxicological-only consequences (nonnuclear) exceed offsite or onsite risk guidelines, or where the toxicological consequences exceed offsite or onsite risk guidelines and are not prevented or mitigated by the selected radiological controls. Controls for toxicological hazards where the consequences do not exceed risk guidelines are implemented through WHC-SD-WM-HSP-002, *Tank Farm Health and Safety Plan*. If the hazard produced only environmental consequences, evaluation against risk guidelines was not performed.

- **Nuclear Safety Enhancement**—Controls were selected with the objective of identifying necessary and sufficient safety SSCs and TSR controls that satisfy the risk guidelines, provide significant Defense-in-Depth, protect generalized accident analysis assumptions, and provide support to other controls.

- **Radiological Safety Enhancement**—Controls were selected to address hazardous conditions with significant facility worker consequences.

- **Minimize Release of Radiological and Toxicological Material**—Controls were selected to minimize environmental consequences while preventing or mitigating consequences to the public, onsite workers, and facility workers, based on the results of the hazards and accident analyses.

- **Conservatism**—Controls were selected to reduce consequences further below risk guidelines for additional risk reduction.

- **Facility Worker Safety**—Controls were selected that would not significantly increase radiological or toxicological exposures to the facility worker.

- **Significant Defense-in-Depth**—Controls were selected from the suite of Defense-in-Depth items if they significantly minimized risk.

- **Operational Flexibility**—Controls were selected that minimized the need for additional operators or maintenance personnel.

- **Procedure Minimization**—Controls were selected that minimized the need for new or significantly modified operational or administrative procedures.

- **Existing Hardware**—Controls were selected primarily for equipment systems that were in place.

- **Cost-Benefit**—Controls were selected, when new systems were needed, that minimized costs on a qualitative basis.

- **Impacts on TWRS Mission**—Controls were selected that minimized impact to the current TWRS mission including characterization and stabilization activities.

- **Applicability/Consistency**—Controls were selected if they were compatible with activities already in progress in the field.

5.4 DERIVATION OF FACILITY MODES

5.4.1 Operational Modes

The operational modes (Operation and Limited) for TWRS facilities were defined so that transfer status conditions would be clearly understood by plant personnel. Generally, all activities are allowed in Operation mode, while transfers are prohibited in Limited mode. Mode definition was not based on allowing relaxation of controls or placing the facility in a safer condition. The mode applicability is listed in the LCO. The intent of mode applicability is to place the facility into a more restrictive and controlled condition, but the nature of the hazards of TWRS does not allow that type of mode definition. Therefore, both modes are always applicable for all LCOs. The nature of the hazards in the analyses is that the tank waste, the source of the hazards, is always present. Accidental pump starts, mistransfers, accidental confinement breaches, and natural phenomena contribute to initiation of defined accidents regardless of mode definition. The waste remains a hazard and potentially available for involvement in an accident regardless of mode. The modes suggested by DOE 5480.22 are generally not applicable for TWRS facilities because the TWRS mission is storage, characterization, and transfer of waste instead of processing of waste.

A mode is the state of an individual tank at a given time. A particular support system may provide services for several individual tanks, with each tank operating in a different mode. Under these circumstances, the applicable mode for the support system is the most restrictive mode applicable to any of the tanks being provided with supporting services. Mode definitions for the TWRS facilities are provided in the following paragraphs.

The modes for single-shell tanks (SSTs), double-shell tanks (DSTs), Aging Waste Facility (AWF) tanks, double-contained receiver tanks (DCRTs), catch tanks, and inactive miscellaneous underground storage tanks (encompassed by miscellaneous inactive storage facilities), are defined as follows:

Operation—Waste is being stored. Waste transfers to or from tanks are authorized in accordance with TSRs. Routine operational and maintenance activities may be performed.

Limited—Waste is being stored. Waste transfers to or from any tank are not authorized except in accordance with an approved recovery plan. Routine operational and maintenance activities may be performed.

The modes for the 204-AR Waste Unloading Facility are defined as follows.

Operation—Waste may be stored in catch tanks temporarily. Receiving, unloading, processing, or transferring waste is authorized. Routine operational and maintenance activities may be performed.

Limited—Waste may be stored in catch tanks temporarily. Receiving, unloading, processing, or transferring of waste is not authorized. Routine operational and maintenance activities may be performed.

The modes for the 244-AR Vault are defined as follows.

Operation—Waste may be stored in process tanks temporarily. Interfacility or process-tank-to-process-tank waste transfers are authorized. Sumps-to-process-tank waste transfers are authorized. Routine operational and maintenance activities may be performed.

Limited—Waste may be stored in process tanks temporarily. Interfacility or process-tank-to-process-tank waste transfers are not authorized. Sumps-to-process-tank waste transfers are authorized. Routine operational and maintenance activities may be performed.

5.4.2 Minimum Staffing Levels

The minimum operations shift complement in the Operation and Limited modes is one shift manager/operational engineer, five nuclear operators, three radiological control technicians, and the Emergency Control Center staff. (Per agreement with DOE-Office of River Protection, the requirement for three radiological control technicians will be reevaluated as part of Phase 2 of the FSAR implementation. Only two radiological control technicians will be required until this issue is resolved.) This minimum staff in each mode is considered adequate to perform the minimum safety functions necessary to protect the health and safety of the public, onsite workers, facility workers, and the environment during normal operations and during abnormal and emergency conditions.

If (for unforseen reasons) this minimum staff is not maintained, the staff that remains is not considered adequate to perform tasks outside the defined set of mandatory surveillances and monitoring activities. Immediate action will be taken to restore staffing to minimum levels. Until staffing levels are returned to minimum levels, a reduction in the scope of operations will ensure protection of the health and safety of the public, onsite workers, facility workers, and the environment during normal operations and abnormal and emergency conditions.

Consideration is given to the human factors principles addressed in Chapter 13.0, "Human Factors," that guide day-to-day operations. The minimum staff is allowed to be shared with other TWRS facilities not in the FSAR scope for which facility or operation training was received and is not required to be at a specific facility or operation continuously. The shift manager/operational engineer is required to be qualified as a Building Emergency Director.

Determination of the minimum staff is based on ensuring that the following safety criteria are met:

- TSR compliance
- Emergency initial notification and initial response.

The minimum staff does not include individuals necessary to fulfill the TWRS mission, goals, and objectives or individuals necessary to meet all other safety, environmental, and Authorization Basis requirements and commitments.

Qualification training for the minimum staff (managers, engineers, operators, and radiological control technicians) is addressed in Chapter 12.0, "Procedures and Training." The program for TSR, emergency, and alarm response administrative procedures is also addressed in Chapter 12.0. Emergency response is addressed in Chapter 15.0, "Emergency Preparedness Program." The bases for determining the minimum staff are provided in the following paragraphs.

Normal Operations—The minimum staff during normal operations is necessary to (1) safely operate TWRS facilities, (2) perform frequent (less than 8 h) TSR surveillances of SSTs, DSTs, AWF tanks, DCRTs, 204-AR Waste Unloading Facility, 244-AR Vault, and waste transfer systems to ensure minimum TSR compliance, and (3) provide radiological control. Less frequent surveillances such as system calibrations and functional tests and AC program commitments are planned and scheduled to ensure TSR compliance. Additional staff is provided, as necessary, to operate, support, and maintain TWRS facilities safely.

Determination of the minimum staff during normal operations assumes the following are occurring: waste transfers (including salt well pumping), routine surveillances for TSR compliance, radiological control activities, limited field crew operations to support tank farm activities, and adequate staffing at computerized surveillance systems. A waste transfer is considered a low-to-moderate-difficulty task based on human factors. Multiple salt well pumping through a common line and submersible pumping are assumed to not be occurring with the minimum staff. Additional staff would be needed to perform frequent (less than 8 h) ground-level radiation surveys of single-walled, direct-buried, or bermed lines, or to perform flammable gas monitoring according to AC requirements.

A surveillance is considered a low-difficulty task based on human factors. Surveillances (primarily operator rounds) identified in the TSR document (HNF-SD-WM-TSR-006) that must be performed by the minimum staff during normal operations include the following:

- Verifications that systems are operable
- Verifications that ventilation system air flows are adequate
- Verifications that waste temperatures in SSTs, DSTs, and AWF tanks are within limits
- Verifications that transfer system covers and service water pressure detection systems are operable
- Verifications of facility conditions through routine radiation surveys.

The minimum staff is judged to be adequate during normal operations to perform necessary job functions.

Abnormal Conditions—The minimum staff during abnormal conditions is necessary to perform required actions specified in LCO action statements with completion times of "immediately" or less than 8 h to ensure TSR compliance. Additional staff could be provided within 8 h, if needed (considering the most adverse weather and travel conditions) to ensure that all LCO completion times are met. LCO completion times of "immediately" imply the highest sense of urgency and are given top priority over all other activities. The minimum staff is not given tasks that could interfere with meeting TSR requirements.

Determination of the minimum staff during abnormal conditions considers a loss of electrical distribution (blackout) in the 200 East and 200 West Areas as the most limiting situation regarding TSR compliance other than an emergency condition. Although tank farm history shows that electrical power outages are infrequent events, they can occur because of several different causes (Chapter 4.0). The situation considered for determination of the minimum staff is a 48-h blackout followed by a 24-h recovery period (i.e., 72 h to restore power and resume operations). Loss of electrical power requires multiple LCO action statements to be entered simultaneously. Tank farm electrical distribution is discussed in Chapter 4.0.

The Tank Farms manual, HNF-IP-1178, *Tank Farms Event Response Manual*, includes a procedure to address a potential loss of electrical power at the Tank Farms. The procedure, "Plant Casualty Plan No. 1 - Total Loss of Electrical Power," lists prioritized actions regarding personal protective actions, notifications, and the operation of back-up equipment during a loss of electrical power. This procedure provides specific steps that must be taken in accordance with, and consistent with, the TSR controls described in HNF-SD-WM-TSR-006.

The minimum staff is the same in Operation or Limited mode because the LCO action statements that must be entered in a loss of power event are applicable in both modes. Specific LCO required actions that would need to be performed immediately, or within 8 h depending on the LCO, with a minimum staff include the following:

- Stop waste transfers
- Stop operations and activities in affected tanks
- Place administrative locks on transfer pumps
- Verify operating conditions
- Restore systems
- Implement alternate monitoring methods
- Stop ventilation systems (upon high radiation levels)
- Deenergize equipment
- Open valves or remove blanks.

The minimum staff is judged to be adequate during abnormal conditions to perform necessary job functions.

Emergency Conditions—The minimum staff during emergency conditions is necessary to respond to the spectrum of accidents analyzed in Chapter 3.0. The minimum staff must make prompt initial notifications and implement initial protective actions to preclude or reduce the exposure of individuals affected by hazards or unsafe conditions during an emergency.

Specific functions that must be performed by the minimum staff in an emergency include the following:

- Classify events
- Make initial prompt notifications
- Implement alarm response, plant response, and emergency management procedures
- Perform administrative functions such as preparing occurrence reports
- Communicate facility status, and respond to questions
- Support the U.S. Department of Energy (DOE), Richland Operations Office (RL) Emergency Operations Center.

Determination of the minimum staff during an emergency considers a hypothetical situation where a seismic event occurs and causes multiple occurrences of spray leaks in valve pits, seismically induced gas release events, and deflagrations in waste tanks. Response to an emergency is considered a high-difficulty task.

The shift manager/operations engineer is the Building Emergency Director. The Building Emergency Director is primarily responsible for the event scene and protective actions at a TWRS facility. The Building Emergency Director also makes onsite notifications, implements emergency management procedures, implements facility emergency plans, classifies events, and controls event scenes. Five operators and three radiological control technicians are considered adequate to respond to an event scene and support actions requested by the Building Emergency Director, based on protective actions suggested in Chapter 15.0 for the hypothetical emergency situation. The Building Emergency Director requests support services, as necessary, to perform administrative functions and the minimum functions required to ensure the health and safety of the public, onsite workers, and the environment. The Emergency Operations Center staff performs various functions and normally responds to emergencies within 1 h of notification.

TWRS provides support to other Hanford Site facilities during emergencies. For emergencies occurring on back shifts, holidays, and weekends, the Emergency Operations Center may request a radiological control technician to provide temporary support at an event scene until on-call teams arrive. Additionally, the Hanford Fire Department may require a radiological control technician to assist in surveying their personnel for radiological contamination before leaving a nearby facility. The commitment for TWRS to provide support to other Hanford Site facilities during emergencies was considered when determining the minimum staffing level of three

radiological control technicians. Two radiological control technicians would be available to respond to an emergency at TWRS facilities and support actions requested by the TWRS Building Emergency Director. One radiological control technician would also be available to provide support, where needed, to the Building Emergency Director controlling the emergency at another facility.

The minimum staff is judged to be adequate to meet applicable emergency preparedness requirements.

5.5 TECHNICAL SAFETY REQUIREMENT DERIVATION

This section details type of control and derivation bases for the TSR document organized by control. This section can be used as an interface to link the accident analyses and the TSR controls. This section defines why controls were chosen and provides details about AC bases that are not discussed in the TSR document (HNF-SD-WM-TSR-006).

Table 5-3 outlines all applicable accidents for each control. Tables 5-1, 5-2, and 5-3 provide cross-references to controls or accident summaries. Table 5-1 maps TSR controls to analyzed accidents, Table 5-2 cross-references TSRs from FSAR chapters, and Table 5-3 maps TSRs to the analyzed accidents.

5.5.1 Type of Control Criteria

This section outlines the criteria for determining the level of control, such as determining when an AC is chosen rather than LCO control. Generalized criteria may be found in DOE orders. The following criteria, while considered to meet the generalized order criteria, reflect an interpretive base determined by coordination with other personnel who write TSR documents at other DOE Sites, a DOE-sponsored TSR control training course for writing TSR documents, contractor procedures, reactor standard technical specifications (NUREG 1431, *Standard Technical Specifications, Westinghouse Plants*), and Site expertise. The control-level verification process used for the TSRs to ensure compliance with DOE 5480.22 is documented in Washenfelder (1997).

5.5.1.1 Safety Limits/Limiting Control Settings. There is one Safety Limit for TWRS facilities. The Safety Limit was selected based on all of the following elements being met:

- A primary passive barrier failed (e.g., tank, piping).
- The passive barrier failure was the direct result of exceeding a process variable.
- The process variable is directly measurable, observable, and controllable by field personnel.

- Radiological or toxicological consequences without controls exceeded offsite risk guidelines.

Because a Safety Limit was identified based on the analyzed accidents, an LCS was also included. LCSs are normally setpoints on safety systems that control process variables to prevent exceeding Safety Limits. The specific setpoints are chosen such that if they are exceeded, sufficient time is available to automatically or manually correct the condition before exceeding Safety Limits. The LCSs are normally combined with their respective LCOs. By combining the LCSs with the LCOs, the LCS setpoint becomes part of the definition of the operability of the system. Safety is also enhanced by placing the applicability, actions, and surveillances for a system in a single location, which reduces the complexity of the TSR document.

The only LCS values in the TSR document are included in LCS/LCO 3.3.1, "SST Waste Temperature Controls," and LCS/LCO 3.3.2, "DST and AWF Tank Waste Temperature Controls." The LCSs/LCOs do not require operability of specific temperature monitoring instrumentation, but limit tank waste temperatures to protect the associated Safety Limit SL 2.1.1, "Waste Temperature." The Safety Limit provides assurance that tank waste temperatures remain below the threshold for a postulated "chemical runaway" reaction that causes bulk heatup of the waste. For this postulated accident (Section 3.4.2.6, "Organic Salt-Nitrate Reaction"), the LCSs/LCOs are not required, according to the analysis, to automatically actuate a protective action to protect the Safety Limit because exceedance of the LCSs/LCOs leaves the operator sufficient time to take manual protective actions to prevent exceeding the Safety Limit. Therefore, the LCSs/LCOs are placed on the parameter of temperature, instead of operability of specific temperature monitoring instrumentation. Several temperature monitoring systems are available to provide operators the information needed to verify waste temperature. Each system consists of a temperature-sensing device (e.g., thermocouple) and a temperature display system. Functional requirements of the temperature monitoring systems are discussed in Chapter 4.0, Sections 4.3.24 and 4.4.10. The systems are subject to traceable testing protocols as part of AC 5.19, "Process Instrumentation and Measuring and Test Equipment," to ensure reliable verification of waste temperature. The derivation of AC 5.19 is discussed in Section 5.5.33.

5.5.1.2 Limiting Conditions for Operation Versus Administrative Controls. Accidents/ hazards with risk exceeding offsite or onsite risk guidelines, which are not candidates for Safety Limits per the criteria listed above, are candidates for LCOs or ACs. Administrative Controls are considered as important to the control philosophy as LCOs; they are not treated as less meaningful controls for safety. An AC is selected rather than an LCO if the control is better managed by a program than a direct measurement and ensuing action. The following comparison identifies the process used in determining the proper type of control for reduction of risk. This approach is consistent with the guidance in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports,* which states: "The decision as to whether an operating limit (such as an LCO) or a TSR AC is more appropriate is left to the judgment of the SAR Preparer."

- **Parameter Measurement**

  LCO—A process parameter or hardware is available for measurement by field operating or maintenance personnel and is available in real-time or near to real-time.

  Administrative Control—The control involves several conditions required for the accident to occur, or requires an analysis of field parameters by engineering or management personnel, or involves a parameter obtainable only by physical sampling requiring analytical delay time, or no measurement equipment is available.

- **Control of Field Condition**

  LCO—Hazard/accident results solely from exceeding a physically monitored parameter (e.g., continuous air monitor [CAM] interlock actuation).

  Administrative Control—Hazard/accident does not occur as a result of exceeding a physically monitored parameter, but requires a combination of conditions to occur such as noncompliance with procedures, involvement of multiple organizations or personnel, or involves the corroboration of field information to protect accident analysis assumptions or programmatic deficiencies.

- **Response Action**

  LCO—Exceeding a specific parameter requires immediate actions by field personnel according to operating or maintenance procedures to reduce risk.

  Administrative Control—Exceeding a parameter or condition either requires no immediate applicable actions to reduce risk, or actions are complex requiring evaluation and possible further data gathering, or actions involve emergency response personnel for mitigation.

- **Surveillances**

  LCO—Equipment or instrumentation is required to monitor a specific parameter and it is appropriate to have surveillances to demonstrate operability.

  Administrative Control—Conditions leading to an accident either cannot be measured by instrumentation, or surveillance intervals can be long because the parameter of concern changes slowly, or a condition does not require immediate action and sufficient recovery time exists to permit response action.

- **Prior Control Method**

  LCO—Hazard is currently controlled by an LCO or is controlled by a lower-tiered control involving system(s) measurement and response.

  Administrative Control—Hazard is currently managed by an AC or other program.

5.5.1.3 Design Features. Safety SSCs are defined as Design Features rather than LCOs or ACs when their safety function is to maintain specific design criteria as assumed or implied in the safety analysis. Detailed discussion related to Design Features is located in the TSR document, HNF-SD-WM-TSR-006, Appendix B. Design Features are considered TSR controls and are managed with appropriate configuration and engineering control processes.

5.5.2 Safety Limit 2.1.1—Waste Temperature

5.5.2.1 Purpose. This Safety Limit on waste temperature provides protection against a postulated "chemical runaway" accident as discussed in Section 3.4.2.6, "Organic Salt-Nitrate Reaction." Based on the results of the analysis, the release of material without controls exceeds offsite and onsite radiological and toxicological risk guidelines. In this postulated accident scenario, the active tank ventilation is lost and the waste temperature increases because of radioactive decay heat until a sufficiently high temperature is reached that initiates a "runaway" chemical reaction. Past tank farm operating experience and experimental data indicate that significant chemical heating would not occur until temperatures significantly above the waste saturation temperature are reached. Until this chemical phenomenon and its threshold temperature are better understood and defined, this Safety Limit on waste temperature serves to prevent this postulated accident, thereby ensuring that the offsite and onsite consequences are within risk guidelines.

This control is closely associated with "SST Waste Temperature Controls" (LCS/LCO 3.3.1) and "DST and AWF Tank Waste Temperature Controls" (LCS/LCO 3.3.2).

5.5.2.2 Derivation Criteria. Waste temperature controls were selected because temperature is the parameter of concern, is under the control of operations, and is monitored with existing systems. In addition, implementation of temperature controls minimizes the need for modifications to administrative procedures because the process for monitoring temperatures is already a part of existing procedures. Temperature can be controlled by a variety of methods (e.g., ventilation, engineered heat removal, limiting activities in the tank). Temperature monitoring provides protection of the waste against the postulated phenomenon of organic salt-nitrate reactions initiated by bulk heat-up of the waste. Temperature control was already selected for the tank bump accident. Therefore, LCO temperature controls for tank bump serve as the LCS controls for "chemical runaway."

5.5.3 Limiting Condition for Operation 3.1.1—Transfer System Covers

5.5.3.1 Purpose. This control ensures transfer system cover operability (Section 5.5.3.2 for operability discussion) to minimize the transport of aerosols or liquids from surface pool and spray leak accidents within transfer-associated structures containing transfer piping. This control is closely associated with "Transfer Pump Administrative Lock Controls" (AC 5.20) and "Transfer System Cover Removal Controls" (AC 5.22). Because surface pools and spray leaks are less probable when their motive force is removed via administrative locks on pumps as outlined in AC 5.20, transfer system cover operability controls are relaxed (i.e., not applicable) under these conditions. Surface pools and spray leaks are likewise less likely when multiple isolation valves separate the transfer path and the structure of concern. In this situation, an alternate (and less stringent) control, as outlined in AC 5.22, is allowed in lieu of the transfer system cover control.

5.5.3.2 Derivation Criteria. This control was selected because it takes advantage of existing hardware. Transfer system covers are already an integral part of transfer structure design. In addition, implementation of this control minimizes the need for modifications to administrative procedures because the process for inspecting transfer system covers associated with planned transfers is already a part of existing procedures.

This control is unique for LCO application. Large passive structures such as cover blocks are normally reserved for Design Features or managed by ACs. Operability is usually defined for instrument systems or other active hardware as compared to the operability of cover blocks, which includes placement and proper fit. An LCO format for this control was chosen because the size of the transfer system covers and the ease of removal from their functional safety position can vary considerably. Specific and immediate actions, which are necessary to reduce the consequences of a potential surface pool or spray leak, are required upon finding a cover not in place or inadequately fitted to the opening.

5.5.4 Limiting Condition for Operation 3.1.2—Service Water Pressure Detection Systems

5.5.4.1 Purpose. This control ensures service water pressure detection system operability to allow transfer pump shutdown by interlock or operator response and thus minimize the transport of aerosols or liquids from surface pool or spray leak accidents where transfer system covers would not adequately prevent material transport. When active transfer pumps are not under administrative lock, a potential exists for an inadvertent pump start or misroute to the service water system if the intervening isolation valves are compromised. Ensuring that service water pressure detection systems are operable reduces the likelihood of waste entering the service water system, which could result in a spray leak or surface pool. This control is closely associated with the "Transfer Pump Administrative Lock Controls" (AC 5.20). Because surface pools and spray leaks are less probable when their motive force is removed via administrative locks on pumps as

outlined in AC 5.20, service water pressure detection system operability controls are relaxed (i.e., not applicable) under these conditions.

5.5.4.2 Derivation Criteria. This control was selected because it takes advantage of existing active hardware. Service water pressure detection systems are already an integral part of the transfer system-flush system interface.

5.5.5 Limiting Condition for Operation 3.1.3—Transfer Leak Detection Systems

5.5.5.1 Purpose. This control ensures transfer leak detection system operability to minimize the transport of liquids from pool accidents within transfer-associated structures containing transfer piping or where unencased piping failures may allow liquid transport into such structures. Transport of liquids is minimized by a combination of alarm and operator response to shut down associated transfer pumps, or alternatively by interlocks that directly shut down the associated transfer pumps, thus removing the motive force behind the leak and limiting further leakage. This control is closely associated with the "Transfer Pump Administrative Lock Controls" (AC 5.20). Because subsurface leaks and surface leaks are less probable when their motive force is removed via administrative locks on pumps as outlined within AC 5.20, transfer leak detection system operability controls are not applicable under these conditions.

5.5.5.2 Derivation Criteria. This control was selected because it takes advantage of existing active hardware. Transfer leak detection systems are already installed in all transfer-associated structures.

5.5.6 Limiting Condition for Operation 3.1.4—Ventilation Stack Continuous Air Monitor Interlock Systems

5.5.6.1 Purpose. This control ensures ventilation stack CAM interlock operability to minimize transport of contaminated particulates and aerosols by shutting down exhaust fans upon indication of high radiation in the exhaust air stream. A related control is "HEPA Filter Controls" (AC 5.18). This control requires verification that the high-efficiency particulate air (HEPA) filter and prefilter housing radiation levels are less than or equal to 200 mrem/h. This control protects a key accident analysis assumption used to calculate the quantity of waste material accumulated on the HEPA filters based on the radionuclide content, thereby limiting the inventory on the filters available for release.

5.5.6.2 Derivation Criteria. The ventilation stack CAM interlock systems were selected as the controls because the analysis with controls assumed the ventilation system shuts off within 10 min, thereby terminating the unfiltered release or spray within a tank. Human factor assumptions required an allowable operator response timing of 30 min; therefore it was necessary to rely on an automatic feature to terminate continued ventilation flow. The CAM interlock

provides that automatic response. This control directly measures the hazard (i.e., a release of radiological material) and is thus a good indicator of an accident.

5.5.7 Limiting Condition for Operation 3.2.1—Double-Shell Tank and Aging Waste Facility Tank Ventilation Systems

5.5.7.1 Purpose. This control ensures the operability of tank exhaust ventilation systems to minimize the accumulation of flammable gas constituents and thus reduces the likelihood of flammable gas deflagrations within storage tanks.

5.5.7.2 Derivation Criteria. This control was selected because the analysis took credit for an existing system that had demonstrated the necessary operational performance. Although the historical requirements related to active ventilation of the primary tanks were not established to control flammable gases, available gas sample results indicate that flammable gas concentrations in all sampled tanks are less than 5% of the Lower Flammability Limit (LFL). The control requires near constant operation of the exhausters for the primary tank ventilation system for DSTs and AWF tanks. Therefore, one of the key elements of the flammable gas control strategy is the use of currently installed active ventilation systems on the primary tanks to dilute and remove flammable gases that are continuously released from stored waste. The ventilation system is credited with preventing the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the accident.

5.5.8 Limiting Condition for Operation 3.2.2—Single-Shell Tank Ventilation Systems-Active

5.5.8.1 Purpose. This control ensures the operability of tank exhaust ventilation systems to minimize the accumulation of flammable gas constituents and thus reduces the likelihood of flammable gas deflagrations within storage tanks.

5.5.8.2 Derivation Criteria. This control was selected because the analysis took credit for an existing system that had demonstrated the necessary operational performance. Although the historical requirements related to active ventilation of the SSTs with active ventilation systems were not established to control flammable gases, available gas sample results indicate that flammable gases in all sampled tanks are at less than 5% of the LFL. This control requires near constant operation of the exhausters for the SSTs with active ventilation systems. Therefore, one of the key elements of the flammable gas control strategy is the use of currently installed active ventilation systems on the tanks to dilute and remove flammable gases that are continuously released from stored waste. The ventilation system is credited with preventing the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the accident.

5.5.9 Limiting Condition for Operation 3.2.3—Single-Shell Tank Ventilation Systems-Passive

5.5.9.1 Purpose. This control ensures the operability of tank ventilation flowpaths to minimize the accumulation of flammable gas constituents and thus reduces the likelihood of flammable gas deflagrations within tanks.

5.5.9.2 Derivation Criteria. This control was selected because the analysis took credit for an existing system that had demonstrated the necessary operational performance. Passive systems only maintain an open filtered ventilation flowpath without exhaust fans. One of the key elements of the flammable gas control strategy is the use of currently installed ventilation systems to dilute and remove flammable gases that are continuously released from stored waste. The ventilation system is credited with preventing the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the accident.

5.5.10 Limiting Condition for Operation 3.2.4—Double-Contained Receiver Tank Ventilation Systems

5.5.10.1 Purpose. This control ensures the operability of tank exhaust ventilation systems to minimize the accumulation of flammable gas constituents and thus reduces the likelihood of flammable gas deflagrations within tanks.

5.5.10.2 Derivation Criteria. This control was selected because the analysis took credit for an existing system that had demonstrated the necessary operational performance. One of the key elements of the flammable gas control strategy is the use of currently installed ventilation systems to dilute and remove flammable gases that are continuously released from stored waste. The ventilation system is credited with preventing the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the accident.

5.5.11 Limiting Condition for Operation 3.2.5—244-AR TK-002 Ventilation System

5.5.11.1 Purpose. This control ensures the operability of tank exhaust ventilation systems to minimize the accumulation of flammable gas constituents and thus reduce the likelihood of flammable gas deflagrations within the tank.

5.5.11.2 Derivation Criteria. This control was selected because the analysis took credit for an existing system that had demonstrated the necessary operational performance. One of the key elements of the flammable gas control strategy is the use of currently installed ventilation systems to dilute and remove flammable gases that are continuously released from stored waste. The ventilation system is credited with preventing the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the accident.

5.5.12 Limiting Condition for Operation 3.2.6—Primary Tank Leak Detection Systems

5.5.12.1 Purpose. This control ensures the operability of leak detection systems in DST and AWF tank annulus spaces to prevent a flammable gas deflagration in the annulus and minimize the transport of radioactive liquids from leaking vessels or piping.

5.5.12.2 Derivation Criteria. The primary tank leak detection systems were selected as the controls because they took credit for an existing system that had demonstrated the necessary operational performance. A primary tank leak detection system comprises a CAM that detects the presence of airborne radionuclides in the annulus ventilation exhaust stream or a conductivity probe leak detection system installed in the annulus between the primary and secondary tanks on DSTs and AWF tanks. A primary tank leak detection system will detect primary tank leakage as well as a waste transfer misrouting to the annulus.

5.5.13 Limiting Control Setting/Limiting Condition for Operation 3.3.1—Single-Shell Tank Waste Temperature Controls

5.5.13.1 Purpose. This control provides a control setting and ensuing operability requirements to minimize the transport of particulates and aerosols from organic nitrate reactions caused by uncontrolled waste temperature rise. The temperature limits and operability requirements also apply to SST waste temperature monitoring systems to minimize the transport of particulates and aerosols from tank bump reactions. The LCS and operability requirements for the two accidents are combined in a common LCO because the temperature limits reduce the likelihood of both accidents. Additional discussion of the LCS/LCO value and the temperature monitoring systems that are available to provide information on waste temperatures is provided in Section 5.5.1.1. This control is associated with "Transfer Controls" (AC 5.12). Transfer controls are imposed to ensure that transfers do not produce tank conditions conducive to a tank bump (i.e., high heat load and high sludge level).

5.5.13.2 Derivation Criteria. Waste temperature controls were selected because temperature is the parameter of concern, is under the control of operations, and is monitored with existing systems. In addition, implementation of temperature controls minimizes the need for modifications to administrative procedures because the process for monitoring temperatures is already a part of existing procedures. Temperature can be controlled by a variety of methods (e.g., ventilation, engineered heat removal, limiting activities in the tank).

5.5.14 Limiting Control Setting/Limiting Condition for Operation 3.3.2—Double-Shell Tank and Aging Waste Facility Tank Waste Temperature Controls

5.5.14.1 Purpose. This control provides a control setting and ensuing operability requirements to minimize the transport of particulates and aerosols from organic nitrate reactions caused by uncontrolled waste temperature rise. The temperature limits and operability requirements also apply to DST and AWF tank waste temperature monitoring systems to minimize the transport of particulates and aerosols from tank bump reactions. The LCS and operability requirements for both accidents are combined in a common LCO because the temperature limits reduce the likelihood of both accidents. Additional discussion of the LCS/LCO value and the temperature monitoring systems that are available to provide information on waste temperatures is provided in Section 5.5.1.1. This control is associated with "Transfer Controls" (AC 5.12). Transfer controls are imposed to ensure that transfers do not produce tank conditions conducive to a tank bump (i.e., high heat load and high sludge level).

5.5.14.2 Derivation Criteria. Waste temperature controls were selected because temperature is the parameter of concern, is under the control of operations, and is monitored with existing systems. In addition, implementation of temperature controls minimizes the need for modifications to administrative procedures because the process for monitoring temperatures is already a part of existing procedures. Temperature can be controlled by a variety of methods (e.g., ventilation, engineered heat removal, limiting activities in the tank).

5.5.15 Administrative Control 5.1—Purpose

5.5.15.1 Purpose. This section presents no ACs relative to the TWRS FSAR safety analysis, but is an introduction to the ACs section. This section is provided because it has been historically maintained in Operational Safety Requirements (OSR) documents and is familiar to the Operations organization.

5.5.16 Administrative Control 5.2—Contractor Responsibility

5.5.16.1 Purpose. This section presents no ACs relative to the TWRS FSAR safety analysis, but outlines contractor roles in managing the safe operation of TWRS facilities. This section is provided because it has been historically maintained in OSR documents, and is familiar to the Operations organization.

5.5.17 Administrative Control 5.3—Compliance

5.5.17.1 Purpose. This section presents no ACs relative to the TWRS FSAR safety analysis but outlines the tank farm operating contractor role in ensuring TSR compliance. This section is

provided because it has been historically maintained in OSRs documents, and is familiar to the Operations organization.

5.5.18 Administrative Control 5.4—Technical Safety Requirement Violations

5.5.18.1 Purpose. This section presents no ACs relative to the TWRS FSAR safety analysis but satisfies requirements outlined in DOE 5480.22, Section 9.e.(5).

5.5.19 Administrative Control 5.5—Occurrence Reporting

5.5.19.1 Purpose. This section presents no ACs relative to the TWRS FSAR safety analysis but satisfies requirements outlined in DOE 5480.22, Section 9.e.(5).

5.5.20 Administrative Control 5.6—Organization

5.5.20.1 Purpose. This section presents no ACs relative to the TWRS FSAR safety analysis but satisfies requirements outlined in DOE 5480.22, Section 9.e.(5).

5.5.21 Administrative Control 5.7—Nuclear Criticality Safety

5.5.21.1 Purpose. This control protects the accident analysis assumptions of the nuclear criticality accident in Section 3.3.2.4.1, "Nuclear Criticality." The bounding nuclear criticality accident did not exceed onsite or offsite risk guidelines. The hypothetical accident analysis did, however, identify assumptions. The controls protect these assumptions.

5.5.21.2 Derivation Criteria. Several key assumptions were noted in the accident analysis. The controls included in the TSR limit key verifiable parameters to values necessary to protect the analysis assumptions, specifically alkalinity and plutonium concentration. An AC was appropriate because the controls apply to transfers from outside TWRS into TWRS and are not under the direct control of TWRS. The nuclear criticality safety controls are verified prior to a transfer. If any sample results are above the limits, then the transfer is not allowed. Pretransfer controls also involve material sampling and engineering analysis and are not related to any specific instrument readout under the direct control of the tank farm operators.

A nuclear criticality safety program is also required per DOE 5480.22, Section 9.e.(5) as one of the standard ACs. This control meets the intent of that requirement.

5.5.21.3 Key Element Bases. The key elements within this control apply to either the requirement for a nuclear criticality safety program per DOE 5480.22, or serve to protect accident analysis assumptions. Key elements (a), (b), and (c) apply to the requirement for establishing a

criticality safety program. These key elements were included in past OSRs and are already well implemented. Key element (d) applies controls to protect the transfer assumptions. The two main items here are alkalinity and plutonium concentration. The neutron absorber ratio and independent verification subelements are added controls representing the double-contingency approach for criticality safety, while sample analysis or calculation options allow Operations flexibility. The subelement prohibiting activities in miscellaneous inactive storage facilities is added because, while it is assumed that they contain mass levels below critical values, insufficient sample data exists for verification of the assumption.

5.5.22 Administrative Control 5.8—Source Inventory Controls

5.5.22.1 Purpose. This control protects source term assumptions in the 204-AR Waste Unloading Facility accident analyses and generalized source term assumptions used in every accident analysis.

5.5.22.2 Derivation Criteria. Because the accident results did not require mitigation, only controls that specifically addressed the analysis assumptions were examined. The packaging and shipping safety analyses were specifically reviewed in the analysis and thus were logical choices for this control. An AC is practical for this control because it involves sampling and analysis for verification of compliance, review of shipping records, interfaces with the waste characterization program, and links to other safety analyses, which include numerous shipment options.

5.5.22.3 Key Element Bases. Key element (a) details an assumption not linked to any specific accident but protects the generalized source term assumptions used in every accident analysis. Key element (b) includes three controls to be verified before accepting waste at the 204-AR Waste Unloading Facility: (1) tank trailer waste receipts from the 222-S Laboratory shall conform to the container, volume, radioactive loading, and AC criteria established by WHC-SD-TP-SEP-011, *Safety Evaluation for Packaging for the 222-S Laboratory Cargo Tank*, and in accordance with 49 CFR 173.403, "Definitions"; 49 CFR 173.425, "Transport Requirements for Low Specific Activity (LSA) Radioactive Materials"; and 49 CFR 173.435, "Table of A_1 and A_2 Values for Radionuclides"; (2) railcar waste receipts shall conform to the container, volume, radioactive loading, and AC criteria established by WHC-SD-RE-SAP-013, *Safety Analysis Report for Packaging, Railroad Liquid Waste Tank Cars*; and (3) waste receipts shall be nonflammable and thermally stable. Key element (b) reflects those controls necessary to protect the key accident analysis assumptions for the limits on railcar and tank trailer radionuclide content. The controls also protect accident analysis assumptions regarding the thermal stability and nonflammability of the wastes received at the 204-AR Waste Unloading Facility.

5.5.23 Administrative Control 5.9—Flammability Controls

5.5.23.1 Purpose. This control is derived from the flammable gas deflagrations accidents. Maintaining the flammability controls in conjunction with the "DST and AWF Tank Ventilation Systems" (LCO 3.2.1), "SST Ventilation Systems - Active" (LCO 3.2.2), "SST Ventilation

Systems - Passive" (LCO 3.2.3), "DCRT Ventilation Systems" (LCO 3.2.4), "244-AR TK-002 Ventilation System" (LCO 3.2.5), "Primary Tank Leak Detection Systems" (LCO 3.2.6), "Ignition Controls" (AC 5.10), and "Flammable Gas Monitoring Controls" (AC 5.11) ensures that flammable gas hazards are managed to reduce the risk of a deflagration.

5.5.23.2 Derivation Criteria. Because of the varied number and type of controls, an ACs methodology was selected as the best form for these elements. The administrative program for flammability controls is credited in the reduction of likelihood of a flammable gas deflagration. The Tank 241-SY-101 controls incorporated existing controls that have already been implemented. Although consequences were not reduced below risk guidelines, these controls contribute to a reduction in accident likelihood, thereby minimizing the potential for a flammable gas deflagration event.

5.5.23.3 Key Element Bases. Key element (a) establishes controls for the operation of flammable gas mitigation equipment (e.g., mixer pump operation) in Tank 241-SY-101. These controls include the Level I requirements of Chapter 6.0 of the mixer pump safety assessment (LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*). Controls are also established for the removal of the mixer pump from Tank 241-SY-101 to minimize the risk of a flammable gas deflagration. The mixer pump flammability controls apply to Tank 241-SY-101 and the installed mixer pump. Operation of the mixer pump and controls for removal of the mixer pump are also credited in decreasing the likelihood of a potential flammable gas deflagration. The operation of the mixer pump induces small gas release events resulting in flammable gas concentrations in the headspace that are well below the LFL.

Key element (b) provides a table that identifies the flammable gas Facility Group assignments per current strategy and is not directly related to the safety analysis.

5.5.24 Administrative Control 5.10—Ignition Controls

5.5.24.1 Purpose. This control provides ignition controls to be applied across the tank farm complex to minimize the risk of fire or deflagrations from varied flammable gas sources.

5.5.24.2 Derivation Criteria. Because of the number and variety of administrative-type controls required for the varied accidents, an AC methodology was chosen. The administrative program to control ignition sources is credited primarily in decreasing likelihood of the accident scenarios for which the control was selected. In the majority of cases frequency was reduced such that the associated consequences were also below the risk guidelines. Controls were selected to adhere as closely as possible to current operating practices and were chosen because of adequate reliability for the desired result.

5.5.24.3 Key Element Bases. Key element (a) includes four controls selected to minimize the risk of transmitting sparks into tank areas where high accumulations of flammable gas may occur or there is a risk of organic solvent fires or organic salt-nitrate reactions. This control identifies

lightning as a source when detected within a 48-km (30-mi) radius of the tank farm. The 48-km (30-mi) radius was selected based on the speed of thunderstorm fronts in the Hanford Site area and estimation of job stoppage/take-down time. Chapter 1.0, Section 1.4.1.1.3, discusses thunderstorm action and storm front speeds of 32 to 40 km/h (20 to 25 m/h). The average stoppage or take-down time for intrusive activities in TWRS is 1 h, including notification. The 48-km (30-mi) limit allows adequate time for responding to moving thunderstorm fronts. For the intrusive controls for flame cutting, welding, and installing equipment with hot filaments, the main objective is to prevent foreign objects with sufficient thermal energy from causing an ignition within the tanks. This is accomplished by establishing a barrier between the activity and the waste surface. The requirement for written authorization by the Project Hanford Management Contract Team president to conduct flame cutting/welding in a tank with a potential organic solvent or organic salt-nitrate hazard was added according to RL direction.

Key element (b) includes vehicle controls to prevent a fuel source from entering a tank structure and an ignition of the fuel resulting in the release of radiological or toxicological material from the tank structures.

Key element (c) identifies ignition source control as one of the three aspects of the flammable gas control strategy, which also includes ventilation controls and flammable gas monitoring. In the event that flammable gas concentrations accumulate above 25% of the LFL, the primary defense against the flammable gas hazard is the strict control of ignition sources. While such controls cannot eliminate all possible ignition sources, the controls selected meet the intent of industry standards while allowing continued tank farm operations. The ignition source controls are applied to equipment installed or used during work activities in tanks on a graded basis depending on the potential flammable gas hazard associated with the structure. The equipment requirements are treated as design specifications. Because it is not possible to postulate every situation or application, the ignition source control also requires the maintenance of a Flammable Gas Equipment Advisory Board to review and approve deviations to ignition source controls as necessary. These controls are not derived from the accident analysis but are based on current control strategy.

5.5.25 Administrative Control 5.11—Flammable Gas Monitoring Controls

5.5.25.1 Purpose. Gas monitoring controls are applied across the tank farm complex to minimize the risk of producing sparks in known concentrated accumulations of highly flammable gas to prevent a deflagration.

5.5.25.2 Derivation Criteria. The control represents best-practice activities currently in progress in the tank farms and are controlled by several administrative procedures. Thus an AC was chosen as the best format for these control elements. The administrative program for flammable gas monitoring is credited in decreasing the frequency of the flammable gas deflagration scenario.

5.5.25.3 Key Element Bases. Key elements (a), (b), and (c) establish manned work activity controls, unmanned operations controls, and controls for nongas release facility events, respectively. These key elements represent detailed ignition control methodologies established from site experience and from engineering evaluations of national codes. Specific actions are detailed within these program key elements to provide prescriptive direction to the field. This detail, not normally seen in an AC, is added (1) because the potential significant consequences of the flammable gas deflagration accident have not been controlled below risk guidelines, (2) because much uncertainty still exists in deflagration/detonation scenarios, and (3) to ensure facility worker protection.

Key element (d) details controls to maintain DCRT flammable gas concentration $\leq$ 25% of the LFL before placing new waste types from a new waste source in the receiver tank. New waste types are defined as waste originating from different tanks or waste-generating facilities other than those that have been evaluated for flammable gas generation in the DCRTs. This control protects a key assumption associated with DCRTs. The analysis of DCRTs involved accident consequences that depend on parametric variation of tank level, temperature, source term, and length of waste holdup. Because each parameter is affected by the other, a program was defined to ensure DCRT contents are within the analyzed flammable gas generation rates.

5.5.26 Administrative Control 5.12—Transfer Controls

5.5.26.1 Purpose. This control reduces the risk of radiological and toxicological material being released from confinement systems during waste storage and transfer operations.

Maintaining the transfer controls in conjunction with "Transfer Leak Detection Systems" (LCO 3.1.3), "Encasement Seal Loop Controls" (AC 5.13), and "Transfer Pump Administrative Lock Controls" (AC 5.20), provides protection for the facility worker and is a significant Defense-in-Depth control. The transfer controls key elements relied upon include (a) transfer system configuration management, (b) operating requirements, and (c) waste compatibility controls.

5.5.26.2 Derivation Criteria. The controls represent best-practice activities currently in progress in the TWRS facilities that are controlled by several administrative procedures. Thus an AC was chosen as the best format for these control elements. The transfer controls were selected to reduce consequences below risk guidelines where possible, reflect current operational practices, protect the analysis assumptions, and use existing systems to the maximum extent practical.

5.5.26.3 Key Element Bases. Key element (a) includes 10 transfer system configuration management controls that minimize the potential for a misrouting, facilitate the detection of leakage, provide mitigation for spray leaks, and protect analysis assumptions, as applicable: configuration management, approved procedures, double valve isolation on interconnected lines, independent route verification, use of concrete shielding systems or vehicle restrictions around

overground transfer lines, aboveground labeling of direct-buried piping, caps/blanks on open nozzles, newly installed jumper leak testing, 204-AR Waste Unloading Facility door controls, and AWF tank waste transfer limitations.

Configuration management of transfer routes, double valve isolation on interconnecting transfer lines, and independent verification of transfer routes prior to initiating transfers minimize the potential for misroutes into transfer-associated structures, waste storage tanks, service water systems, or interfacing facilities where waste could overflow to the ground surface. Material balances provide additional indication of an equipment leak or provide indication that waste is being misrouted. Monitoring of the interconnected tanks provides indication of waste misroutes into tanks, or waste leaks into transfer-associated structures that drain to those tanks.

Performing waste transfers by approved procedures ensures control and discipline of transfer operations. The use of procedures is an implicit assumption in the analyzed transfer system accidents to minimize risks to the public, onsite workers, and facility workers. Additional discussion of procedures is provided in the programmatic chapters.

The control to ensure use of the overground transfer line concrete shielding system or vehicle restrictions around overground transfer lines is necessary to protect the overground transfer lines from damage caused by vehicle impacts. The overground transfer line concrete shielding system must withstand credible vehicle impacts.

Permanent aboveground labeling of single-walled direct buried/bermed waste transfer lines outside of the tank farm boundaries supports required ground-level radiation surveys to facilitate the detection of transfer line leakage.

The control to ensure nozzles are capped when not in use is necessary to prevent potential high flow rate leaks through open nozzles. High flow rate leaks can result in pit overflows in less than the 30-min operator response time assumed in the analysis to manually shut off the transfer pump after the pit leak detector alarm activates.

Leak testing of newly installed jumpers prior to use ensures proper installation to prevent misalignment of the jumper, or prevent the jumper from falling off during a transfer, resulting in a leak.

Verifying that the west exterior rollup door and the west exterior personnel access door are closed during waste transfers physically connected to the 204-AR Waste Unloading Facility ensures that the doors are closed to mitigate the effects of potential spray leaks inside the unloading area of the building.

AWF tank waste transfer limitations, which prevent the transfer of AWF tank liquids and solids through DST waste transfer-associated structures, protect a key assumption in the spray leak analysis. In the accident analysis with controls, the accident was analyzed for two cases. The first case involved the transfer of AWF liquids/solids through the largest AWF waste transfer-associated structure and the second case was performed to address the transfer of DST

liquids/solids through the largest DST waste transfer-associated structure. The transfer of AWF liquids/solids through the largest DST waste transfer-associated structure has been shown to exceed the risk guidelines. Hence, the need to control the risk associated with this accident by ensuring that AWF liquids/solids are transferred only through AWF waste transfer-associated structures. (Note that implementation of this AWF transfer control has been deferred until March 30, 2000 [Allen 1999b].)

Key element (b) includes eight operating requirements that ensure timely detection of leakage and minimize the potential for tank and transfer-associated structure overflows. Key element (b) ensures that material balance monitoring criteria are documented based on planned transfer rates. Key element (b) also requires a material balance during waste transfers and monitoring the interconnected tanks on the transfer route to identify discrepancies in the amount of material transferred which indicates a potential leak or misrouting. Performing the material balance calculation and tank level monitoring at 30 min and 60 min following waste transfer initiation will help identify if a misroute is occurring because of a misalignment or if there is leakage from the transfer system. Performing the material balance calculation and tank level monitoring every 2 h thereafter until the transfer is complete is based on current operating practices with sufficiently short intervals to detect any leakage so that actions can be taken to stop and contain the leakage should the preventive controls fail.

Performing ground-level radiation surveys of any single-walled, direct-buried/bermed lines that are part of the waste transfer route every 12 h during salt well pumping (maximum of 15 L/min [4 gal/min]), and every 30 min during submersible pumping (maximum of 189 L/min [50 gal/min]) facilitates early detection of leakage so that actions can be taken to mitigate the consequences to the worker. The frequencies are based on the pumping rates and amount of radiological material source term that approaches the risk guidelines. Because the frequency of the surveys is dependent on the pumping rate, a note was included that decreases the surveillance interval for multiple salt well pumping through a common line. The radiation surveys shall be performed at an increased frequency, for pumping of multiple salt wells. The frequency would be two salt wells (maximum of 30 L/min [8 gal/min]) every 6 h, three salt wells (maximum of 45 L/min [12 gal/min]) every 4 h, four salt wells (maximum of 61 L/min [16 gal/min]) every 3 h, and five salt wells (maximum of 76 L/min [20 gal/min]) every 2 h.

A basic assumption in the analysis is that transfers into SSTs are not permitted (exclusive of flushing). This general control is included in the transfer controls.

Verifying that physically connected catch tanks not in the direct transfer route are less than 50% full prior to waste transfer minimizes the potential for generation of a surface pool. With waste levels less than 50% in physically connected catch tanks, space is ensured to be available in the catch tanks to contain potential waste leaks, misroutes, and line drainbacks. This 50% value was qualitatively derived during the control selection process and does not ensure prevention of catch tank overflow.

Verifying that the pit floor drains are open on the cross-site transfer route prevents a transfer-associated structure overflow that may be associated with a misrouting. This control is

necessary because the line holdup in the cross-site transfer line is large enough to potentially overflow several of the pits even if the transfer pump is shut off shortly after the pit leak detectors are activated.

Cross reference to AC 5.17, "Excavation Controls," is provided to emphasize the requirements to coordinate excavation activities in areas of waste transfers to minimize the potential for waste leakage to the surface from an excavation accident.

Key element (c) includes four waste compatibility controls. Final tank state controls evaluate planned transfers to ensure that controls for criticality, tank bumps, flammable gas deflagrations, organic solvent fires, and organic salt-nitrate reactions are applied to the final state of the tank (i.e., prevent hazards from becoming applicable to new tanks). Cross reference to AC 5.15, "Moisture Controls," is provided to emphasize the requirements to prevent removal of moisture that protects wastes from potential propagating organic salt-nitrate reactions. Chemical compatibility controls evaluate planned transfers from process facilities to DCRTs 244-S, 244-TX, and 244-A to verify that only compatible material is transferred, which prevents an energetic chemical reaction (i.e., heat generation from acid/base reactions) from occurring that will release waste through the operating ventilation system. These controls are also applicable for transfers into DSTs via a tank truck and the 204-AR Waste Unloading Facility (AC 5.7 also has pH controls). Transfer controls also evaluate organic solvent transfers, to avoid transfers to nonorganic tanks unless necessary. This restriction prevents the organic solvent fire potential from becoming applicable to new tanks. Transfer controls also ensure that transfers do not produce conditions in a tank (e.g., high heat load) and high sludge level such that, if tank cooling was inoperable, a potential to create an organic salt-nitrate reaction or tank bump before the cooling is restored.

Verifying, prior to waste transfers or additions into DSTs and AWF tanks, that the time to reach 25% of the LFL remains ≥7 days protects requirements and assumptions of LCO 3.2.1, "DST and AWF Tank Ventilation Systems," and Surveillance Requirement 3.2.1.1. The steady-state flammable gas concentration and time to reach 25% of the LFL is impacted by both the gas generation rate and the gas accumulation rate in the tank vapor space. The gas generation rate is impacted by changes in tank chemistry, temperature, and waste volume. The gas accumulation rate is impacted by the tank ventilation rate and natural breathing rate.

The Surveillance Requirement 3.2.1.1 specifies a 24-h frequency for verifying that the active primary tank ventilation system is operable and operating in DSTs and AWF tanks. The surveillance frequency establishes a conservative margin to the predicted 7 days required to reach 25% of the LFL for Tank 241-SY-101, as analyzed in calculation note HNF-SD-WM-CN-117, *Calculations of Hydrogen Release Rate at Steady State for Double-Shell Tanks*. This allows for time to detect ventilation system outages and to take appropriate actions per LCO 3.2.1 before flammable gas concentration exceeds 25% of the LFL in the tank vapor space. The minimum 7 day time to reach 25% of the LFL requirement is based on Tank 241-SY-101 and is considered bounding for all other DSTs and AWF tanks. The methodology for calculating gas generation rates and time to reach 25% of the LFL is detailed in the calculation note, HNF-SD-WM-CN-117.

For DCRTs, verifying prior to any waste transfers or additions that the maximum flammable gas concentration in the DCRT vapor space remains ≤25% of the LFL (based on the proposed fill rate, waste level, changes to the waste characteristics, and the known ventilation rate [air flow through dip-tubes]), protects the assumptions defined in calculation note HNF-SD-WM-CN-118, *Calculation of Flammable Gas Mixtures in Double-Contained Receiver Tanks*. The flammable gas concentration in a DCRT vapor space is dependent on the vapor space volume (tank headspace), release of dissolved gases, amount of gas generated, and the gas accumulation rate. The DCRT vapor space volume is inversely proportional to the tank fill level. The potential for release of dissolved gases is dependent on the DCRT fill rate. The gas accumulation rate is dependent on the ventilation rate and the tank natural breathing rate. The gas generation rate is dependent on the waste characteristics that affect gas generation because of tank corrosion, radiolysis in the waste, and the thermal degradation of organics.

5.5.27 Administrative Control 5.13—Encasement Seal Loop Controls

5.5.27.1 Purpose. This control reduces the consequences of a leak in the primary piping by ensuring that material is directed into the pit and then activates transfer leak detection to protect accident assumptions.

5.5.27.2 Derivation Criteria. Leak detection, cover blocks, and transfer controls are the primary controls for the noted accidents. This control is specific because it protects a key assumption of plant configuration in the analysis, namely that leaked material can be detected before the encasement is pressurized.

5.5.27.3 Key Element Bases. The key element for the encasement seal loop controls ensures that, during waste transfer through a waste transfer system, all encasement seal loop drain line isolation valves associated with physically connected piping will provide an open drain path. The single key element acknowledges that various plant configurations exist to ensure that leaked waste from the primary line will flow from encasements into pits. Ensuring that leaked waste will flow to pits allows for detection in the waste transfer-associated structure so that action can be taken to terminate the leak to decrease the consequences of the leak.

5.5.28 Administrative Control 5.14—Emergency Preparedness

5.5.28.1 Purpose. This control ensures that proper management systems are used to manage radiological or toxicological releases from pool leak, spray leak, organic salt-nitrate reaction, fire in contaminated area, sodium fire, organic solvent fire, and flammable gas deflagration accidents, as well as accidents caused by natural phenomena.

5.5.28.2 Derivation Criteria. The subsurface leak resulting in pool accident takes credit for moving personnel away from the pool. This activity is a programmatic response rather than an operator-directed event. The activity involves the coordination of several operational

organizations and maintenance crafts, thus making emergency preparedness a logical programmatic control.

This control is also applied to those accidents where site conditions and controls degrade. Fire is an example of an accident where emergency responses activate facility worker protection controls (e.g., safety equipment) and protect site personnel through firefighting and evacuation procedures. This control was selected for all of the fire-related accidents because in a fire event it is necessary to protect personnel before attempting to determine the cause of the event and subsequent actions. Likewise for surface pools and organic salt-nitrate reactions, this control helps isolate personnel to minimize exposures to radiological and toxicological material. Lastly, this control requires the development of responses to earthquakes that produce indeterminate damage and earthquakes that disrupt normal communications and safety controls, thus ensuring proper protection of personnel, property, and the public.

5.5.28.3 Key Element Bases. There are no quantitative safety analysis requirements for emergency response. The key elements of this control represent best management practices for current systems.

Key element (a) is a generic program description of emergency response activities and addresses the following elements: Emergency Response Organization (ERO), notification, emergency event assessment, protective actions, medical support, recovery, emergency equipment, training, drills and exercises, and program administration.

Key element (b) requires the evaluation of seismic information sources because detection equipment is not available. Graded-approach procedures are required because earthquake consequences are extremely varied. Emergency-response plans for a seismic event shall include the following: (1) identification of the seismic event detection method used to initiate response procedure actions (e.g., 200 Areas seismic monitor, notification from external source), (2) response procedures based on the magnitude of the seismic event to protect the offsite public, onsite worker, and facility worker (e.g., facility inspections, transfer termination, intrusive activity termination, ventilation system evaluation of required functionality, site evacuation), and (3) a recovery plan to address restart of services and equipment. These controls provide for mitigative actions to control potential releases by terminating transfers, provide for surveillance and recovery actions, and provide means to evaluate the ability of safety SSCs to meet their safety function following a seismic event. These controls manage the risk of uncontrolled releases of radiological and toxicological material, caused by an earthquake and limit direct risk of exposures to facility workers.

Key element (c) provides a generic control description for ensuring a proper fire protection program. Because emergency responses to fires was an original Defense-in-Depth item not quantified in the analysis, specific response details (e.g., number of fire trucks needed onsite) are not warranted. The emergency response plans for a fire include response procedures based on the type, location, and size of the fire to protect the offsite public, onsite worker, and facility worker (e.g., firefighting coverage and response, limitations on TWRS activities, site evacuation). Although credit for the control was not quantified in the analysis, emergency response plans for a

fire would mitigate the consequences of a fire in a contaminated area if one occurred. These controls are used in conjunction with the program for fire protection required by AC 5.24, "Safety Management Programs."

Key element (d) has been developed to protect assumptions in the analysis of the main accident requiring this control for mitigation, which is the subsurface leak resulting in pool. The response details represent the conservative logic of removing personnel from the hazard prior to full waste pool assessment. This minimizes exposure to site and facility workers. Emergency response plans for a waste leak shall include response procedures with a graded approach based on the magnitude of the leak to protect the offsite public, onsite worker, and facility worker (e.g., transfer termination, leakage containment and removal, and site evacuation).

Key element (e) requires verification of safety SSCs for degradation of design criteria parameters that are credited in the analyses following significant, relevant, natural phenomena events (e.g., high winds). This control protects the 2727-W Building design features credited in the sodium fire accident analyses. This control ensures the 2727-W Building structural integrity and foundation height, thereby preserving the capability to withstand high winds and vehicle collisions and protect the stored sodium tanks. This control prevents a sodium fire and decreases the likelihood of the sodium fire accident.

5.5.29 Administrative Control 5.15—Moisture Controls

5.5.29.1 Purpose. These controls reduce the probability of conditions necessary to support a propagating organic salt-nitrate reaction. This control is closely associated with "Transfer Controls" (AC 5.12). Waste compatibility controls require an evaluation of the planned final state of a pumped tank before a waste transfer to ensure safety criteria for moisture are met. This control is also associated with "Ignition Controls" (AC 5.10). Ignition controls are imposed to minimize initiators with sufficient energy to ignite the waste and cause an organic salt-nitrate reaction.

5.5.29.2 Derivation Criteria. Moisture controls were selected because if the waste in a tank contains ≥20% water, the waste cannot sustain a propagating reaction. Moisture controls are administrative. Currently no moisture measurement instruments are installed in the tanks; therefore, moisture is not measured in real-time. Moisture in the waste is a variable that changes slowly under storage conditions. A change in moisture is normally not a time-dependent situation, and sufficient time is available for periodic verifications that moisture concentrations still meet the safety criteria. However, moisture may not always be under the immediate control of tank farm operations (e.g., tank leak). In addition, fuel and nitrate/nitrite oxidizer concentrations in tank wastes are not variables that can be controlled during interim storage of waste in the tanks. The fuel and oxidizer are present in the wastes and are not under the control of tank farm operations. Therefore, moisture is the preferred variable to control.

5.5.29.3 Key Element Bases. Key element (a) provides controls for interim stabilization activities to ensure that the organic salt-nitrate safety criteria based on the combination of total

organic carbon and moisture are met. The analysis assumes that waste that exceeds the safety criteria will burn. That is, wastes with total organic carbon and moisture estimates that exceed the safety criteria are assumed to support a propagating combustion reaction. This key element requires sampling and engineering analysis of total organic carbon and moisture.

Key elements (b), (c), and (d) for emergency pumping, moisture monitoring, and ventilation system changes have been developed to protect accident analysis assumptions and involve a variety of procedural operations by personnel other than operators. The cumulative time limit described in key element (d) for temporary active ventilation on passively ventilated tanks is derived from the noted accident analysis. Some tank farm operations may include the use of a portable exhauster. The effect of portable exhauster operation was evaluated in WHC-SD-WM-SARR-033, *Preliminary Safety Criteria For Organic Watch List Tanks at the Hanford Site*. It is shown that occasional use cannot significantly impact the moisture loss rate of a tank. Operation for several weeks removes only a trivial amount of moisture. The significant effect of portable exhauster operations on waste moisture would be possible drying from increased ventilation flow rates.

5.5.30 Administrative Control 5.16—Dome Loading Controls

5.5.30.1 Purpose. This control ensures that suspended loads are not dropped in tank pits which result in the release of contaminated particulates and provides Defense-in-Depth for ensuring that tank structures are not compromised from excessive loads.

5.5.30.2 Derivation Criteria. The controlling of lifted loads was detailed as an AC because of the following reasons:

- There are various methodologies that can be used for controlling lifting operations.
- There is the need to restrict any lifting activities over certain underground tanks.
- Several parameters must be controlled to ensure lifting activities remain within the Authorization Basis.
- Exceeding a lift height of 6 m (20 ft) does not cause the accident that was evaluated.
- Conservatisms present in the accident analysis would likely mitigate the consequences of the accident below levels that were calculated for the accident without controls.

This control is consistent with several of the criteria noted in Section 5.3.2, "Criteria," and was chosen because of its minimal impact on daily operational activities.

The dome loading controls are only a subset of potential load controls. The dome load controls were elevated to TSR status because they are significant to Defense-in-Depth. For example, there are no controls on snow or ash loading because these were noted in the analysis as

being insignificant. Of great value for the analysis, however, is the requirement for baselining and managing changing loads. This detail protects the assumptions of the analysis.

5.5.30.3 Key Element Bases. Key element (a) requires that, for mechanical lifts within 6 m (20 ft) of underground storage tanks, the lower equipment boundary of the lifted item (e.g., bottom of the cover block, thermocouple tree) shall be less than 6 m (20 ft) above surface grade, or pit floor above a waste storage tank (covered or uncovered). Mechanical lifts traveling over a miscellaneous inactive storage facility are not allowed. This control is applicable for SSTs (100 Series), DSTs, and AWF tanks. Key element (b) requires that DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*, controls be used for critical lifts. Key elements (a) and (b) represent the controls to ensure that lifted loads do not puncture pit floors/tank domes. The 6-m (20-ft) restriction is based on analysis of lifts with the largest cover blocks and bounds worst-case operating conditions. The controls limit load handling over a tank so that in the event a load is dropped, the tank dome will not collapse. These controls will decrease the likelihood of the load drop accident. This data is detailed in the accident analysis section and respective calculations for the controls, Section 3.4.2.1, "Tank Failure Due to Excessive Loads," accident.

Key element (c) establishes a dome loading program that manages soil and concentrated load baselines above waste storage tanks. The values here represent current existing dome loading control values and are not representative of a quantitative analysis. The values were subjectively agreed upon as prudent and conservative values consistent with operational limits within current ACs.

5.5.31 Administrative Control 5.17—Excavation Controls

5.5.31.1 Purpose. This control was developed to minimize transport of radiological or toxicological material from sprays or pools while excavating piping systems during a transfer. In addition, the excavation controls reduce the likelihood of inadvertently intruding into any structure potentially containing flammable gas.

5.5.31.2 Derivation Criteria. The control represents a broad selection of current operational activities to cover the varied contingencies during excavation activities. The control does not solely rely upon an excavation permit process because transfers could be initiated after proper completion of permitting. These activities involve a variety of field personnel and include several activities prior to actual excavation, thus qualifying this control as administrative.

5.5.31.3 Key Element Bases. Key elements (a) through (e) outline excavation activity controls to prevent damage to waste transfer lines that can result in leaks. The effective implementation of these controls should ensure that excavation activities are not inadvertently performed near waste transfer lines during waste transfers and that excavation activities are carefully controlled when required near waste transfer lines. The controls also prohibit transfers through waste transfer lines that are uncovered by excavation activities that could cause worker radiation doses to exceed limits established by the radiation protection program. The controls also serve to mitigate waste transfer leaks caused by excavation activities by requiring prompt shutdown of the waste

transfer pump. The key elements represent current field protocols derived from lessons learned and proper conduct of operations. Specific distances noted in the control likewise originate from existing operations and do not represent the results of a quantitative analysis. Labeling elements of the control (i.e., composite maps of planned excavation site and physical marking of the ground surface) have been included to address piping locations outside the tank farm boundaries.

5.5.32 Administrative Control 5.18—High-Efficiency Particulate Air Filter Controls

5.5.32.1 Purpose. These controls protect assumptions of the safety analysis to ensure that particulates or sprays are not released in amounts analyzed from HEPA filter failure caused by several accidents or from filter absence.

5.5.32.2 Derivation Criteria. These controls represent activities that are currently managed by several organizations in both Operations and Maintenance using established procedures and programs; therefore, an AC was the most appropriate.

The HEPA filter control on radioactive loading for tanks and waste handling and storage facilities was selected because it was a key analysis assumption and reflected current practices for HEPA filter monitoring and replacement. The control also applied to multiple accidents and reduced the consequence to within acceptable risk guidelines where possible.

The HEPA filter control on efficiency testing for DCRTs 244-A, 244-S, and 244-TX was selected because it ensures that a HEPA filter on the DCRT ventilation system is installed and will reduce the consequences of a mistransfer by maintaining the filter efficiency of 99.95%.

5.5.32.3 Key Element Bases. Key element (a) requires periodic verification that the HEPA filter (inlet and exhaust) and prefilter housing radiation level is ≤200 mrem/h on contact. The HEPA filters and prefilters are replaced prior to filter housing radiation levels exceeding 200 mrem/h. The 200 mrem/h dose rate is based on historical analyses and current operational practices and bounds the contact dose rates observed in the tank farm. The rate also reflects current practice for HEPA filter changeout to address As Low As Reasonably Achievable issues. This key element protects the source term assumptions in the accident analysis for HEPA filter releases. This reduces the consequences from a possible HEPA filter failure by limiting the inventory on the filters available for release. The verification of housing radiation levels applies to vessel/system inlet and exhaust HEPA filters and prefilters on SSTs, DSTs, AWF tanks, DCRTs, catch tanks, the 204-AR Waste Unloading Facility, 244-AR Vault vessel vent and canyon, and the 213-W Dry Waste Compactor Building.

Key element (b) requires the HEPA filter nominal particulate removal efficiency to be demonstrated ≥ 99.95% by performance of an aerosol test with the design air flow through the filter in accordance with ASME N510, *Testing of Nuclear Air Treatment Systems*. The aerosol test is performed after installation and every 12 months thereafter, and controls are established for the replacement of the HEPA filters. This key element provides mitigation for a pressurized

release for an accident initiated by incompatible waste. For the bounding scenario analyzed, the HEPA filters would likely fail because of the overpressurization and, therefore, were not credited. In the less severe scenarios, however, the HEPA filters would serve to mitigate the release by filtration of DCRT headspace gases before release to the environment. Verification of the HEPA filter efficiency applies to a minimum of one stage of HEPA filters installed on DCRTs 244-A, 244-S, and 244-TX.

5.5.33 Administrative Control 5.19—Process Instrumentation and Measuring and Test Equipment

5.5.33.1 Purpose. This control provides a support control for the process instrumentation and measuring and test equipment used to verify process parameters to comply with the TSRs when specific instrumentation and associated surveillances are not included in the TSR. This control applies to (1) optional instrument systems allowable per the LCO bases, (2) the instrumentation used to monitor flammable gas concentrations, (3) the instrumentation used to monitor waste temperatures and levels, and (4) instrumentation used to verify process parameters for the ACs in the TSR. This control on the process instrumentation and measuring and test equipment ensures that process parameters are properly monitored.

5.5.33.2 Derivation Criteria. This control was included because for some process parameters included in the TSR, it is not essential to specify the particular instrumentation or measuring equipment to demonstrate compliance with the process parameter provided the instrumentation or equipment used to monitor the parameter is maintained. If the analysis credits a specific process parameter (e.g., temperature) but does not require specific instrumentation (e.g., credit is not taken for interlock actuation upon reaching the setpoint), then any instrumentation or measuring equipment can be used provided it has the capability to monitor the required parameter. This support control was selected because it provides operational flexibility to use various instrumentation and equipment to measure TSR parameters provided it complies with requirements of AC 5.19 while ensuring that the safety functions assumed in the accident analysis are met.

5.5.33.3 Key Element Bases. Key elements (a) through (c) include maintaining identification and traceability of TSR-related instrumentation and equipment, periodic testing of the instrumentation and equipment used, and maintaining records that demonstrate that the instrumentation and equipment were used while in calibration. The intent of the AC program is to ensure that TSR parameters are measured with operable instrumentation and equipment that are appropriate for the parameter. Records are maintained to demonstrate that this was accomplished.

The program applies to installed and portable process instrumentation and measuring and test equipment when used to verify process parameters specified in the TSRs where specific instrumentation and associated surveillances are not already identified in the TSR. The instrumentation and equipment include plant-installed instrumentation and portable instrumentation such as tools, gauges, and other instruments used to inspect, test, calibrate,

measure, or troubleshoot instruments, devices, or pieces of equipment to verify that their operation conforms to their functional requirements.

This program does not apply to equipment such as rulers, tape measures, levels, and other measurement devices if commercial equipment provides accuracy adequate to meet the measurement specifications.

5.5.34 Administrative Control 5.20—Transfer Pump Administrative Lock Controls

5.5.34.1 Purpose. This control ensures the minimization of transport of particulates and aerosols from pools and spray leaks caused by inadvertent pump starts through unqualified or failed piping systems. This control is closely associated with a number of other controls: "Transfer System Covers" (LCO 3.1.1), "Service Water Pressure Detection Systems" (LCO 3.1.2), and "Transfer Leak Detection Systems" (LCO 3.1.3). These controls are established based on the potential for leaks caused by the pressurization of the waste transfer system. Because leaks are less probable when their motive force is removed, these controls are relaxed (i.e., not applicable) when all physically connected transfer pumps are administratively locked per AC 5.20.

5.5.34.2 Derivation Criteria. An AC was selected because it applies to multiple accident scenarios and is implemented and monitored similarly to other lock programs onsite. This control reduces implementation costs and allows operational flexibility because implementation of this control allows the relaxation of other transfer system leak-related controls while transfer pumps are administratively locked.

5.5.34.3 Key Element Bases. Key element (a) controls the placement of an administrative lock on a transfer pump to remove and secure the motive force from the pump. This greatly reduces the possibility of a pump start pressurizing the transfer system unexpectedly.

Key element (b) defines further details of lock compliance and verification. Even while transfer system cover, service water pressure detection system, and transfer leak detection controls are relaxed because of the administrative lock program, emphasis is placed on maintaining these systems operable. This forces heightened operator and management awareness on those systems that are not operable. This key element of the program is based on the need to recognize the importance of these systems regardless of the state of the facility.

Key element (c) identifies cross-reference controls for transfer system covers, service water pressure detection systems, and transfer leak detection systems physically connected to a waste transfer route with waste transfer pump not under administrative lock.

5.5.35 Administrative Control 5.21—Tank Service Water Intrusion Monitoring Program

5.5.35.1 Purpose. This control ensures the minimization of transport of liquids and aerosols from pools caused by water-induced tank overflow. A service water leak could have the potential to result in service water inadvertently entering tanks located in the tank farm serviced by the service water system. This is one possible initiator for a surface leak resulting in pool. Through a program requiring daily checks for service water leakage or resultant intrusion, the potential for this initiator to overflow a tank is significantly decreased. This reduces the likelihood of the accident occurring.

5.5.35.2 Derivation Criteria. This control was selected because it represents a minimal cost to implement and it does not involve the installation of new equipment or the development of complex procedures. Because this control does not require the control of actual water volumes, only the determination of leakage, an AC was chosen as the proper format.

5.5.35.3 Key Element Bases. Monitoring service water usage or tank levels every 24 h to detect leaks reduces the likelihood that service water leaks will intrude into individual tanks and cause an overflow resulting in a pool. The 24-h duration was qualitatively derived from typical rain water flow rates and general assumptions used in pool scenarios. While some basic calculations produced these numbers, this value is essentially qualitative. Monitoring service water usage requires reading each tank farm's flow totalizer to verify that there is no unplanned service water intrusion in tanks. The local inspection of the associated service water pit or flush pit for leakage provides a means of detecting leakage upstream of the flow totalizer, which may otherwise not be detected strictly from a flow totalizer reading. Monitoring tank levels requires a verification that the waste levels in tank farms serviced by the water system are not increasing unexpectedly.

5.5.36 Administrative Control 5.22—Transfer System Cover Removal Controls

5.5.36.1 Purpose. The transfer system cover removal controls provide Defense-in-Depth to ensure that covers are in place to mitigate spray and pool accidents.

5.5.36.2 Derivation Criteria. This control was selected because it allows operational flexibility through the relaxation of transfer system cover operability controls when a minimum of two closed valves in series separates the transfer route and the structure of concern. Because it involves monitoring of varied configurations and is not strictly limited to operability (though this is the prime definition for transfer cover operability), an AC format was selected.

5.5.36.3 Key Element Bases. Key elements (a) through (c) detail three specific requirements to ensure that added oversight of relaxed controls occurs. Cover block removal must occur as part of normal tank farm operation and maintenance. This control reflects the need for increased attention during normal operation and maintenance.

When two or more closed valves in series separate the waste transfer route and a transfer system structure, the potential for waste leakage through the valves with sufficient pressurization of the piping to cause significant leakage within the structure is minimal. This control greatly reduces the likelihood of the accidents identified from occurring within the structure. When two or more valves are closed, an alternate (and less stringent) control using the transfer system cover removal control program is allowed in lieu of the transfer system cover control.

Even though transfer system cover controls are relaxed (i.e., do not apply) when a structure is controlled by the transfer system cover removal control program, emphasis is still placed on maintaining a heightened operator awareness of the fact that the structure in question remains physically connected to an active transfer route. This awareness is maintained through requirements to provide continuous monitoring for waste leakage as well as requiring Facility Manager (or designee) approval before removal of transfer system covers that meet the requirements of the program.

5.5.37 Administrative Control 5.23—Caustic Transfer Controls

5.5.37.1 Purpose. The caustic transfer controls ensure that toxicological material is not released from piping system failure.

5.5.37.2 Derivation Criteria. This control was selected because it represents a minimal cost to implement and does not involve the installation of new equipment.

5.5.37.3 Key Element Bases. Key element (a) requires polyethylene (or similar) sleeving around delivery piping to have a thickness of ≥4 mil. This control prevents a spray leak from piping/hose. Polyethylene (or similar) sleeving around delivery piping provides secondary containment such that sprays are not formed given a failure in the primary pressure boundary. Standard 4 mil polyethylene (or similar) sleeving was determined to have ample strength to contain the spray. The sleeving would not be expected to be pressure tight, thus allowing some pool leakage, but there would be no significant aerosol release.

Key element (b) requires pipeline transfer pressures to be ≤125 lb/in.^{2} gauge. This requirement protects an assumption made in the accident analysis and reduces the consequences of a spray leak caused by overpressurization by reducing the leak rate. The control on delivery system pressure is not applicable to the 204-AR Waste Unloading Facility because the consequences were found to be within the offsite and onsite risk guidelines.

Key element (c) requires steel pipe to be Schedule 10 or thicker, and polyethylene hose or other delivery piping shall be designed for appropriate delivery pressure. Caustic transfer piping shall have a wall thickness of ≥0.28 cm (≥0.109 in.). This requirement protects an assumption made in the accident analysis and prevents a spray leak from the piping/hose by reducing the leak rate. Use of a thinner wall would increase the maximum release rate (because of the smaller crack depth and subsequently reduced friction losses). A higher release rate would result in higher consequences.

5.5.38 Administrative Control 5.24—Safety Management Programs

5.5.38.1 Purpose. This AC requires commitments to maintain safety management programs as part of the TWRS safety management system per DOE directive (Wagoner 1997). The programs listed in AC 5.24 provide Defense-in-Depth as a fundamental approach to hazard control and are implicitly assumed in the analyzed accidents to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions. The listed programs reduce the likelihood and potential impacts of events, and are covered by their respective regulatory and contractual systems of basic requirements.

5.5.39 Limiting Condition for Operation 3.1.6 - 204-AR Backflow Prevention System

5.5.39.1 Purpose. This control ensures operability of the 204-AR backflow prevention system and thereby prevents backflow of waste into the raw water system which could be released by a raw water surface pool or spray leak accident in the Mechanical Equipment Room. When physically connected active waste transfer pumps are not under administrative lock, a potential exists for an inadvertent pump start or misroute to cause a backflow of waste into the raw water system if the intervening backflow prevention system is compromised. This control is closely associated with the "Transfer Pump Administrative Lock Controls," (AC 5.20). Because surface pools and spray leaks are less probable when the motive force is removed via administrative locks on pumps as outlined in AC 5.20, the 204-AR backflow prevention system operability controls are relaxed (i.e., not applicable under these conditions). It is important to note that this control only applies to the 204-AR backflow prevention system and fulfills a function analogous to that provided by "Service Water Pressure Detection Systems" (LCO 3.1.2), which minimizes the backflow of waste into service water systems elsewhere in the Tank Farms.

5.5.39.2 Derivation Criteria. This control was selected because it takes advantage of existing hardware in the 204-AR Waste Unloading Facility. Backflow prevention devices are already installed in the Unloading Room to prevent contamination of the raw water system.

5.5.40 Limiting Condition for Operation 3.1.7 – Supplemental Covers

5.5.40.1 Purpose. This control ensures operability of the supplemental covers that are installed in transfer-associated structures with volumes less than 15 m^3 (530 ft^3) to limit the release of aerosols generated by a spray. Supplemental covers are required in addition to transfer system covers (LCO 3.1.1) and are closely associated with "Transfer Pump Administrative Lock Controls" (AC 5.20) and "Transfer System Cover Removal Controls" (AC 5.22). Because surface pools and spray leaks are less likely when the motive force is removed via administrative locks on pumps as outlined in AC 5.20, supplemental cover operability controls are relaxed (i.e., not applicable) under these conditions. Surface pools and spray leaks are likewise less likely when multiple isolation valves separate the transfer path and the structure of concern. In this situation, an alternate (and less stringent) control, as outlined in AC 5.22, is allowed in lieu of the supplemental cover control.

5.5.40.2 Derivation Criteria. This control was selected to protect against the potential for inadequate transfer system covers on transfer-associated structures with volumes less than 15 m^3 (530 ft^3). Most waste transfer-associated structures have sufficient interior volume to prevent most or all of a waste leak or spray stream from reaching the atmosphere. However, those structures with volumes less than 15 m^3 (530 ft^3) will overflow even when all controls are applied. Because of the potential for inadequate transfer system covers on these small structures, there is the possibility for a spray release before and after the structure has filled. Establishing the control for supplemental covers serves to mitigate the consequences of a such a potential leak.

An LCO format for this control was selected to be consistent with the LCO application for transfer system covers (LCO 3.1.1). Like permanent transfer system covers, the size of supplemental covers can vary. Supplemental covers can be made of lightweight construction materials and thus can be more easily disturbed, or removed from their functional safety position, than permanent covers. Specific and immediate actions, which are necessary to reduce the consequences of a potential spray leak, are required upon finding a supplemental cover not in place.

5.6 DESIGN FEATURES

Design Features are TSRs that are best managed by standard engineering and configuration control processes. Design Features normally are permanently built-in features that do not require, or infrequently require, maintenance or surveillance and are normally not subject to change by operations personnel. The categories of Design Features to be addressed in accordance with DOE 5480.22 include the following:

- Vital passive components such as piping, vessels, supports, confinement structures, and containers

- Configuration and physical arrangement of the facility where safety is a concern including site characteristics, such as the locations of public access roads, collocated facilities, facility area boundaries, site boundaries, and distances to the nearest residences

- Building materials if the safe operation of the facility depends on any component being constructed of a particular material.

Changes to Design Features are considered significant modifications. The Unreviewed Safety Question process ensures that changes to Design Features are appropriately analyzed and controlled so that they do not adversely affect safe operation of the facility. The configuration management system that controls changes to Design Features is discussed in Section 17.4, "Safety Management Policies and Programs."

Design Features for TWRS facilities that, if altered or modified, would have a significant effect on safe operation are listed for each TWRS facility type in HNF-SD-WM-TSR-006,

Appendix B. Descriptions of these Design Features are provided in Chapter 2.0, "Facility Description." The safety functions of the passive Safety-Class and Safety-Significant Design Features for applicable analyzed accidents are provided in Chapter 4.0. Based on the criteria for Design Features in DOE 5480.22, passive features only for environmental protection are not listed. Environmental features are, however, discussed in Chapter 3.0. Radioactive and hazardous waste management control features are discussed in Chapter 9.0, "Radioactive and Hazardous Waste Management." The list of Design Features is located only in HNF-SD-WM-TSR-006, Appendix B, for best configuration management of the listing.

5.7 INTERFACES WITH TECHNICAL SAFETY REQUIREMENTS FROM OTHER FACILITIES

The TWRS facility interfaces physically and administratively with other Hanford Site facilities. These interfaces include utilities, fire protection, emergency preparedness, and waste material transfers. Implemented TWRS programs are adequate to ensure that interactions with other facilities and their safety requirements do not affect the TWRS Authorization Basis and do not exceed the safety analyses requirements. Table 5-4 lists the TSR interfaces with other facilities.

The following discussion includes a description of the utilities, fire protection, and emergency preparedness interfaces, and applicable safety programs. The waste material transfers section (5.7.4) includes a description of the waste transfer interfaces and the TSR controls required by these facilities.

5.7.1 Utilities

The interfacing utilities include water and electrical power. Raw water is pumped from the Columbia River and sent to reservoirs, which then supply raw water to the 200 East and 200 West facilities. Raw water is used for cooling, flushing, and dilution systems. Sanitary water is treated for drinking and sanitary facilities and also for fire protection uses. The fire protection water system is addressed in WHC-SD-WM-FHA-020, *Tank Farms Fire Hazards Analysis*.

The Bonneville Power Administration provides the main source of electrical power to the 200 East and 200 West Areas. Power is fed through substations and distributed to each individual tank farm.

Both the water system and electrical system have proven to be reliable. The configuration management program, documented in WHC-SD-WM-CM-013, *TWRS Configuration Management Program Plan*, ensures that any proposed changes to these systems are properly reviewed, approved, and screened through the Unreviewed Safety Question process to ensure that there are no impacts to the safety Authorization Basis.

There are no utility interface requirements that affect the TWRS Authorization Basis.

5.7.2 Fire Protection

The TWRS fire protection program interfaces with the Hanford Fire Department, RL, and the Emergency Preparedness Program. The fire protection program is established to meet the requirements of DOE 5480.7A, *Fire Protection*, which ensures that no threats to the public health or welfare will result from a fire. The TWRS fire protection program is implemented through WHC-CM-4-41, *Fire Protection Program Manual*, which describes the interfaces with the Hanford Fire Department, RL, and outside emergency response agencies.

There are no fire protection interface requirements that affect the TWRS Authorization Basis.

5.7.3 Emergency Preparedness

The TWRS Emergency Preparedness Program (Chapter 15.0) applies to all TWRS facilities, operations, and personnel. The scope of the Emergency Preparedness Program ensures that appropriate actions are taken to protect the health and safety of the workers, the public, and the environment. The TWRS ERO responds to all emergencies involving TWRS facilities and activities. The interfaces between the TWRS ERO and other emergency organizations are described in DOE/RL-94-02, *Hanford Emergency Response Plan*, which applies to all Hanford Site employees and facilities. Under this plan, the contractor ERO and the RL ERO provide guidance to the TWRS ERO and oversee the TWRS response actions. RL establishes interfaces with other onsite EROs and offsite agencies, including the DOE-Headquarters emergency management team.

There are no emergency preparedness interface requirements that affect the TWRS Authorization Basis.

5.7.4 Waste Material Transfers

TWRS interfaces with other facilities through the transfer of radioactive/hazardous waste. Waste can be received by TWRS from other facilities, such as double-shell slurry from the 242-A Evaporator or low-level radioactive liquid waste from the Fast Flux Test Facility. Waste can be shipped by TWRS to other facilities, such as radioactive samples to the 222-S Laboratory or solid waste to the Central Waste Complex (CWC).

The safety documentation for these facilities includes controls for the handling of this waste. This section describes the TWRS waste management program, the other facility interfaces, and the operational controls of the other facilities. This section describes the waste transfers that are shipped to and from TWRS facilities and applicable controls. There are no safety requirements in the safety documentation of these facilities that affect the TWRS Authorization Basis or impose any requirements upon TWRS. TWRS ACs are considered adequate to manage interfaces during waste transfers.

5.7.4.1 Tank Waste Remediation System Waste Management Program. The TWRS waste management program (Chapter 9.0) focuses on (1) protecting the workers, the public, and the environment, (2) ensuring proper management of waste from its point of generation to its final disposition, (3) ensuring compliance with the applicable federal and state regulations, and (4) ensuring that radiological and toxicological material exposure is As Low As Reasonably Achievable. To accomplish these objectives, the waste management program contains the following basic elements:

- Plans and procedures governing waste designation, segregation, packaging, monitoring, treatment, storage, transportation, disposal, recordkeeping, and reporting
- Policies and programs for employee training, audits, and inspections
- Waste minimization goals and practices that reduce the volume of radioactive and hazardous waste and the spread of contamination.

All waste transfers into and out of TWRS are controlled by procedures that meet the requirements specified in the appropriate DOE orders, Hanford Site requirements, federal and state regulations, and industry standards. Requirements for contact-handled solid wastes including transuranic waste, low-level waste, and radioactive-mixed waste comply with the requirements of DOE 5820.2A, *Radioactive Waste Management*, and the appropriate DOE 5400 series orders. WHC-EP-0063-A, *Hanford Site Solid Waste Acceptance Criteria*, also identifies requirements for radioactive wastes and dangerous wastes as defined in WAC 173-303, "Dangerous Waste Regulations." The TWRS TSR AC, "Transfer Controls" (AC 5.12), ensures that transfers of waste are adequately controlled.

5.7.4.2 Waste Transfers From Outside Facilities to Tank Waste Remediation System. Waste transfers from outside facilities to TWRS are discussed in the following subsections.

5.7.4.2.1 242-A Evaporator. The 242-A Evaporator sends double-shell slurry to the 241-AW Tank Farm per AC 2.8.6, "OSR Interfaces with Other Facilities."

The 242-A Evaporator control requires a program to maintain consistency and coordination among the evaporator OSRs and the OSRs/TSRs of interfacing facilities through the use of approved and controlled operating specifications and procedures. When the evaporator sends waste to the 241-AW Tank Farm, the TWRS TSR controls must be reviewed by evaporator operations personnel for compliance. This AC does not affect the TWRS safety basis. There is no requirement from the 242-A Evaporator that affects the TWRS Authorization Basis.

Evaporator operation may affect TWRS by an unplanned dump of the evaporator vessel contents to the tank farms. This hazard was specifically identified and evaluated in Chapter 3.0 in the accident "Evaporator Dump," Section 3.3.2.4.4.

5.7.4.2.2 Fast Flux Test Facility. This interface involves the shipment of low-level radioactive liquid waste to the 204-AR Waste Unloading Facility per OSR 18.3.1.2, "Radioactive Liquids."

Low-level radioactive liquid wastes resulting from Fast Flux Test Facility operations are collected and transported to the 204-AR Waste Unloading Facility. This requirement ensures that the volume, curies, and radionuclides of the waste are recorded before shipment.

This OSR does not affect or place any requirement on the TWRS facility. There are no Fast Flux Test Facility requirements that affect the TWRS Authorization Basis. No Fast Flux Test Facility waste transfer will be accepted by TWRS if it does not conform to the TWRS TSR controls.

5.7.4.2.3 Plutonium Finishing Plant. This interface involves material transfers to TWRS per AC 5.19.1, "Requirement for OSR Interfaces with Other Facilities."

This control requires a program to maintain consistency and coordination among the Plutonium Finishing Plant OSRs and the OSRs/TSRs of interfacing facilities where material transfers are involved through the use of approved and controlled operating specifications and procedures.

This AC does not affect or place any requirement on the TWRS facility. There are no Plutonium Finishing Plant requirements that affect the TWRS Authorization Basis.

5.7.4.3 Waste Transfers from Tank Waste Remediation System to Outside Facilities. Waste transfers from TWRS to outside facilities are discussed in the following subsections.

5.7.4.3.1 222-S Laboratory. This interface involves the shipment of samples from TWRS to the 222-S Laboratory for analysis per Administrative Requirement 6.1.1, "Requirement for 222-S Laboratory Radiological Inventory Control."

The purpose of this control is to ensure that radioactive material stays within the bounds established for the design basis accidents in the 222-S Laboratory Authorization Basis. Radioactive material from TWRS is verified against the inventory upon receipt to ensure the 222-S Laboratory remains within the administrative requirement.

The TWRS waste management program adequately controls all shipments of samples to the 222-S Laboratory by procedures that meet the requirements specified in the appropriate DOE orders, Hanford Site requirements, and federal and state regulations.

The 222-S Laboratory Administrative Requirement does not place any requirement on TWRS.

5.7.4.3.2 Solid Waste Complex. The solid waste complex includes three facilities: the CWC, the Solid Waste Burial Grounds, and the Waste Receiving and Processing Facility.

Central Waste Complex. The CWC receives transuranic waste, such as barrels and boxes of waste from trenches that are managed by the following controls:

- OSR 3.4.1, "Container Inventory Control"
- OSR 3.4.2, "Vehicle Inventory Control"
- OSR 3.4.3, "Facility Inventory Receiving Control."

The purpose of these controls is to ensure that radioactive inventories, concentration limits, and packaging limits assumed in the CWC hazard categorizations and accident analyses will not be exceeded without additional analyses. Radioactive material from TWRS is verified against the inventory upon receipt to ensure that the CWC inventory remains within the required limits.

The TWRS waste management program adequately controls all shipments of solid waste from TWRS to the CWC by procedures that meet the requirements specified in the appropriate DOE orders, Hanford Site requirements, and federal and state regulations.

The CWC OSRs do not place any requirements on TWRS and do not affect the TWRS Authorization Basis.

Solid Waste Burial Grounds. TWRS sends solid waste to the Solid Waste Burial Ground. The Solid Waste Burial Ground contains trenches that store drums and boxes and has pads for storing containers that are managed by AC/Operational Restriction 3.2.2.1.4, "Fire Prevention and Suppression."

This requirement implements a program to ensure that containers to be buried are not filled with incompatible chemicals that may result in spontaneous ignition or explosion when mixed. This requirement also ensures that requirements for thermal output of waste packages are met before acceptance.

The TWRS waste management program adequately controls all shipments of solid waste from TWRS to the Solid Waste Burial Ground by procedures that meet the requirements specified in the appropriate DOE orders, Hanford Site requirements, and federal and state regulations.

The Solid Waste Burial Ground AC/Operational Restriction does not place any requirements on TWRS and does not affect the TWRS Authorization Basis.

Waste Receiving and Processing Facility. The Waste Receiving and Processing Facility is a waste characterization facility, in which radioactive and hazardous materials in containers such as barrels and boxes are characterized and sorted. The materials are then packaged and sent to the CWC to be stored. The Waste Receiving and Processing Facility is in the process of obtaining a license to operate and has the following control: AC 5.19.1, "TSR Interfaces with Other Facilities."

This requirement establishes a program to maintain consistency and coordination among the Waste Receiving and Processing Facility TSR controls and the TSRs/OSRs of interfacing facilities when radioactive material transfers are involved through the use of approved and controlled operating specifications and procedures.

The TWRS waste management program will adequately control all shipments of solid waste from TWRS to the Waste Receiving and Processing Facility by procedures that meet the requirements specified in the appropriate DOE orders, Hanford Site requirements, and federal and state regulations.

The Waste Receiving and Processing Facility AC does not place any requirements on TWRS and does not affect the TWRS Authorization Basis.

5.7.4.3.3 Purgewater Storage Facility. The Purgewater Storage Facility (PWSF) accepts purgewater from all the groundwater monitoring wells on the Hanford Site, including at TWRS, per Operational Safety Limit 7.3, "Operational Safety Limit for the PWSF."

The PWSF stores purgewater from a network of groundwater monitoring wells. Purgewater refers to all water purges from wells during development, sampling, aquifer testing, maintenance, and remediation activities. The purpose of the Operational Safety Limit is to ensure that specified limits of radiological or toxicological contaminants in the received purgewater are not exceeded and to maintain the integrity of the operational safety envelope for the PWSF.

The TWRS waste management program adequately controls all shipments of purgewater from TWRS to the PWSF by procedures that meet the requirements specified in the appropriate DOE orders, Hanford Site requirements, and federal and state regulations.

The PWSF Operational Safety Limit does not place any requirements on TWRS and does not affect the TWRS Authorization Basis.

5.8 REFERENCES

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Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (5 sheets)

Analyzed accident and FSAR section	Technical Safety Requirement		Control basis
Nuclear Criticality (3.3.2.4.1)	AC 5.7	Nuclear Criticality Safety	AC 5.7 protects the accident analysis assumptions
HEPA Filter Failure—Exposure to High Temperature or Pressure (3.3.2.4.2)	LCO 3.1.4 AC 5.18	Ventilation Stack CAM Interlock Systems HEPA Filter Controls	LCO 3.1.4 prevents consequences of accident from exceeding onsite risk guidelines AC 5.18 protects radioactive loading assumptions on HEPA filters in accident analysis
Fire in Contaminated Area (3.3.2.4.3)	AC 5.10 AC 5.14	Ignition Controls Emergency Preparedness	AC 5.10 provides controls to reduce likelihood of accident to within acceptable onsite risk guidelines AC 5.14 represents a significant Defense-in-Depth item that helps control consequences of accident
Evaporator Dump (3.3.2.4.4)	None		There are no controls because accident consequences do not exceed onsite or offsite risk guidelines
Steam Intrusion From Interfacing Systems (3.3.2.4.5)	AC 5.18	HEPA Filter Controls	AC 5.18 protects radioactive loading assumptions on HEPA filters in accident analysis
Leak from Railcar/Tank Trailer (3.3.2.4.6)	AC 5.8	Source Inventory Controls	AC 5.8 protects source term assumptions in 204-AR Waste Unloading Facility accident analyses and generalized source term assumptions used in every accident analysis
Subsurface Leak Remaining Subsurface (3.3.2.4.7)	LCO 3.1.3 AC 5.12 AC 5.13 AC 5.20	Transfer Leak Detection Systems Transfer Controls Encasement Seal Loop Controls Transfer Pump Administrative Lock Controls	LCO 3.1.3, AC 5.12, AC 5.13, and AC 5.20 represent significant Defense-in-Depth items that are identified to protect the facility worker
Unplanned Excavation/Drilling in Crib/Ditch/Pond (3.3.2.4.8)	None		There are no controls because accident consequences do not exceed onsite or offsite risk guidelines
Caustic Spray Leak (3.3.2.4.9)	AC 5.23	Caustic Transfer Controls	AC 5.23 controls consequences of the accident from exceeding onsite risk guidelines. This accident has only toxicological consequences
Sodium Fire (3.3.2.4.10)	AC 5.14	Emergency Preparedness	AC 5.14 protects analysis assumptions regarding 2727-W building structural integrity and foundation height

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (5 sheets)

Analyzed accident and FSAR section	Technical Safety Requirement		Control basis
Mixing of Incompatible Material—Toxic Vapor Generation (3.3.2.4.11)	None		There are no controls because accident consequences do not exceed onsite or offsite risk guidelines
Mixing of Incompatible Material—Tank Pressurization (3.3.2.4.12)	AC 5.12 AC 5.18	Transfer Controls HEPA Filter Controls	AC 5.12 provides controls to reduce likelihood of accident to within onsite risk guidelines AC 5.18 protects assumptions for operating HEPA filters in accident analysis
Tank Failure Due to Excessive Loads (3.4.2.1)	AC 5.16	Dome Loading Controls	AC 5.16 provides controls to reduce likelihood of accident to within onsite toxicological risk guidelines and to protect the facility worker with significant Defense-in-Depth key elements
Flammable Gas Deflagrations (3.4.2.2)	LCO 3.2.1 LCO 3.2.2 LCO 3.2.3 LCO 3.2.4 LCO 3.2.5 LCO 3.2.6 AC 5.9 AC 5.10 AC 5.11 AC 5.12 AC 5.14 AC 5.17 AC 5.18 AC 5.19	DST and AWF Tank Ventilation Systems SST Ventilation Systems - Active SST Ventilation Systems - Passive DCRT Ventilation Systems 244-AR TK-002 Ventilation System Primary Tank Leak Detection Systems Flammability Controls Ignition Controls Flammable Gas Monitoring Controls Transfer Controls Emergency Preparedness Excavation Controls HEPA Filter Controls Process Instrumentation and Measuring and Test Equipment	LCO 3.2.1, LCO 3.2.2, LCO 3.2.3, LCO 3.2.4, LCO 3.2.5, LCO 3.2.6, AC 5.9, AC 5.10 and AC 5.11 provide controls to reduce likelihood of accident AC 5.14 represents a significant Defense-in-Depth item that helps control consequences of accident AC 5.17 provides controls to reduce the likelihood of the accident by minimizing inadvertent intrusion into any structure potentially containing flammable gas
Organic Solvent Fire (3.4.2.4)	AC 5.10 AC 5.12 AC 5.14 AC 5.18	Ignition Controls Transfer Controls Emergency Preparedness HEPA Filter Controls	AC 5.10 and AC 5.12 provide controls to lessen likelihood of accident but onsite risk guidelines are still exceeded, and AC 5.10 protects the facility worker with significant Defense-in-Depth key elements AC 5.14 represents a significant Defense-in-Depth item that helps reduce consequences of accident AC 5.18 protects radioactive loading assumptions on HEPA filters in accident analysis

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (5 sheets)

Analyzed accident and FSAR section	Technical Safety Requirement		Control basis
In-Tank Fuel Fire/Deflagration (3.4.2.5)	AC 5.10 AC 5.14	Ignition Controls Emergency Preparedness	AC 5.10 provides controls to reduce likelihood of accident to within onsite risk guidelines and protects the facility worker with significant Defense-in-Depth key elements AC 5.14 represents a significant Defense-in-Depth item that helps reduce consequences of accident
Organic Salt-Nitrate Reaction (3.4.2.6)	SL 2.1.1 LCS/LCO 3.3.1 LCS/LCO 3.3.2 AC 5.10 AC 5.12 AC 5.14 AC 5.15 AC 5.18 AC 5.19	Waste Temperature SST Waste Temperature Controls DST and AWF Tank Waste Temperature Controls Ignition Controls Transfer Controls Emergency Preparedness Moisture Controls HEPA Filter Controls Process Instrumentation and Measuring and Test Equipment	SL 2.1.1, LCS/LCOs 3.3.1 and 3.3.2, and AC 5.19 provide controls to reduce likelihood of accident AC 5.10, AC 5.12 and AC 5.15 provide controls to reduce likelihood of accident AC 5.14 and AC 5.18 represent significant Defense-in-Depth items that help reduce consequences of accident
Surface Leak Resulting in Pool (3.4.2.7)	LCO 3.1.1 LCO 3.1.2 LCO 3.1.3 LCO 3.1.6 LCO 3.1.7 LCO 3.2.6 AC 5.12 AC 5.13 AC 5.14 AC 5.17 AC 5.20 AC 5.21 AC 5.22	Transfer System Covers Service Water Pressure Detection Systems Transfer Leak Detection Systems 204-AR Backflow Prevention System Supplemental Covers Primary Tank Leak Detection Systems Transfer Controls Encasement Seal Loop Controls Emergency Preparedness Excavation Controls Transfer Pump Administrative Lock Controls Tank Service Water Intrusion Monitoring Program Transfer System Cover Removal Controls	LCO 3.1.2, LCO 3.1.6, AC 5.12, AC 5.20, and AC 5.21 provide controls to reduce likelihood of accident to within onsite and offsite risk guidelines LCO 3.1.3, LCO 3.1.7, and LCO 3.2.6 reduce consequences of accident to within onsite and offsite risk guidelines LCO 3.1.1 and AC 5.22 control consequences of accident to within onsite risk guidelines AC 5.14 represents significant Defense-in-Depth item that helps reduce consequences of accident AC 5.13 protects a key assumption of the accident analysis AC 5.17 provides controls to reduce the likelihood of the accident to within onsite and offsite risk guidelines

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (5 sheets)

Analyzed accident and FSAR section	Technical Safety Requirement		Control basis
Subsurface Leak Resulting in Pool (3.4.2.8)	LCO 3.1.1 LCO 3.1.3 AC 5.12 AC 5.13 AC 5.14 AC 5.20 AC 5.22	Transfer System Covers Transfer Leak Detection Systems Transfer Controls Encasement Seal Loop Controls Emergency Preparedness Transfer Pump Administrative Lock Controls Transfer System Cover Removal Controls	LCO 3.1.1, LCO 3.1.3, AC 5.12, AC 5.14, AC 5.20, and AC 5.22 reduce consequences of accident to within offsite and onsite risk guidelines AC 5.13 protects a key assumption of the accident analysis
Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9) Spray Leak from Underground Waste Transfer Lines (3.4.2.10)	LCO 3.1.1 LCO 3.1.2 LCO 3.1.4 LCO 3.1.6 AC 5.12 AC 5.13 AC 5.14 AC 5.17 AC 5.20 AC 5.22	Transfer System Covers Service Water Pressure Detection Systems Ventilation Stack CAM Interlock Systems 204-AR Backflow Prevention System Transfer Controls Encasement Seal Loop Controls Emergency Preparedness Excavation Controls Transfer Pump Administrative Lock Controls Transfer System Cover Removal Controls	LCO 3.1.2, 3.1.6, and AC 5.20 provide controls to reduce likelihood of accident to within offsite risk guidelines LCO 3.1.1 and LCO 3.1.4 reduce consequences of accident to within offsite risk guidelines AC 5.13 protects a key assumption of the accident analysis AC 5.12, AC 5.14, and AC 5.22 represent significant Defense-in-Depth items that help reduce accident likelihood and control consequences of accident AC 5.17 provides controls to reduce the likelihood of the accident to within onsite and offsite risk guidelines
Tank Bump (3.4.2.11)	LCS/LCO 3.3.1 LCS/LCO 3.3.2 AC 5.12 AC 5.19	SST Waste Temperature Controls DST and AWF Tank Waste Temperature Controls Transfer Controls Process Instrumentation and Measuring and Test Equipment	LCS/LCO 3.3.1, LCS/LCO 3.3.2, AC 5.12, and AC 5.19 provide controls to reduce likelihood of accident to within onsite risk guidelines
Natural Phenomena—High Wind a. Waste Transport Vehicle Accident (3.4.2.12.1)	None		There are no controls because accident consequences do not exceed onsite or offsite risk guidelines; waste transportation accidents are covered by separate safety analyses
Natural Phenomena—High Wind b. Load Drop (3.4.2.12.1)	AC 5.16	Dome Loading Controls	AC 5.16 provides controls to reduce likelihood of accident to within onsite risk guidelines

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (5 sheets)

Analyzed accident and FSAR section	Technical Safety Requirement	Control basis
Natural Phenomena—High Wind c. Aboveground Structure Failure (3.4.2.12.1)	None	There are no controls because accident consequences do not exceed onsite or offsite risk guidelines
Natural Phenomena—Lightning (3.4.2.12.2)	AC 5.10 Ignition Controls	AC 5.10 provides controls to reduce likelihood of accident to within onsite and offsite risk guidelines
Natural Phenomena—Seismic (3.4.2.12.3)	AC 5.14 Emergency Preparedness	AC 5.14 provides controls to reduce likelihood of accident to within onsite and offsite risk guidelines

AC = Administrative Control.
AWF = Aging Waste Facility.
CAM = continuous air monitor.
DCRT = double-contained receiver tank.
DST = double-shell tank.
FSAR = Final Safety Analysis Report.
HEPA = high-efficiency particulate air (filter).
LCO = Limiting Condition for Operation.
SST = single-shell tank.

Table 5-2. FSAR Chapter and Administrative Control Technical Safety Requirement Cross-Reference.

FSAR Chapter	TSR Administrative Controls
Chapter 1.0 - Site Characteristics	None
Chapter 2.0 - Facility Description	None
Chapter 3.0 - Hazard and Accident Analyses	See Table 5-1
Chapter 4.0 - Safety Structures, Systems, and Components	None
Chapter 5.0 - Derivation of Technical Safety Requirements	Not Applicable
Chapter 6.0 - Prevention of Inadvertent Criticality	AC 5.7 - Nuclear Criticality Safety
Chapter 7.0 - Radiation Protection	None
Chapter 8.0 - Hazardous Material Protection	None
Chapter 9.0 - Radioactive and Hazardous Waste Management	None
Chapter 10.0 - Initial Testing, In-Service Surveillance, and Maintenance	None
Chapter 11.0 - Operational Safety	None
Chapter 12.0 - Procedures and Training	None
Chapter 13.0 - Human Factors	None
Chapter 14.0 - Quality Assurance	None
Chapter 15.0 - Emergency Preparedness Program	AC 5.14 - Emergency Preparedness
Chapter 16.0 - Provisions for Decontamination and Decommissioning	None
Chapter 17.0 - Management, Organization, and Institutional Safety Provisions	AC 5.2 - Contractor Responsibility AC 5.3 - Compliance AC 5.4 - Technical Safety Requirement Violations AC 5.5 - Occurrence Reporting AC 5.6 - Organization AC 5.8 - Source Inventory Controls AC 5.24 - Safety Management Programs

FSAR = Final Safety Analysis Report.
TSR = Technical Safety Requirement.

Table 5-3. Technical Safety Requirement Controls Cross-Reference with Applicable Accidents. (3 sheets)

TSR control #	TSR control name	Applicable accidents (FSAR reference)
SL 2.1.1	Waste Temperature	• Organic Salt-Nitrate Reaction (3.4.2.6)
LCO 3.1.1	Transfer Systems Covers	• Surface Leak Resulting in Pool (3.4.2.7) • Subsurface Leak Resulting in Pool (3.4.2.8) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)
LCO 3.1.2	Service Water Pressure Detection Systems	• Surface Leak Resulting in Pool (3.4.2.7) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)
LCO 3.1.3	Transfer Leak Detection Systems	• Subsurface Leak Remaining Subsurface (3.3.2.4.7) • Surface Leak Resulting in Pool (3.4.2.7) • Subsurface Leak Resulting in Pool (3.4.2.8)
LCO 3.1.4	Ventilation Stack CAM Interlock Systems	• HEPA Filter Failure-Exposure to High Temperature or Pressure (3.3.2.4.2) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)
LCO 3.1.6	204-AR Backflow Prevention System	• Surface Leak Resulting in Pool (3.4.2.7) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)
LCO 3.1.7	Supplemental Covers	• Surface Leak Resulting in Pool (3.4.2.7)
LCO 3.2.1	DST and AWF Tank Ventilation Systems	• Flammable Gas Deflagrations (3.4.2.2)
LCO 3.2.2	SST Ventilation Systems - Active	• Flammable Gas Deflagrations (3.4.2.2)
LCO 3.2.3	SST Ventilation Systems - Passive	• Flammable Gas Deflagrations (3.4.2.2)
LCO 3.2.4	DCRT Ventilation Systems	• Flammable Gas Deflagrations (3.4.2.2)
LCO 3.2.5	244-AR TK-002 Ventilation System	• Flammable Gas Deflagrations (3.4.2.2)
LCO 3.2.6	Primary Tank Leak Detection Systems	• Flammable Gas Deflagrations (3.4.2.2) • Surface Leak Resulting in Pool (3.4.2.7)
LCS/LCO 3.3.1	SST Waste Temperature Controls	• Organic Salt-Nitrate Reaction (3.4.2.6) • Tank Bump (3.4.2.11)
LCS/LCO 3.3.2	DST and AWF Tank Waste Temperature Controls	• Organic Salt-Nitrate Reaction (3.4.2.6) • Tank Bump (3.4.2.11)
AC 5.7	Nuclear Criticality Safety	• Nuclear Criticality (3.3.2.4.1)
AC 5.8	Source Inventory Controls	• Leak from Railcar/Tank Trailer (3.3.2.4.6)
AC 5.9	Flammability Controls	• Flammable Gas Deflagrations (3.4.2.2)

Table 5-3. Technical Safety Requirement Controls Cross-Reference with Applicable Accidents. (3 sheets)

TSR control #	TSR control name	Applicable accidents (FSAR reference)
AC 5.10	Ignition Controls	• Fire in Contaminated Area (3.3.2.4.3) • Flammable Gas Deflagrations (3.4.2.2) • Organic Solvent Fire (3.4.2.4) • In-Tank Fuel Fire/Deflagration (3.4.2.5) • Organic Salt-Nitrate Reaction (3.4.2.6) • Natural Phenomena—Lightning (3.4.2.12)
AC 5.11	Flammable Gas Monitoring Controls	• Flammable Gas Deflagrations (3.4.2.2)
AC 5.12	Transfer Controls	• Subsurface Leak Remaining Subsurface (3.3.2.4.7) • Mixing of Incompatible Material—Tank Pressurization (3.3.2.4.12) • Flammable Gas Deflagrations (3.4.2.2) • Organic Solvent Fire (3.4.2.4) • Organic Salt-Nitrate Reaction (3.4.2.6) • Surface Leak Resulting in Pool (3.4.2.7) • Subsurface Leak Resulting in Pool (3.4.2.8) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9) • Tank Bump (3.4.2.11)
AC 5.13	Encasement Seal Loop Controls	• Subsurface Leak Remaining Subsurface (3.3.2.4.7) • Surface Leak Resulting in Pool (3.4.2.7) • Subsurface Leak Resulting in Pool (3.4.2.8) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)
AC 5.14	Emergency Preparedness	• Fire in Contaminated Area (3.3.2.4.3) • Sodium Fire (3.3.2.4.10) • Flammable Gas Deflagrations (3.4.2.2) • Organic Solvent Fire (3.4.2.4) • In-Tank Fuel Fire/Deflagration (3.4.2.5) • Organic Salt-Nitrate Reaction (3.4.2.6) • Surface Leak Resulting in Pool (3.4.2.7) • Subsurface Leak Resulting in Pool (3.4.2.8) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9) • Natural Phenomena—Seismic (3.4.2.12)
AC 5.15	Moisture Controls	• Organic Salt-Nitrate Reaction (3.4.2.6)
AC 5.16	Dome Loading Controls	• Tank Failure Due To Excessive Loads (3.4.2.1) • Natural Phenomena—High Wind (Load Drop) (3.4.2.12)
AC 5.17	Excavation Controls	• Flammable Gas Deflagrations (3.4.2.2) • Surface Leak Resulting in Pool (3.4.2.7) • Spray Leak from Underground Waste Transfer Lines (3.4.2.10)

Table 5-3. Technical Safety Requirement Controls Cross-Reference with Applicable Accidents. (3 sheets)

TSR control #	TSR control name	Applicable accidents (FSAR reference)
AC 5.18	HEPA Filter Controls	• HEPA Filter Failure—Exposure to High Temperature or Pressure (3.3.2.4.2) • Steam Intrusion From Interfacing Systems (3.3.2.4.5) • Mixing of Incompatible Material—Tank Pressurization (3.3.2.4.12) • Flammable Gas Deflagrations (3.4.2.2) • Organic Solvent Fire (3.4.2.4) • Organic Salt-Nitrate Reaction (3.4.2.6)
AC 5.19	Process Instrumentation and Measuring and Test Equipment	• Flammable Gas Deflagrations (3.4.2.2) • Organic Salt-Nitrate Reaction (3.4.2.6) • Tank Bump (3.4.2.11)
AC 5.20	Transfer Pump Administrative Lock Controls	• Subsurface Leak Remaining Subsurface (3.3.2.4.7) • Surface Leak Resulting in Pool (3.4.2.7) • Subsurface Leak Resulting in Pool (3.4.2.8) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)
AC 5.21	Tank Service Water Intrusion Monitoring Program	• Surface Leak Resulting in Pool (3.4.2.7)
AC 5.22	Transfer System Cover Removal Controls	• Surface Leak Resulting in Pool (3.4.2.7) • Subsurface Leak Resulting in Surface Pool (3.4.2.8) • Spray Leak in Structure or From Waste Transfer Lines (3.4.2.9)
AC 5.23	Caustic Transfer Controls	• Caustic Spray Leak (3.3.2.4.9)
AC 5.24	Safety Management Programs	• The programs listed in AC 5.24 provide Defense-in-Depth as a fundamental approach to hazard control and are implicitly assumed in the analyzed accidents to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions.

AC = Administrative Control.
AWF = Aging Waste Facility.
CAM = continuous air monitor.
DCRT = double-contained receiver tank.
DST = double-shell tank.
FSAR = Final Safety Analysis Report.
HEPA = high-efficiency particulate air (filter).
LCO = Limiting Condition for Operation.
LCS = Limiting Control Setting.
SL = Safety Limit.
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 5-4. Technical Safety Requirement Interfaces With Other Facilities. (4 sheets)

Facility	Authorization Basis[a]	Interface with TWRS[b]
209-E Critical Mass Laboratory	WHC-SD-SQA-CSA-20326 WHC-SD-WM-TI-789 Note: currently being transitioned to minimum safe surveillance and maintenance (MinSafe S&M) conditions.	No
222-S Laboratory	WHC-SD-CP-ISB-002	Yes
242-A Evaporator	WHC-SD-WM-SAR-023	Yes
242-B/BL Evaporator	NA - Facility owned by other contractor with no interfaces at this time Note: currently being transitioned to minimum safe surveillance and maintenance (MinSafe S&M) conditions.	No
242-S Evaporator	WHC-SD-WM-SSP-002	No
242-T Evaporator	WHC-SD-HS-SAR-009	No
308 Building	WHC-SD-FL-ISB-001	No
340 Facility	WHC-SD-WM-ISB-003	No
B Plant	WHC-SD-WM-SAR-013	No
Central Waste Complex	WHC-SD-SAR-049	Yes
Effluent Treatment Facility	WHC-SD-ETF-ASA-001	No
Fast Flux Test Facility	HEDL-TI-75002	Yes
Fuel Supply Shutdown Facility (N Reactor)	WHC-SD-NR-ISB-001 WHC-SD-NR-TSR-001	No
Grout Treatment Facility	WHC-SD-WM-SAR-027	No
In-tank solidification system (241-BY Tank Farm)	NA - Facility owned by other contractor with no interfaces at this time	No

Table 5-4. Technical Safety Requirement Interfaces With Other Facilities. (4 sheets)

Facility	Authorization Basis[a]	Interface with TWRS[b]
K Basin Facility	WHC-SD-WM-OSR-006	No
Liquid Effluent Retention Facility	WHC-SD-W105-SAR-001	No
Plutonium Finishing Plant	WHC-SD-CP-OSR-10	Yes
Pacific Northwest National Laboratory	PNL-SAR-324 PNL-SAR-325 PNL-SAR-327	No
Plutonium Uranium Extraction Facility	WHC-SD-HS-SAR-001	No
Purgewater Storage Facility	WHC-SD-EN-SAD-001	Yes
Reduction Oxidation Facility	NA - Facility owned by other contractor with no interfaces at this time	No
Solid Waste Burial Grounds	WHC-SD-WM-ISB-002 WHC-SD-WM-TSR-001	Yes
T Plant	WHC-SD-CP-SAR-007	No
Transuranic Storage and Assay Facility	WHC-WM-SAR-025	No
UO_3 Plant	WHC-SD-CP-SAR-002	No
U Plant	NA - Facility owned by other contractor with no interfaces at this time	No
Waste Encapsulation Storage Facility	WHC-SD-WM-SAR-005	No
Waste Receiving and Processing Facility	WHC-SD-W026-SAR-001	Yes

Table 5-4. Technical Safety Requirement Interfaces With Other Facilities. (4 sheets)

Sources:

HEDL-TI-75002, 1975, *Fast Flux Test Facility Final Safety Analysis Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
PNL-SAR-324, 1995, *Safety Analysis Report for the 324 Building*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.
PNL-SAR-325, 1995, *Safety Analysis Report for the 325 Building*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.
PNL-SAR-327, 1995, *Safety Analysis Report for the 327 Building*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.
WHC-SD-CP-ISB-002, 1996, *222-S Laboratory Interim Safety Basis*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-CP-OSR-10, 1996, *Plutonium Finishing Plant Operational Safety Analysis Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-CP-SAR-002, 1993, *UO_3 Plant Safety Analysis Report*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-CP-SAR-007, 1994, *T Plant FSAR*, Rev. 1-D, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-EN-SAD-001, 1993, *Final Safety Analysis Report, Purge Water Storage Facility*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-ETF-ASA-001, 1996, *200 Area ETF Auditable Safety Analysis Report*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-FL-ISB-001, 1996, *Interim Safety Basis for the 308 Building*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-HS-SAR-001, 1996, *PUREX Plant Final Safety Analysis Report*, Rev. 5A, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-HS-SAR-009, 1983, *242-T Evaporator Facility Shutdown/Standby to Condition V Safety Analysis Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-NR-ISB-001, 1995, *Interim Safety Basis for Fuel Supply Shutdown Facility*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-NR-TSR-001, 1995, *Fuel Supply Shutdown Facility Interim Operational Safety Requirements*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-SQA-CSA-20326, 1990, *CSER-90-008: Reclassification of the Critical Mass Laboratory, Building 209-E as a Limited Control Facility*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-W026-SAR-001, 1994, *Waste Receiving and Processing Facility*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-W105-SAR-001, 1992, *Final Safety Analysis Report, 242-A Evaporator Liquid Effluent Retention Facility*, Rev. 0-C, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ISB-002, 1996, *Solid Waste Burial Grounds Interim Safety Basis*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ISB-003, 1996, *340 Waste Handling Facility Interim Safety Basis*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-OSR-006, 1996, *Operational Safety Requirements - 100-KE and 100-KW Fuel Storage Basins*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SAR-005, 1996, *WESF Safety Analysis Report*, Rev. 12A, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SAR-013, 1986, *B-Plant Safety Analysis Report*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SAR-023, 1995, *242-A Evaporator/Crystallizer Safety Analysis Report*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SAR-025, 1987, *TRUSAF Hazards Identification and Evaluation*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SAR-027, 1988, *Hazards Identification and Evaluation Report for the Operation of the Grout Facilities and Near Surface Disposal of Grouted Phosphate/Sulfate Low-Level Liquid Waste*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SAR-049, 1992, *Central Waste Complex Final Safety Analysis Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SSP-002, 1988, *242-S Facility Shutdown/Standby Plan*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table 5-4. Technical Safety Requirement Interfaces With Other Facilities. (4 sheets)

Sources (Cont'd):

WHC-SD-WM-TI-789, *Preliminary Hazards Analysis, 209-E Building, Critical Mass Laboratory*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TSR-001, 1996, *Solid Waste Burial Grounds Interim Safety Basis, Technical Safety Requirements*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[a]A current listing of the Authorization Basis documents for the TWRS facilities listed in this table is maintained as Attachment A of the TWRS Unreviewed Safety Question procedure.

[b]The only interfaces between TWRS and these outside facilities, where a "Yes" is indicated, is through waste material transfers. There are no other physical interfaces (such as electrical power, water, or instrument air).

NA = not applicable.

TWRS = Tank Waste Remediation System.

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CHAPTER 6.0
PREVENTION OF INADVERTENT CRITICALITY

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CHAPTER 6.0
PREVENTION OF INADVERTENT CRITICALITY

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LIST OF TERMS

CPS	criticality prevention specification
CSER	criticality safety evaluation report
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
MISF	miscellaneous inactive storage facility
PFP	Plutonium Finishing Plant
PUREX	Plutonium Uranium Extraction (facility)
SAR	safety analysis report
SST	single-shell tank
TWRS	Tank Waste Remediation System

6.0 PREVENTION OF INADVERTENT CRITICALITY

6.1 INTRODUCTION

This chapter describes the essential features of criticality safety in the Tank Waste Remediation System (TWRS) facilities and provides the bases for the development of facility-specific procedures dealing with criticality safety issues. The scope of this chapter includes the facilities and operations described in Chapter 2.0, "Facility Description."

Prevention of a criticality accident is of principal importance to personnel working with and managing fissionable materials. The criticality safety program provides for the safe handling, storage, transfer, and transport of fissionable material by following applicable requirements and good safety practices. This program applies the graded approach to required criticality safety practices. A graded approach ensures sufficient controls are implemented to minimize the potential for the occurrence of an inadvertent criticality.

The hazard categorization of TWRS is based on an evaluation of the associated fissile-material inventory, form, and distribution. The criticality safety program applies to all TWRS facilities and operations containing inventories of more than 15 g of fissile material. Implementation of this safety program is the responsibility of design, operations, technical support, and overview organizational units. Employees receive criticality training commensurate with their work and facility assignments. Collectively, the TWRS safety practices provide Defense in-Depth to prevent an inadvertent criticality during normal or routine operations.

6.2 REQUIREMENTS

The following design codes, federal regulations, U.S. Department of Energy (DOE) orders, and standards were used as the basis for the elements of the TWRS criticality safety program:

- 10 CFR 71, "Packaging and Transportation of Radioactive Materials for Transport"
- 49 CFR 171-179, "Transportation"
- DOE 5480.24[1], *Nuclear Criticality Safety*, Change 0 (1992)

[1]Cancelled by DOE O 420.1. Compliance with DOE 5480.24 is required until the Contracting Officer directs compliance with DOE O 420.1 or provides other direction to terminate compliance with DOE 5480.24.

- As cited and modified by DOE 5480.24.
  - ANSI/ANS-8.1-1983, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors* (1983)
  - ANSI/ANS-8.3-1986, *Criticality Accident Alarm System* (1986)
  - ANSI/ANS-8.7-1975, *Guide for Nuclear Criticality Safety in the Storage of Fissile Materials* (1975)
  - ANSI/ANS-8.19-1984, *Administrative Practices for Nuclear Criticality Safety* (1984).

ANSI/ANS-8.5-1986, *Use of Borosilicate-Glass Rashig Rings as a Neutron Absorber in Solutions of Fissile Material*, and ANSI/ANS-8.15-1981, *Nuclear Criticality Control of Special Actinide Elements*, are not applicable to TWRS. The technical basis is contained in the *Westinghouse Hanford Company Compliance Assessment and Implementation Plan for DOE Order 5480.24 Nuclear Criticality Safety*, which is attached to Reed (1994).

TWRS is required to comply with the requirements and recommendations of the mandatory ANSI/ANS nuclear criticality safety standards as modified in DOE 5480.24 and summarized below:

- For DOE application, sections of ANSI/ANS-8.1-1983, which discuss the Double Contingency Principle and Geometry Control shall be complied with as written in DOE 5480.24.
- The requirements in ANSI/ANS-8.3-1986 relating to the needs for an alarm system are not applicable to DOE 5480.24. For purposes of DOE 5480.24, Criticality Alarm Systems and criticality detection systems shall be required as written in the order.

6.3 CRITICALITY CONCERNS

This section identifies the fissile isotopes contained within TWRS facilities, describes the associated waste forms, cites the locations of potential criticality hazards, describes the associated control measures, and discusses the potential for a criticality accident at the TWRS facility. Additional discussion of the technical basis for the TWRS criticality safety program is found in Appendix F, "Criticality."

6.3.1 Description of Fissile Material at Tank Waste Remediation System Facilities

Some fissionable materials were sent to the waste tanks as part of waste streams because of the physical, chemical, and economic limitations of the separation processes. These limitations prevented the complete extraction of the fissionable isotopes from the purified product stream.

The fissile materials in the tank waste include ^{235}U, ^{239}Pu, ^{241}Pu, and ^{233}U. Fissionable isotopes include ^{237}Np, ^{238}Pu, ^{240}Pu, and ^{241}Am. Because the nonfissile fissionable isotopes are unable to sustain a neutron chain reaction in moderated systems, these isotopes are not a criticality safety concern.

The TWRS facilities that contain or transfer fissionable materials include underground waste storage tanks; waste transfer systems; 204-AR Waste Unloading Facility; the 244-AR Vault; miscellaneous inactive storage facilities (MISFs); double-contained receiver tanks (DCRTs); catch tanks and condensate return systems; the 209-E Storage Area; cribs, ditches, and ponds; and vertical storage units.

The tanks classified as MISFs (Chapter 2.0) were used for a wide variety of operations that were substantially different than the bulk tank farm operations. These operations included the storage of acidic waste and use as experimental vessels. In addition, some MISFs were fabricated from a variety of materials including mild steel, stainless steel, and concrete. The criticality arguments presented in this chapter that are acceptable for the bulk tank farm storage operations are not valid arguments for the MISFs considering the different construction of the MISFs and the different operations conducted in the MISFs. Therefore, this safety analysis report is not an acceptable safety basis for MISFs in their uncharacterized condition. To reinforce this point, the controls identified to protect against an inadvertent criticality include a specific key element to prohibit activities in MISFs until waste characterization data is obtained. Section 3.3.2.4.1 summarizes the Technical Safety Requirement controls identified to prevent the nuclear criticality accident.

6.3.1.1 Origin of Fissile Material in Tank Waste Remediation System Facilities. Plutonium-containing wastes were routed to the underground storage tanks from five different chemical processing plants that operated at the Hanford Site between 1944 and 1988. These processes routinely discharged wastes to the tanks in the form and composition specified in associated chemical process flowsheets. Between 500 and 1,000 kg (1,100 and 2,200 lb) of plutonium are currently being stored in the waste tanks. The 1,000 kg (2,200 lb) is a bounding number regarding plutonium, since the processing efficiencies exceed the nominal efficiencies reported by the processing plants.

The plutonium separation plants have not operated since 1988, and the associated equipment is being decontaminated. The continuing decontamination of these facilities requires the transfer of waste that contains traces of plutonium to the underground storage tanks.

Various metal hydroxides and hydrated oxides were formed when sodium hydroxide was added to the acidic waste solutions. The abundant evidence that exists indicates that all the waste streams contained only very small amounts of plutonium combined with large concentrations of neutron absorbers like iron, aluminum, and uranium (WHC-SD-WM-SARR-003, *High-Level Waste Tank Subcriticality Safety Assessment*).

All radioactive waste that is handled, stored, or transported by or to TWRS facilities contains low concentrations of fissionable material. Regardless of the waste form, the concentration of plutonium is low and the concentration of neutron absorbers is high, relative to the concentration needed to achieve a criticality.

6.3.1.2 Basic Waste Forms. The fissile material sent to waste storage resides in three waste forms: sludge, supernate, and salt cake. The chemical and physical considerations of the plutonium in each waste form have been evaluated and are summarized in the following subsections.

6.3.1.2.1 Sludge. Most of the plutonium sent to the storage tanks resides in the sludge that forms the settled-solids portion of the waste. Three chemical mechanisms by which the plutonium may enter the sludge were considered:

- Sorption onto precipitated metal oxide sludge particles
- Precipitation as pure plutonium oxide crystals
- Formation of solid-solid solutions with nonneutron absorbers such as Zr(IV) and Bi(III).

The sorption bonding of plutonium to strong neutron-absorbing metals such as iron and manganese provides direct assurance of sufficient neutron poisoning to prevent an accidental tank criticality. If pure hydrous plutonium oxide were formed as a crystalline precipitate when acidic wastes were made alkaline, the plutonium oxide particles would agglomerate or mix with neutron absorbers. For nuclear criticality to occur, large plutonium particles, tens of micrometers in size with minimal neutron absorbers, must be created and then concentrated by some hydraulic force. Literature data and hydraulic modeling calculations (WHC-SD-WM-TI-757, *Fluid Dynamics, Particulate Segregation, Chemical Processes, and Natural Ore Analog Discussions that Relate to the Potential for Criticality in Hanford Tanks*, and PNL-11304, *The Potential for Criticality in Hanford Tanks Resulting from Retrieval of Tank Waste*) performed to date indicate that creation and separation of such plutonium-bearing particles are not plausible. A possible precipitation mechanism is the selective formation of individual crystals of $PuO_2 \cdot H_2O$, despite the presence of many other constituents that could precipitate.

Small amounts of plutonium oxide were added to Tank 241-SY-102. This plutonium oxide was material that did not dissolve during the processing of various plutonium scraps and remained suspended in feeds to the tributyl phosphate solvent extraction process.

Another co-precipitation mechanism is solid solution formation in which a plutonium ion can replace a metal ion present in a crystalline lattice. Because the ionic radius of Pu(IV) differs so much from those of Fe(III) and Al(III), solid solution of these three metal ions can be discounted. However, the ionic radii of Pu(IV), Zr(IV), La(III), and Bi(III) are quite similar and solid solutions of these four ions occur in wastes (e.g., zircaloy cladding waste and $BiPO_4$ process waste). These latter waste solutions contained large concentrations of Fe(III); therefore, in addition to solid solution formation with Zr(IV), Bi(III), or La(III), some of the plutonium co-precipitated with hydrated iron oxide.

6.3.1.2.2 Supernate. The liquid portion of waste above the settled sludge is known as supernate. Within liquid portions of any tank, thermal gradients tend to promote mixing; consequently, this region of the tank should be inherently homogeneous. The concentration of plutonium in these aqueous solutions is very low because plutonium is efficiently removed as product before waste neutralization. The solubility of plutonium oxyhydroxide is also very low (WHC-SD-WM-TI-725, *Tank Farm Nuclear Criticality Review*).

6.3.1.2.3 Salt Cake. The major components of salt cake are sodium nitrate and sodium phosphate that crystallized during evaporation and subsequent cooling of the saturated waste solutions. Any plutonium dissolved in these solutions likely did not reach saturation with respect to plutonium oxyhydroxide solubility; thus, some plutonium remained in solution as the sodium salts crystallized. Plutonium does not form a solid solution with any of the crystallized sodium salts and, hence, remains in the interstitial liquor when crystallization is complete. If any plutonium-bearing solutions did become oversaturated, pure-phase plutonium oxyhydroxide would likely have formed. Only insignificant amounts of plutonium (if any) were sorbed on the salt surface.

6.3.1.3 Fissile Material in Double-Shell Tanks, Single-Shell Tanks, and Double-Contained Receiver Tanks. The waste in the tank farms is contained within double-shell and single-shell storage tanks. In the process, some transferred waste is routed through DCRTs. This fissile material may be in any of the three basic waste forms: sludge, supernate, or salt cake.

Tank waste at TWRS facilities is described in WHC-SD-WM-TI-725 as follows:

- The plutonium concentration in the liquid is generally much less than that in the precipitated solids.
- The sludge contains most of the plutonium, and the plutonium is broadly distributed throughout the sludge.
- The plutonium was precipitated along with neutron absorbers to form sludge. The plutonium is tightly bound with the absorbers and is not easily removed.
- The areal concentration of plutonium required for criticality 2,580 g Pu/m^2 (240 g Pu/ft^2) corresponds to a plutonium inventory in a single tank that is near the "upper limit value" inventory in all of the TWRS tanks combined.

The fissionable isotopes potentially present in waste are ^{233}U, ^{235}U, ^{238}Pu, ^{239}Pu, and ^{241}Pu. Because ^{235}U is always combined with a quantity of ^{238}U sufficient to ensure that the uranium is subcritical, the ^{235}U can usually be ignored. When the ^{235}U is greater than 0.72 wt% of the uranium, it is treated as if it were ^{239}Pu and added to the plutonium for concentration and total mass calculations.

The ^{233}U content of the waste streams is described in WHC-EP-0793, *Estimation of Plutonium in Hanford Site Waste Tanks Based on Historical Records*, as follows:

> Another fissionable (sic) isotope of criticality concern is ^{233}U. The thorium irradiation process resulted in the direct production of ^{233}U, which was then recovered with the Plutonium Uranium Extraction (PUREX) process. The waste from this recovery was discharged to the waste tanks. Since the recovery of ^{233}U from thoria was much more difficult than the separation of plutonium from uranium, the recovery efficiency was less (approximately 95%). Approximately 45 kg of ^{233}U were discharged to the Hanford Site waste tanks from the 1966 and 1970 thoria campaigns.

The ^{233}U was transferred into Tanks 241-C-102 and 241-C-104 during the thoria campaigns of 1966 and 1970. ^{233}U has a larger critical mass than ^{239}Pu in systems which have fissile material concentrations below 50 g/L, which is typical of the waste in Tanks 241-C-102 and 241-C-104 and indeed any of the other waste tanks. Therefore, adding the ^{233}U to ^{239}Pu for all concentration and total mass calculations is a conservative treatment of ^{233}U with respect to criticality safety. The practice of adding the concentration and quantity of fissile uranium isotopes to plutonium is referred to as "plutonium equivalence". Discussions about the nuclear criticality safety of tank waste which refer solely to plutonium are making reference to plutonium equivalence (WHC-SD-SQA-CSA-20368, *CSER 94-004: Criticality Safety of Double-Shell Waste Storage Tanks*).

6.3.1.4 Fissile Material in Piping Used for Waste Transfers. A description of the transfer of waste products from source facilities and among the TWRS facilities is given in Chapter 2.0. The waste transfer process includes flushing operations to prevent accumulations in the transfer piping and other waste transfer-associated structures such as valve pits, pump pits and diversion boxes.

Because individual transfers between storage tanks contain suspended fissile material bearing solids or trace amounts of those solids in the supernate, the transfers are governed by the criticality safety requirements on the receiving tank. The waste acceptance criticality safety controls on transfers among the TWRS facilities or tanks are in place to ensure that the accumulation of fissile material concentrations, or quantities, that could result in a criticality is prevented. The tank waste transfer system contains fissile material only when a transfer is actually in progress. When a transfer is complete, the transfer line and equipment is flushed.

6.3.1.5 Fissile Material in the 204-AR Waste Unloading Facility. The fissile form and inventory for the 204-AR Waste Unloading Facility is controlled by the criticality safety

restrictions on the transport vehicles (e.g., railcars and trailer trucks) and by the TWRS waste receipt controls. These restrictions on fissile material concentration and waste chemistry ensure the criticality safety of the 204-AR Waste Unloading Facility.

6.3.1.6 Fissile Material in the 244-AR Vault. The 244-AR Vault uses the same criticality safety procedures and controls that govern the double-shell tanks and other TWRS facilities containing tank waste. Similarly, the 244-AR Vault uses the same operating restrictions on concentration of fissile material, transfer restrictions, and waste chemistry requirements.

The 244-AR Vault is an inactive facility that contains a small quantity of waste in its four process tanks. The composition of the waste is basically unknown, but it is expected to be similar to the waste streams routed through the facility. Any retrieval or distribution of the waste, except sampling, must be preceded by an evaluation according to WHC-CM-4-29, *Nuclear Criticality Safety Manual*.

6.3.1.7 Fissile Material in the Miscellaneous Inactive Storage Facilities. The composition of the waste material in the MISFs is expected to be similar to the waste streams that were routed through these tanks, hence, similar to tank farm waste. Any retrieval or distribution of the waste, except sampling, must be preceded by an evaluation according to WHC-CM-4-29.

6.3.1.8 Fissile Material in the Catch Tanks and Condensate Return Systems. The catch tanks and condensate return systems have a relatively small volume capacity compared with the waste tanks and are restricted to the same fissile concentration requirements as the other TWRS tank waste operations. These catch tanks and condensate return systems contain only trace amounts of fissile material.

6.3.1.9 Fissile Material in the 242-A Evaporator. The operation and criticality safety of the 242-A Evaporator is analyzed in WHC-SD-WM-SAR-023, *242-A Evaporator/Crystallizer Safety Analysis Report*. The 242-A Evaporator is not included in the scope of this safety analysis report.

6.3.1.10 Fissile Material in the 209-E Storage Area. Nearly all of the waste stored on the less than 90-day storage pads is nontransuranic *Resource Conservation and Recovery Act of 1976* waste. This category of waste contains less fissile material than the regulated limit for criticality safety. The low-level radioactive waste in the Intermediate Holding Area is also non-transuranic. If transuranic waste is placed on the less than 90-day waste storage pad or in the Intermediate Holding Area, the fissile content in the containers is controlled following the fissile content controls established for the container.

Hazardous, mixed, and radioactive waste/material generated within the tank farm facilities, as well as generated by other Project Hanford Management Contract companies is received at the 209-E Storage Area. The Less Than 90-day storage pad is used to temporarily store hazardous waste and mixed waste. The Intermediate Holding Area is a staging area for low-level radioactive waste. The definition of hazardous waste is found in 40 CFR 261, "Identification and Listing of Hazardous Waste", while dangerous or extremely hazardous waste is designated in

WAC 173-303, "Dangerous Waste Regulations." Considering the 15-g fissile material shipment limit (Section 6.4.2.2.1), the waste acceptance criteria for the hazardous, mixed, low level, recyclable, hazardous material, or non-regulated Tank Farm and non-Tank Farm generated waste are not based on criticality safety concerns.

6.3.1.11 Fissile Material in the Cribs, Ditches, and Ponds. The fissile material in the cribs, ditches, and ponds has been estimated on the basis of operating history and is assumed to be distributed in the soil matrix below each waste site. Because it is mixed with the soil, the chemical and physical characteristics of the fissile material discharged to the ground differ from that in the waste tanks.

The current criticality prevention specification (CPS) for these deactivated sites permits a limited range of activities, related to discovery, characterization, and stabilization. The specification is not intended to cover relocation of appreciable amounts of plutonium-contaminated soil. A criticality safety evaluation will be performed prior to authorizing activities affecting the fissile material in the cribs, ditches, or ponds.

Section F6.1.4 contains additional details related to the potential for a criticality in soil.

6.3.1.12 Fissile Material in the Vertical Storage Units. The vertical storage units are described in Chapter 2.0. Vertical storage units are designed and used for storage of radiologically contaminated equipment (e.g., as caps for tank risers). These units are not involved with the storage of waste; hence, only contamination quantities of fissionable material are expected. Therefore, the vertical storage units may be characterized without any distribution of the fissile material. However, the detection of greater than an exempt quantity of fissile material will require an evaluation of the criticality hazards before additional work is performed.

6.3.1.13 Fissile Material in Ventilation Systems. Fissile material stored in alkaline salt waste solutions exists primarily in the precipitated solid phase. The solubility of plutonium is about 0.002 g Pu/L in solutions which do not contain materials that form complexes with plutonium (WHC-SD-WM-TI-725). The upper bound concentration of plutonium found in the supernate samples is 0.2 g Pu/L (WHC-SD-WM-SARR-003). Suspended plutonium containing particulate does not exist as discrete plutonium particles, but rather in the form of neutralized oxyhydroxides that are neither easily airborne nor volatile. Because other insoluble oxyhydroxides precipitated in great excess with plutonium oxyhydroxide, co-precipitation of plutonium with the sludge-forming solids occurred. Several likely co-precipitation mechanisms are important. The most important mechanism is believed to be sorption of plutonium oxyhydroxide on the solid metal oxyhydroxides (WHC-SD-WM-TI-725). One potential mechanism for plutonium containing particulates to become deposited in ventilation ducts or filters would be the aerosolization of dried particulate. The co-precipitation of plutonium with the other oxyhydroxides into agglomerates will result in a mass ratio of neutron absorbers to plutonium which is consistent with typical tank waste.

The accumulation of waste solids in the ventilation ducts or on filter media is not expected to change the distribution of absorbers to fissile material. Since the highest plutonium concentration found in a sample analysis is 0.35 g Pu/L (WHC-SD-WM-SARR-003) the volume

of solid waste which contains a minimum critical mass of 520 g ^{239}Pu is equal to 1,486 L. With tank farms typical ventilation duct diameters of about 25.4 cm (10 in) (Chapter 2.0) a layer of solids 292.1 cm (115 in) is required to achieve 520 g. The air flow path would certainly be plugged with this amount of solid waste on the filter.

Another way to review the margin of safety for the accumulation of fissile material in ventilation systems is to consider that the minimum critical plutonium concentration of an infinitely long 25.4-cm (10-in.) -diameter cylinder is 22 g Pu/L (ARH-600, *Criticality Handbook*, Volume 1) which assumes there is no ^{240}Pu. So, with a plutonium concentration of 0.35 g Pu/L of waste, a plutonium concentration increase of 63 times is required for criticality to occur. There is no identified mechanism which would facilitate this concentration factor.

6.3.2 Criticality Accident Scenarios

It has been shown that a criticality at TWRS is not credible during operations covered by this safety analysis report.

Essentially all of the plutonium under the custodial responsibility of TWRS is located in the underground storage tanks with the remainder held up in associated piping and transfer systems. Therefore, the consequences of a postulated hypothetical accident in a waste storage tank was analyzed based on a transfer of a small volume of very high concentration plutonium from the Plutonium Finishing Plant (PFP). The accident scenario involves a series of implausible events that would include the violation of multiple management practices (i.e., operational limits, controls, and procedures) and equipment controls. This series of violations would have to occur in combination with the formation and concentration of the plutonium into a small, compact volume (e.g., spherical geometry) in a waste tank rather than the more likely and less reactive deposit in a planar vein deposit (i.e., slab-like layer) that usually occurs when waste flows into a tank. Even with these implausible events and a postulated criticality accident, the consequences were within the risk guidelines.

For the purposes of criticality safety, no restrictions are required on fire fighting at TWRS facilities. The concentrations of fissile materials are very low, and the addition of water cannot lead to criticality (Appendix F).

6.4 CRITICALITY CONTROLS

This section summarizes criticality controls including engineering and administrative controls that are in place to ensure criticality limits are not exceeded. Similarly, this section explains how the application of the double-contingency principle minimizes the potential for a criticality accident.

The criticality controls for TWRS facilities were developed, documented, and applied following the criticality safety program (Section 6.5). The foundation of the criticality safety program is the double-contingency principle described in Section 6.4.3. TWRS implements criticality control practices through facility-specific procedures.

The technical practices and measurement control programs (including the reliability and operability characteristics) are established, periodically evaluated, and subject to the contractor quality assurance program (WHC-CM-4-2, *Quality Assurance Manual*). Chapter 14.0, specifically Sections 14.3.1 and 14.3.2, discuss the Hanford Site quality assurance program and its implications for all major subcontractors that support the safe operations of TWRS. The laboratories that analyze samples of waste used to determine compliance with criticality safety controls perform their functions according to documented practices that are also routinely assessed.

A description of the decision logic for waste acceptance into the Tank Farms is detailed in HNF-SD-WM-DQO-001, *Data Quality Objectives for Tank Farms Waste Compatibility Program*. The analytes of interest, the analytical technique, and quality control acceptance criteria are discussed. The method detection limit for plutonium is 0.001 g/L which is at the initial action level for waste discharges into Tank Farms. The quality control criteria are based on normal laboratory operating parameters for the analytical techniques in DOE/RL-96-89, *Hanford Analytical Services Quality Assurance Requirements Document*.

Quality control acceptance criteria related to the analytes of concern for criticality are discussed in HNF-SD-WM-DQO-001. These acceptance criteria include laboratory control standards, matrix spikes, and duplicate relative percent difference analyses. The criteria are used to assess the overall accuracy (or uncertainty) inherent in the measured values. One or all of the identified acceptance criteria may be applied to the sampled analytes to satisfy the requirements established by HNF-SD-WM-DQO-001.

A laboratory control standard is a matrix with known concentration of analytes that is processed with each preparation and analyses batch and is carried through the entire method. Results are expressed as percent recovery (i.e., the amount measured, divided by the known concentration, times 100). This acceptance criteria method is applied to sample data retrieved from the analysis of $^{239/240}$Pu, total Pu, $^{235/238}$U, and total U.

For some analytical techniques (e.g., laser-induced kinetic phosphorescence) the sample accuracy is expressed as percent recovery of a matrix spike sample. Results are presented as percent recovery (i.e., the amount measured, less the amount in the sample, divided by the spike added, times 100). One matrix spike is performed according to the riser from which the sample was pulled. If three samples are collected from a single riser, one matrix spike is analyzed.

Matrix spike analysis is only performed for total U. Matrix spike analyses are not required when analyzing $^{239/240}$Pu, total Pu, and $^{235/238}$U because a tracer is used to correct for analyte loss during sample preparation and analysis. The result generated using the tracer accounts for inaccuracy of the method. The reported results reflect this correction.

Relative percent differences are calculated between the sample and the duplicate results. With this criterion, the sample precision is estimated by analyzing duplicates. Acceptable precision is usually <20 % of the relative percent difference if the sample result is at least 10 times greater than the instrument detection limit. Relative percent difference can be expressed in equation form as:

$$\text{Relative Percent Difference} = (|\text{Result 1} - \text{Result 2}|/\text{average result}) \times 100$$

Table 4-4 of HNF-SD-WM-DQO-001 details the recommended detection levels, analytical techniques, and quality control criteria for generator evaluation of analytes important to continued criticality safety. Measurement uncertainties depend on the analytical technique and are provided in laboratory procedures.

Because the mass ratio of plutonium to the absorbers means that two detection limits must be considered simultaneously, detection limits cannot be established at a fixed point. In order to prevent the laboratory from running multiple dilutions on highly radioactive material and, in order to provide useable data for making the assessment of the ratios, the ratio is calculated by the laboratory project manager. If the detection limit is too high and does not allow calculation of an accurate ratio, another analysis at an appropriate dilution must be performed. In order to obtain useable responses for a particular metal, multiple analysis at various levels of dilution may be required. The metals have been prioritized in the order most likely to be present (HNF-SD-WM-DQO-001). The order of ratio evaluation is based on the following metals, in the order presented: uranium, iron, manganese, nickel, chromium, aluminum, and zirconium. Uranium is first analyzed, the ratio calculated, and if the ratio is above the subcritical mass ratio limit, the transfer is allowed. After each metal is checked against the ratio, and all ratios are below limits, additional dilutions must be analyzed and the ratios assessed until a result which passes the ratio is obtained, or until reasonable efforts in dilution indicate that the ratio is exceeded.

Computer software applied to address criticality concerns is developed and used in a controlled and documented manner to ensure that use of the program achieves the intended goal. The software user performs verification and validation runs before use. An extensive number of benchmark calculations for a wide range of waste compositions and geometries are documented by the developers of the computer codes. These calculations provide adequate assurance of the accuracy of the cross-sections. Chapter 14.0 includes discussion of software quality assurance requirements, and Appendix F includes references to computer software that has been used to assess the criticality safety aspects of waste in tank farms.

Criticality benchmark experiments are not available for dilute plutonium in Hanford Site tank waste. Because the neutron spectrum in tank waste is different from that of available benchmark experiments, a subcritical k_{eff} limit of 0.95 is used. Additionally, conservative assumptions were made to encompass the uncertainties in the calculations (Appendix F).

6.4.1 Engineered Controls

Waste with low concentrations of fissile material in a mixture containing a large ratio of neutron-absorbing solids is received at tank farms. Limits on waste discharged into tank farms help to ensure that an unlimited volume of waste cannot be made critical. Criticality safety depends upon receiving and maintaining waste in a form incapable of achieving a criticality.

The PFP generates plutonium-bearing liquid waste streams that are sent to the 244-TX DCRT. Engineered features were installed to address the potential buildup of plutonium-bearing solids in the 244-TX DCRT. An agitator pump and sluicing nozzles circulate the supernatant liquid to keep the solids in suspension to facilitate transferring these solids into an underground storage tank. Neutron monitors are installed to detect a buildup of solids should the sluicing nozzles become plugged. The PFP does not have an inherent quantity of solid-phase neutron absorbers in the waste stream, so iron is added to ensure sufficient shutdown margins. Waste tank characterization samples are taken to confirm that the plutonium is sufficiently diluted with neutron absorbers. The sluicing nozzles and neutron monitors are not considered engineered controls because they cannot prevent a criticality. However, the installation and use of this equipment enhances criticality safety by facilitating transfers and preventing solids buildup.

6.4.2 Administrative Controls

The TWRS criticality safety program is augmented by the application of administrative controls appropriate to TWRS. These controls include procedures for logbook entries, surveillances, instrumentation and monitoring, evaluation of sample results, database maintenance, trend monitoring, audits, and procedures for real or suspected nonconformance.

Criticality safety in the tank farms depends on verifying compliance with the tank farms criticality safety limits and controls prior to transferring the waste. Transfers of waste to the tank farms are limited to waste that is very dilute in plutonium and contains an excess of neutron-absorbing metals. Limits on waste transfers to tank farms are intended to eliminate any need for volume controls to assure that the added waste cannot cause a nuclear criticality.

TWRS criticality safety relies, in part, on the operating performance of non-TWRS facilities. For example, Administrative Control 5.7 specifies requirements for waste transfers from the PFP, B Plant, and the 222-S Laboratories. Personnel in interfacing facilities such as these are cognizant of and trained on TWRS safety requirements. Transfer-specific procedures, which explicitly contain TWRS-specific safety requirements, are written and approved prior to the initiation of transfers of any waste to TWRS. Detailed training and task performance procedures ensure that the responsibilities of facilities interfacing with TWRS meet the requirements detailed in the TWRS Authorization Basis.

The alkalinity of waste supernate is a secondary control with respect to criticality safety. Key element (a) of Administrative Control 5.7 (HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*) is directed at controlling the pH of waste

being transferred from the generating facility to TWRS and not at the current conditions within the waste tanks. The main objective of the control is to protect the conditions of the criticality safety evaluation. Specifically, the evaluation addresses the criticality safety aspects of precipitated plutonium diluted and most likely agglomerated with solid phase neutron absorbers.

A program exists to compare waste tank characterization results for pH to an investigation level of pH 8. This applies only to tanks with greater than 10 kg (22 lb) of fissile material and 30.5 cm (12 in.) of supernate. Thus, the pH requirement on transfers from generating facilities to the waste tanks ensures that the plutonium and metal absorbers are in a solid form and the integrity of the receiving tank is not compromised. The following key element from Administrative Control 5.7 (HNF-SD-WM-TSR-006) is adequate:

- Criticality limits and controls shall be documented in Criticality Safety Evaluation Reports (CSERs) and implemented in Criticality Prevention Specifications (CPSs) and procedures.

The vast majority of fissionable material at tank farms is distributed in low concentrations in tank waste. For waste at this low concentration, criticality safety is assured by the waste composition. Additional limits and controls are not required.

If fissionable material is in a concentration that has not been previously evaluated or is to be received through abnormal channels for tank waste, a criticality safety evaluation will be made before transferring the material to the tank farms. Limits and controls used to permit shipment shall be adequate to permit transfer and storage. If necessary, the CPS for tank farms will be revised, or a new one written.

Criticality safety evaluations address identified concerns within TWRS buildings, facilities, and operations. Operations with fissionable materials that pose a criticality accident hazard are evaluated and documented to demonstrate that the operation will be subcritical under both normal and credible abnormal conditions. Fissionable material operations are conducted so that no single credible event or failure will result in a criticality accident.

Specific administrative controls that are applied to TWRS operations include the following:

- Documented verification of compliance with the specified concentration controls before each transfer containing fissile material

- Maintaining an auditable continuous inventory of plutonium and an assessment of the plutonium concentration in both the solids and supernate for each DCRT and double-shell tank

- Flushing transfer lines with water after each transfer of PFP solutions from DCRT 244-TX.

6.4.2.1 Control of Fissile Material Type. Normally, all fissile material in tank waste is assumed to be ^{239}Pu (including all fissile and nonfissile plutonium and all fissile nonplutonium isotopes). This is a conservative assumption because the fissile cross-section for ^{239}Pu is higher than other fissile isotopes. However, if the composition of a waste stream is well known, the actual waste constituents may be used for the evaluation.

The tank farms do not control the type of fissionable isotopes in the waste streams. Considering all fissile material to be ^{239}Pu provides the conservative position that actual waste will be less reactive than assumed. Because the waste stream disposal options are limited, these conservative controls provide waste storage options regardless of the fissile isotope provided the concentrations are kept very low.

The critical mass of a fissile material depends on the chemical form of the material. For example, chemical compounds of plutonium usually have a larger minimum critical mass than a metal-water mixture. For TWRS facilities, the criticality safety evaluations are usually based on calculations conservatively assuming a metal-water form is present.

6.4.2.2 Concentration Control. Concentration limits are the primary controls used to assure the subcriticality of waste tanks. When the concentration of plutonium is low enough, the fraction of neutrons absorbed in materials other than plutonium becomes so large that criticality is no longer possible. In a water solution, criticality is not possible when the plutonium concentration is less than 7.2 g/L. This value is supported by experimental data. In contrast, using a conservative model for waste solids, the minimum critical plutonium concentration in tank waste was calculated to be 2.6 g/L (WHC-SD-SQA-CSA-20356, *CSER 92-009: An Analytical Model for Evaluating Subcritical Limits for Waste in Hanford Site Storage Tanks*). At this concentration, the waste tanks are subcritical regardless of the waste volume or total quantity of plutonium.

The goal of concentration control is to ensure that a plutonium concentration in excess of the minimum critical concentration does not occur anywhere in the waste. Because of the limited controls on distribution of the waste after discharge to a tank, the waste must be transferred with a large margin of safety. This is accomplished by placing multiple controls on the waste before discharge to the tanks. Examples of controls include the following:

- Waste is made alkaline to ensure that plutonium and solids are precipitated out of solution in a stable chemical form. This chemical stability keeps the plutonium locked up in the solids and, therefore, less mobile.

- Fissile concentrations of waste received from source facilities are limited to very low values.

- The vast majority of waste is discharged with a large ratio of solids-to-fissile material.

A waste characterization program is actively sampling waste throughout tank farms. Characterization data is examined for adherence to criticality safety controls. WHC-SD-WM-SP-004, *Tank Safety Screening Data Quality Objective*, describes the screening

process used to identify the status of static-state waste. The primary screening criterion is the total alpha concentration (assuming all fissile material is ^{239}Pu) in the solids. The secondary screening criterion is the subcritical ratio of neutron absorbers to plutonium.

In the sludge, which contains fissile material, the settled solids are a significant portion of the diluent. The nonfissionable solids act as neutron-absorber materials (WHC-SD-WM-TI-725). (Appendix F has additional information regarding neutron absorbers.) An iron-to-plutonium mass ratio of more than 160 assures that criticality is not possible, and an aluminum-to-plutonium mass ratio of more than 910 assures subcriticality. The ratio values for waste streams from originating facilities (except those from the PFP) contained absorber-to-plutonium ratios sufficient to guarantee subcriticality. Iron was added to waste from the PFP after processing was complete.

6.4.2.2.1 Radioactive Material/Waste Shipments. The requirements for activities involved with controlling the movement of fissionable material from facility to facility onsite and shipments offsite are delineated in HNF-PRO-545, *Fissionable Material Packaging, and Transportation*. The requirements in HNF-PRO-545 refer only to criticality safety and do not constitute all requirements involved in fissionable material movement or shipment. The manager of Transportation and Packaging administers the nuclear criticality safety program insofar as it applies to the certificate of compliance, U.S. Department of Transportation specification, or DOE 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*, in (1) loading, transportation and unloading of intact/sealed fissionable material packages for off-site shipments, (2) receiving, storing and shipping of fissionable material packages in the 1100 Area, and (3) notifying facility managers before handling any damaged fissionable material package.

The manager of facilities that packages and offers a shipment of radioactive material/waste for offsite/onsite transport must ensure that only appropriately trained personnel are employed to load and transport radioactive material packages and that these personnel comply with applicable operating procedures that provide for nuclear safety, environmental, quality assurance, security, exposure and contamination control and packaging and transportation requirements for fissile and other radioactive materials, as well as applicable federal, state, and contractor requirements such as Safety Analysis Reports for Packaging.

Fissile material packaged for transportation which is U.S. Department of Transportation designated fissile material is also special nuclear material of national strategic importance, therefore; additional controls for security and safeguards are mandatory. TWRS is not involved in U.S. Department of Transportation designated fissile or special nuclear material transportation either onsite or offsite. The requirements for Radioactive Material/Waste Shipments is specified in HNF-PRO-157, *Radioactive Material/Waste Shipments*.

All offsite shipments of greater than 15 g of fissile material shall be packaged in either U.S. Department of Transportation specification packages consistent with 49 CFR 173.417, "Authorized Fissile Materials Packages," or in packages approved by the DOE or the U.S. Nuclear Regulatory Commission for transportation of fissionable material. Approved packages do not require additional criticality safety reviews.

All onsite shipments of greater than 15 g of fissile material not packaged in offsite packages shall be packaged in packages reviewed and approved by the approval authority and the DOE Richland Operations Office, when applicable. Environment, Safety and Health and Quality Assurance shall review onsite packages for criticality safety concerns. Onsite shipments shall be made in accordance with both shipping and receiving facility criticality shipping specifications or facility fissile material status and the package authorized fissile contents based on the package safety analysis documentation.

6.4.2.3 Neutron Absorption. Materials that absorb neutrons that may otherwise cause fissions are called neutron absorbers. Neutron absorbers can be designed to make criticality theoretically impossible, but assuring the continuous and pervasive presence of the absorber is always a practical concern. Therefore, the fissile materials present in tank waste contain large amounts of several effective neutron absorbers.

The vast quantity of nonfissionable solid components of the waste dilutes the plutonium. These solid constituents provide a level of neutron absorption that effectively ensures criticality safety. A verification of the subcritical plutonium concentration in the solid phase of the waste is as easily performed with absorber-to-plutonium ratios as it is with absolute measurements of the plutonium concentration.

Some very effective neutron absorbers often found in tank waste include the following:

- **Fission Products**—Isotopes that are produced by fissioning the uranium fuel.

- **^{238}U, Iron, Manganese, Chromium, and Nickel**—Insoluble materials that are found in the sludge waste form. These materials were part of the processed (dissolved) reactor fuel or, in some cases (notably iron), were deliberately added in large quantities to the waste as previously discussed.

- **Aluminum, Sodium, and Nitrate**—Soluble neutron absorbers that are in liquid or salt cake waste forms.

- **Water**—When plutonium is present in low concentrations, such as in waste, water often provides significant neutron absorption. This absorption increases the minimum plutonium concentration required to achieve criticality. For example, in pure water, the minimum critical plutonium concentration is 7.2 g/L; however, in completely dry solids, the minimum critical concentration is only 2.6 g/L.

6.4.2.4 Controls on Geometry, Moderation, Reflection, and Interaction. At plutonium concentrations less than the minimum critical concentration of 2.6 g Pu/L of solids, an unlimited volume of tank waste will remain subcritical for all degrees of water moderation, from very dry to flooded, and for any degree of reflection. The conservative derivation of the minimum critical concentration determined at optimum moderation and full reflection assures that for any plutonium concentration less then 2.6 g/L, there is no need for controls on moderation or reflection.

The large dimensions of the waste tanks preclude the need for controls on the geometry or interaction. As discussed in Appendix F, a 7.6-cm transfer line would require a 7,000 g Pu/L solution to go critical, and a 15-cm line would require 100 to 1,000 g Pu/L to go critical (LA-10860-MS, *Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U*). Plutonium solutions of this concentration do not exist. The controls on the composition of the waste streams ensure the waste is subcritical regardless of the degree of interaction or geometry. The extremely large degree of conservatism in the criticality safety evaluations are intentional inclusions to preclude the need for controls on moderation, geometry, reflection, redistribution, and interaction.

6.4.3 Application of the Double-Contingency Principle

The double-contingency principle, as stated in DOE 5480.24, is as follows:

> Process designs shall incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible. Protection shall be provided by either (a) the control of two independent process parameters (which is the preferred approach, if practical) or (b) a system of multiple (at least two) controls on a single parameter. In all cases, no single failure shall result in the potential for a criticality accident. The basis for selecting either approach shall be fully documented.

A contingency is defined as an unlikely action, event, or occurrence that causes a change in operating conditions such that a prescribed safe operating condition or limit is exceeded.

Specifications for the transfer of fissile material-bearing waste into the tank farms are designed to place at least two controls on the concentration of plutonium in the tanks. The subcritical plutonium concentration in waste tank solids is 2.6 g/L (WHC-SD-SQA-CSA-20356), so for all plutonium concentrations less than this value the waste will be subcritical regardless of the quantity of plutonium. Administrative Control 5.7 (HNF-SD-WM-TSR-006) limits the plutonium concentration in liquid/solid mixtures to less than 0.04 g/L averaged over the entire volume of transferred waste to ensure the concentration of plutonium in the solid waste is less than 1.17 g Pu/L. The value of 1.17 g Pu/L is 45% of 2.6 g Pu/L (WHC-SD-SQA-CSA-20356) which has been defined as the acceptable margin of subcriticality (HNF-PRO-537, *Criticality Safety Control of, Fissionable Material*).

The second control on plutonium concentration is the subcritical mass ratio of absorbers to plutonium. A component of the waste of which the mass ratio to plutonium exceeds the subcritical mass ratio will ensure the waste is subcritical regardless of the concentration of plutonium. The specifications require at least one of the identified subcritical mass ratios must be met when the plutonium concentration of a waste batch exceeds 0.001 g Pu/L.

With the failure of these two controls, many other contingencies must also fail before criticality safety is a concern. For example, the waste tanks are very large, so the plutonium will spread out over the tank bottom. A localized area of waste that has a plutonium concentration in

excess of the specifications must also have accumulated a mass of plutonium sufficient to be critical for the given plutonium concentration. Also, because the plutonium will be generally in a flat slab, the mass of plutonium required to be critical is considerably higher than for a more spherical geometry. The evaluation of the slab geometry provides the criticality safety consideration of the plutonium spread out over the waste tank bottom. Since the spherical geometry provides the smallest surface area for a given volume, the criticality safety evaluation of a sphere bounds any other geometrical figure, like a cone, cylinder or torroid, because the neutron leakage will be the smallest for a sphere. Because there is basically no control over the tank size or the geometry of the waste, the plutonium concentration is controlled to no more than 45% of the subcritical limit.

The inability to control the localized plutonium concentration or geometry of the plutonium-bearing waste is compensated for by minimizing the migration of the fissile materials. Ensuring the waste is alkaline provides confidence that the fissile material is in the solid phase, (WHC-SD-WM-TI-725) which is consistent with the criticality safety evaluation and minimizes the mobility of the fissile particulate.

The vital criticality safety controls over tank waste composition are exercised before the discharge of waste to the tank farms. Before discharge, the waste is collected in a holdup tank which is controlled to remain subcritical. The waste composition is verified to be in full compliance with tank farms CPSs before the waste is transferred to the tank farms. Once the waste is contained in underground waste tanks, there is very little control that can be exercised over the distribution of the fissile material, as explained above.

6.5 CRITICALITY SAFETY PROGRAM

An overview of the organizational structure and interfaces and the technical and administrative practices of the TWRS criticality safety policy and programs are presented in this section. TWRS procedures define the facility-specific activities, responsibilities, and records by which the contractor criticality safety program is implemented. Collectively, these program elements ensure that criticality safety is responsibly applied, thoroughly documented, well understood and communicated, and vigorously enforced. If a nonconformance is detected, these procedures specify appropriate and prudent response actions that investigate criticality safety after the nonconformance occurs and identify any corrective actions.

6.5.1 Criticality Safety Organization

The TWRS policy for implementing the criticality safety requirements of DOE ensures that all employees involved in operations with fissionable materials are informed of the criticality safety requirements. TWRS management exercises overall responsibility for the criticality safety of operations by delegating the authority and assigning the responsibility for day-to-day criticality safety of operations to the management of the respective facilities.

The TWRS operating organization has responsibility for ensuring criticality safety at TWRS facilities and for implementing the provisions of the criticality safety program (WHC-CM-4-29).

6.5.1.1 Tank Waste Remediation System Management. TWRS management ensures that applicable criticality safety standards, DOE orders, and the contractor criticality safety program are implemented in facility operations under their control.

TWRS management appoints a criticality safety representative and an alternate, as necessary, to perform several related duties. These duties ensure that (1) day-to-day program activities are performed, (2) certification and ongoing training is provided, (3) organizational cooperation is arranged and provided, and (4) prompt attention is given to issues.

6.5.1.2 The Tank Waste Remediation System Criticality Safety Representative. TWRS management appoints a criticality safety representative to coordinate the criticality safety program for operations and facilities. The TWRS criticality safety representative and alternate for TWRS facilities are certified according to the TWRS criticality safety program.

The criticality safety representative and alternate are required to pass the formal Criticality Safety Training Course for Managers and Engineers to meet formal qualification requirements and maintain certification. Attendance at the annual criticality safety representative training meeting, given by the Fluor Daniel Hanford, Inc., Nuclear Safety organization, is also required. Additional criticality safety training is primarily self-taught and consists of facility specific information, policy requirements and review of various subject-specific material provided by other criticality safety specialists. The criticality safety representative and alternate certification is completed by examination by a qualification board. Qualification board members represent the facility safety review organization, process/plant engineering, the operating organization, a criticality safety specialist, and may include others as agreed to by the board. The criticality safety representative has the following responsibilities:

- Serve as liaison for criticality safety issues among the organizations that have responsibilities in the TWRS facilities criticality safety program
- Coordinate the preparation, review, and approval of evaluations and CPSs for TWRS operations
- Provide advice and assistance in facility-specific criticality safety training
- Assist in the preparation of recovery plans in the event of a nonconformance related to criticality safety
- Conduct or supervise the operational inspections for criticality safety program compliance
- Review and approve facility procedures that affect the criticality safety program.

6.5.1.3 Criticality Safety Training Program. Formal criticality safety training classes are required for TWRS employees who are directly involved in the design or operation of equipment for the handling, storage, or transportation of significant quantities of fissionable material. This training program is provided at least every 2 yr or at a frequency as defined in training program procedures.

6.5.1.4 Independent Safety Review Organization. An independent safety review performed by the Nuclear Safety organization (Section 17.3.2.2.2) shall provide the following functions:

- Review and approve the criticality safety evaluations and CPSs for TWRS facilities
- Review and approve administrative and operating procedures for criticality safety at TWRS
- Review nonconformance reports and approve corrective action plans for criticality safety-related issues
- Conduct periodic criticality safety inspections of TWRS operations and criticality safety training (see also Section 6.5.5).

6.5.1.5 Criticality Safety Analysis Support. The Fluor Daniel Northwest, Inc., Criticality and Shielding organization (Chapter 17.0) provides personnel familiar with the physics of criticality and with the associated safety practices. The criticality safety technical organization supports the criticality safety program by (1) providing technical guidance and analytical services to TWRS operations and (2) assisting in the development of training programs and nonconformance recovery plans.

6.5.1.6 Emergency Preparedness. The emergency preparedness organization provides advice and assistance in preparing emergency plans for TWRS facilities and in conducting emergency drills or tabletop exercises.

6.5.1.7 Quality Assurance. Rigorous procedures and calibration standards are applied to the laboratories that supply data used to determine the tank waste inventory used in the TWRS facilities criticality safety program. Assessments are also periodically conducted to determine conformance with criticality control.

6.5.2 Criticality Safety Plans and Procedures

The TWRS criticality safety administrative procedure implements the provisions of the criticality safety manual, WHC-CM-4-29, for TWRS facilities. The criticality safety program applies to all transfer and storage operations involving fissionable material quantities in excess of 15 g.

The following administrative measures specified in the WHC-CM-4-29 are applied to operations at the TWRS facilities:

- Criticality safety evaluation reports that (1) document that criticality is prevented by the form and distribution of the fissionable material and (2) establish criticality safety controls for particular operations
- Criticality prevention specifications that implement criticality safety limits and controls
- Appropriate postings of criticality safety information
- Criticality safety training program
- Inspection and audit program to evaluate compliance with criticality safety controls
- Program for response to special conditions.

6.5.3 Criticality Safety Training

TWRS facilities transfer and store significant quantities of fissile material, therefore, a criticality safety training program is maintained. This program facilitates an understanding of (1) the criticality safety controls implemented at the processing facilities that discharge waste, (2) the characteristics of tank waste that ensure a large margin of safety, and (3) the controls used at tank farms.

The training organization maintains the course content and documents training plans and employee participation. As discussed in Chapter 12.0, TWRS facility managers (or delegates) are responsible for ensuring that their employees are trained in the operation of the facility. This includes preparing nuclear criticality safety training materials, reviewing and approving the curriculum, critiquing the presentation of the curriculum, and the instructor's performance. All TWRS employees receive the general employees (including subcontractors supporting TWRS activities) criticality safety training as part of the Hanford General Employee Training program for contractor employees and when appropriate, nuclear criticality safety facility specific training based on the employees' work location.

6.5.3.1 Training for Tank Waste Remediation System Managers and Engineers. The TWRS managers and engineers who are directly involved in the design of equipment for the handling, storage, or transportation of significant quantities of fissionable material attend the formal biennial criticality safety training class.

6.5.3.2 Annual Training for Tank Waste Remediation System Staff. TWRS personnel (including subcontractors supporting TWRS activities) receive Hanford General Employee

Training annually. This training explains emergency actions to be taken in the event of an inadvertent criticality.

6.5.3.3 Other Tank Waste Remediation System Classes for Criticality Safety. Other briefings that are specialized or targeted for specific applications at TWRS briefings include the following:

- Job-specific orientation follows the formal biennial training. This orientation is for employees who attend the formal criticality safety classes.

- Special job-specific orientation is provided before a new or modified CPS is used. This orientation is for operators and their immediate managers who use the new (or modified) CPS.

- Facility-specific orientation is provided for all TWRS personnel to explain the criticality safety status of the TWRS facilities. This orientation is given with the TWRS orientation class.

6.5.3.4 Criticality Safety Representative Training. In addition to qualification, TWRS management encourages professional development for criticality safety representatives. Activities include national meetings of the criticality safety technical community, workshops, or topical meetings; preparation of papers for such meetings; consultations with criticality safety regulatory authorities; university classes or short courses on criticality safety topics; or local or national forums on waste safety issues.

6.5.4 Determination of Operational Nuclear Criticality Limits (Controls)

A formal process is used to establish, evaluate, document, and approve operating controls for criticality safety. The process also ensures the controls are communicated to the operations managers and staff.

6.5.4.1 Criticality Safety Evaluations. The criticality safety evaluations for TWRS operations are the responsibility of the TWRS facility operations managers (e.g., SSTs and DSTs).

Directions for preparing an evaluation, including the parameters that are considered, the applicable margin of safety, the error conditions considered, the content and format of the report, recordkeeping requirements, and recommended controls are described in the criticality safety manual (WHC-CM-4-29). The evaluation documented in each report demonstrates that the double-contingency principle is met.

A criticality safety evaluation is used to establish the classification of the TWRS facilities. The evaluation documents the rationale for safety of specific operations, storage arrangements, and the handling and transfer of fissionable material. Any planned change or modification of the

fissionable material processes evaluated in the criticality safety evaluation must be evaluated before the changes or modifications are permitted. A new criticality safety evaluation may not be required if planned changes do not impact the conclusions of the previous criticality safety evaluation.

6.5.4.2 Criticality Prevention Specifications. Criticality safety controls are implemented by CPSs. The criticality safety manual (WHC-CM-4-29) specifies preparation, review, approval, and control of the CPSs. CPSs provide the operations managers and staff with a clear, concise list of criticality controls that are established and documented in the criticality safety evaluation report. The specifications are required only if an evaluation specifies that controls must be in place to assure a criticality is prevented or to protect parameters of the evaluation. Evaluations may not always conclude that controls must be implemented (i.e., mixer pump operations).

The CPS documents are maintained in read-only computer files that are readily accessible in control rooms and shift offices. The read-only files prevent changes or modifications without proper approval, which assures the reader that the most recent version is being viewed. Some of the controls and discussion in the specifications are incorporated into operating procedures and data sheets. Criticality safety controls that are incorporated into operating procedures are concise, unambiguous, and clearly marked as a criticality safety control.

6.5.4.3 Posting for Criticality Safety. Criticality safety postings supplement operating procedures by providing operators with ready reference to key CPS limits and controls. The postings should not include limits on operations that are not controlled by the operator. The TWRS facility operations managers are responsible for developing criticality posting criteria that are reviewed and approved by the independent safety organization. The posting criteria for TWRS allows an exemption for postings because no key limits or controls are readily observable to the operators.

6.5.5 Criticality Safety Inspections/Audits

WHC-CM-4-29 describes the responsibilities and requirements for periodic criticality safety inspections, assessments, and appraisals of TWRS facilities. These activities are performed to verify that criticality safety requirements are implemented and to measure the effectiveness of the program.

Formal inspections are conducted by the facility criticality safety representative, or alternate. The inspections are conducted at a frequency dictated by the number of fissionable material movements and with the approval of the independent safety organization. In accordance with HNF-IP-1266, *Tank Farms Operations Administrative Controls*, a TWRS internal criticality inspection shall be conducted at least semi-annually. The scope of the inspection shall be a sample of building(s) from one or more of the limited control facilities where there has been recent, frequent fissionable material movements or such movement is planned for the next period. The facilities to be inspected include those under TWRS cognizance which have greater than 15 g of fissionable material and are defined in HNF-IP-1266. For those facilities where there has been

little or no movement of fissionable material, an inspection should be conducted at least once every five years.

There is no specific format for recording the results of an inspection. Each inspection report must be submitted to the facility within 30 days, and must include the date, name of inspector, area or activities inspected, status of items found on previous inspections, new items for correction, and the signature of the inspector. As required by procedure, each report must address, as appropriate, the corrective actions taken; fissionable material handling, storing or processing; posting of limits and controls; appropriateness of limits and controls; labeling and inventory records of fissionable materials, firefighting symbols; housekeeping; and the measurement or detection systems in place to ensure that limits are not exceeded.

The facility manager is required to submit to the inspection team, within 10 days, should corrective actions be recommended, an itemized listing of the corrective actions taken or planned and their estimated completion date. This list is maintained at the facility and all open items are entered into the facility's action item tracking system. When the items are closed, that fact is noted in the tracking system records and a statement is added to the next inspection report noting the closure. The facility manager is also required to maintain copies of the inspection reports for trending nonconformances.

Tank waste operations are collectively considered one facility for inspection purposes. The criticality safety representative inspects records of transfers among tanks and waste receipts from waste source facilities for compliance with CPS controls. Inspections of waste tanks or facilities for which no fissionable material movement has taken place since the previous inspection are reviewed less frequently.

The inspections and reviews by TWRS, the independent safety review organization, and offsite experts provide added assurance that criticality safety program requirements are met.

6.5.6 Criticality Infraction Reporting and Follow Up

Several TWRS management practices help prevent or detect nonconformance with criticality safety controls. Preventive measures include the following:

- Procedure reviews by the criticality safety representative and the independent safety review organization
- Criticality safety training and orientation programs
- Work-related discussions regarding prejob planning and prejob briefings by operations
- Written work procedures

- Unreviewed Safety Question screenings
- Facility inspections and safety appraisals
- A lessons learned program.

Unreviewed Safety Question screenings are performed by TWRS operations on new or modified systems, procedures, or equipment. The screenings identify nonconformances while the work is still in the planning stages. The Unreviewed Safety Question process used at TWRS is detailed in HNF-IP-0842, *TWRS Administration*, Volume IV, Section 5.4, "Unreviewed Safety Questions."

The event causes of four occurrence reports identified in Table 3.3.2.1.4-1 were reviewed to ensure that actions to prevent reoccurrence have been undertaken. Two of the occurrences were reported 5 to 10 years after discovery of the noncompliant conditions should have taken place. The TWRS facility specific procedure requires the Engineering organization to maintain fissionable material records to ensure compliance with the CPS and ensure that characterization data is reviewed. This action is intended to prevent delayed discovery of characterization data related nonconformances. The other occurrences are related to the safety analysis reports for TWRS facilities. The approval, release, and implementation of HNF-SD-WM-BIO-001, *Tank Waste Remediation System Basis for Interim Operation*, and HNF-SD-WM-TSR-006 in 1997 provide a clear and concise description of the baseline technical basis for the program. Given its well-defined status, the TWRS Authorization Basis facilitates modifications that are needed as a result of facility changes and modifications.

6.5.6.1 Criticality Safety Nonconformance. A criticality safety nonconformance is reported promptly according to the procedure in WHC-CM-4-29. The procedure presents responsibilities, provides for safe recovery from nonconformances, and outlines guidance for the appropriate follow-up investigations and reports. The underlying principles governing recovery from a criticality safety nonconformance are to not exacerbate the situation and to prevent recurrence.

Nuclear criticality safety occurrences are reported as unusual occurrences or off normal events based on the severity of the occurrence. That is, a violation of the double contingency specifications such that no valid controls are available to prevent a criticality accident is classified as an unusual occurrence. Any criticality safety violation or infraction of procedures not covered by other reporting criteria (e.g., violation of a Limiting Condition for Operation) which results in the violation of a single contingency is an off normal. Both the unusual occurrence and off normal event will require an engineering review to determine if an Unreviewed Safety Question exists.

If a nonconformance has occurred, the facility manager is responsible for reporting the nonconformance per the occurrence reporting requirements. With the technical assistance of appropriate safety and engineering organizations, the facility manager will evaluate the situation to determine the appropriate method of recovery and if a formal recovery plan is required. If a CPS limit (i.e., the technical limit required to ensure double contingency for the approved operations, equipment, and material) may have been breached and recovery could increase reactivity, the

facility manager is required to prepare a formal written recovery plan. The formal written recovery plan will identify the process to follow to restore the situation to an in-limit condition and to implement any required temporary corrective action. A formal written recovery plan is reviewed and approved by the following:

- Manager of the operating organization
- Manager of the facility radiological control organization
- Facility safety organization
- Criticality safety representative
- Facility Engineering manager.

If the nonconformance is considered insignificant after consultations with the facility safety and engineering organizations and the criticality safety representative, the facility manager can determine the appropriate actions and reporting requirements. In addition, if the nonconforming condition no longer exists at the time the nonconformance is declared, the facility manager verifies that the current situation is within limits, documents these verifications, and lists any actions taken.

6.5.6.2 Fire Fighting. Firefighting restrictions necessary for criticality safety are analyzed and reported in the criticality safety evaluations (WHC-SD-SQA-CSA-20368). Additionally, a prefire plan is prepared in cooperation with the Hanford Fire Department, as necessary. Waste forms currently handled, transferred, or stored by TWRS facilities have no restrictions on moderator content for criticality safety purposes; thus, no firefighting restrictions are currently applied to the use of water. The concentration of plutonium in both the liquid and solids portion of the waste is below the minimum subcritical concentration of 2.6 g Pu/L. This value was derived for an infinite system which does not take credit for any neutron leakage, so any firefighting materials which increase the reflection will not impact the margin of criticality safety. Also, since the 2.6 g Pu/L was derived at optimum moderation the addition of a moderator will not impact the conclusion that the frequency of a criticality accident is "beyond extremely unlikely."

6.5.6.3 Criticality Evacuation Drills. Because the TWRS operations do not require criticality alarm or detection systems, neither criticality evacuation drills nor criticality accident evacuation routes for personnel are necessary. As discussed in Chapter 1.0, there were no nuclear criticality accidents identified at adjacent facilities (based on facility-specific Authorization Basis documents) with the potential to impact TWRS facilities or personnel.

6.5.6.4 Criticality Safety-Related Emergencies. The procedures for actual emergencies at TWRS facilities are described in Chapter 15.0, "Emergency Preparedness Program." A criticality accident that results in the spread of radioactive contamination will be responded to as a contamination spread because no criticality detection or alarm systems are installed in TWRS facilities. If the employees at the scene suspect that a criticality accident has occurred or there is a potential for a criticality, the initial response is to evacuate the area, declare an emergency, and make the proper notifications.

The Building Emergency Director has the responsibility to form a task team including the facility criticality safety representative, at least one nuclear criticality specialist, a nuclear safety engineer, the radiological control manager, and an operations and engineering support group manager.. The team shall have the expertise to recognize the signs of a criticality such that a criticality can either be ruled out or the occurrence of a criticality can be confirmed.

The TWRS facilities occasionally experience unusual events such as local high-temperature readings in the waste, release of gases, or radiological releases that have the casual appearance of a criticality. Such incidents are usually responded to as a perturbation of the physical characteristics of the waste and resultant investigation explores the data to determine the cause. All possibilities are investigated, but if an accidental criticality is determined to be the probable cause and the nuclear chain reaction is terminated, the response will be to declare an emergency event as governed by the facility's Emergency Action Levels and evacuate the area. If the chain reaction is not terminated, the facility criticality safety representative, nuclear criticality specialist, and nuclear safety engineer provide recommendations to the Emergency Control Center (Chapter 15.0). The Emergency Control Center, based on those recommendations, can order the actions necessary to terminate the criticality.

6.6 CRITICALITY INSTRUMENTATION

As discussed in DOE 5480.24, Section 7.b., the criticality alarm system or detection system requirements specified in ANSI/ANS-8.3 are not applicable. DOE 5480.24 requires, based on occupancy levels, either a criticality alarm system or a detection system if the mass of fissionable material exceeds the limits established in paragraph 4.2.1 of ANSI/ANS-8.3-1986 and the probability of occurrence is determined to be greater than 1×10^{-6} per year (as documented in a DOE approved safety analysis report). The frequency of an occurrence is judged to be "beyond extremely unlikely" (i.e., less than 10^{-6}/yr). Therefore, as further discussed in the same section of the DOE 5480.24, "In those cases where the mass of fissionable material exceeds the limits established in paragraph 4.2.1 of ANSI/ANS-8.3, but a criticality accident is determined to be impossible due to the physical form of the fissionable material, or the probability of occurrence is determined to be less than 1×10^{-6} per year (as documented in a DOE approved SAR), neither a CAS nor a criticality detection system is required" [DOE 5480.24, Section 7.b.(3)] criticality alarms or detection systems are not required.

The radiological consequences for a Hanford Site waste tank criticality have been determined to be 4.0×10^{-2} Sv (4.0 rem) to the onsite individual and 2.5×10^{-5} Sv (2.5×10^{-3} rem) to the offsite individual (Section 3.3.2.4.1). Although the accident is considered to have a frequency in the "beyond extremely unlikely" range (less than 10^{-6}/yr), both the onsite and offsite radiological doses are shown to be within the risk guidelines for an accident in the "extremely unlikely" range (frequency of 10^{-6} to 10^{-4}/yr). The toxicological sum-of-fractions is well below one and, hence, well below the risk evaluation guidelines for both onsite and offsite receptors.

TWRS facilities do not have a criticality accident detection system or alarm capabilities. A criticality accident is determined to be "beyond extremely unlikely" because limits and controls for waste transferred into the tanks ensure that the waste is subcritical under all normal and credible abnormal conditions.

6.7 REFERENCES

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40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*.

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LIST OF TERMS

ACES	Access Control and Entry Systems
ACL	Administrative Control Level
ALARA	As Low As Reasonably Achievable
AMW	ALARA Management Worksheet
DAC	derived air concentration
DOE	U.S. Department of Energy
FDH	Fluor Daniel Hanford, Inc.
GM	Geiger-Mueller (detector tube)
HEPA	high-efficiency particulate air (filter)
HISP	Hanford Instrument Services Project
NA	not available
PCM	personal contamination monitor
PHMC	Project Hanford Management Contract
PNNL	Pacific Northwest National Laboratory
PPE	personal protective equipment
PSO	Program Secretarial Officer
RCIP	Radiological Control Improvement Plan
RCM	radiological control manager
RCO	radiological control organization
RCT	radiological control technician
RL	U.S. Department of Energy, Richland Operations Office
RW	radiological worker
RWP	radiological work permit
S/RID	Standards/Requirements Identification Document
TEDE	total effective dose equivalent
TWRS	Tank Waste Remediation System

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7.0 RADIATION PROTECTION

7.1 INTRODUCTION

The Hanford Site program that provides for radiation protection at the Tank Waste Remediation System (TWRS) facilities is summarized in this chapter. The main topics addressed include the following:

- Radiation protection program and organization
- As Low As Reasonably Achievable (ALARA) policy and program
- Radiological protection training
- Radiation exposure control
- Radiological monitoring
- Radiological protection instrumentation
- Radiological protection recordkeeping
- Occupational radiation exposures.

Program compliance with applicable regulatory requirements is discussed in the following subsections. Measures defined in the program that provide for protection against potential hazards from routine operations or against the hazards identified in Chapter 3.0 are also addressed.

7.2 REQUIREMENTS

The following documents provide the philosophical and legal bases for the radiation protection program at TWRS facilities:

- 10 CFR 835, "Occupational Radiation Protection"
- DOE/EH-0256T, *Radiological Control Manual* (1994)
- DOE 5400.1, *General Environmental Protection Program*, Change 1 (1990)
- DOE 5400.5, *Radiation Protection of the Public and the Environment*, Change 2 (1993).

The relationship of these documents to HSRCM-1, *Hanford Site Radiological Control Manual*, and the implementing documents specific to the Hanford Site are shown in Figure 7-1.

In addition to these principal documents, the following affect parts of the radiation protection program:

- 29 CFR 1910, "Occupational Safety and Health Standards"
- 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants"
- DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, Change 0 (1994)
- DOE 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, Change 4 (1993)[1]
- DOE N 5400.9 (as extended), *Sealed Radiation Source Accountability* (1991).

7.3 RADIATION PROTECTION PROGRAM AND ORGANIZATION

Requirements in 10 CFR 835.101, "Radiation Protection Programs," mandate a contractor radiation protection program that is compliant with 10 CFR 835. The contractor radiation protection program is documented in HNF-SP-1145, *Fluor Daniel Hanford Radiation Protection Program Implementation of Title 10 Code of Federal Regulations Part 835*. This document also includes those elements necessary to satisfy the implementation plan requirements of 10 CFR 820, "Procedural Rules for DOE Nuclear Activities." The purpose of the contractor radiation protection program is to ensure that adequate protection is provided against radiological hazards predicted or observed at the Hanford Site. The basic types of predicted (i.e., those in Chapter 3.0 hazards analysis) or observed (i.e., Final Safety Analysis Report or other safety analyses) radiological hazards that could affect onsite or offsite receptors include the following:

- Direct exposure to radiation emitted from pipes, equipment, or other radiation sources
- Airborne release of radioactive aerosols, gases, or particles that contaminate receptors through inhalation, ingestion, or external exposure
- Release of radioactive liquids from piping or equipment
- Direct exposure to high-level beta radiation from pit walls, tank waste, and component internals removed from tank systems.

[1]This order has been cancelled and replaced by DOE O 440.1, 1996, *Worker Protection Management for DOE Federal and Contractor Employees*. Compliance with DOE 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, is required by the Fluor Daniel Hanford, Inc. (FDH), contract and is, therefore, the applicable requirement for the TWRS safety basis.

7.3.1 Radiological Control Organization

HSRCM-1, Articles 141-144, describe requirements for a Hanford Site radiological control organization (RCO). The RCO and its operating procedures are designed to identify, respond to, and reduce onsite and offsite radiation exposures. The RCO operating procedures have been designed for the steady-state situation found in routine, controlled activities and for rapidly changing or uncertain situations found in unusual events or first-time activities. The RCO's main philosophy is to maintain exposures ALARA and ensure compliance to 10 CFR 835. The RCO changes its procedures or operational controls to respond to and include new or modified operations, equipment, or requirements implementation.

The RCO is established to provide radiological support to line managers and workers. The radiological control manager heads the RCO and is responsible for establishing a radiological control program. The radiological control manager is an experienced professional in radiological control, is familiar with the TWRS design and operations, and is aware of the issues that could impact personnel and the public. The radiological control manager directs the implementation and maintenance of radiological control programs.

RCO personnel are required to monitor onsite activities as described in HSRCM-1 and to be available to the facility line manager for radiological support to the work force. To effectively function in this capacity, RCO personnel receive day-to-day priorities from facility managers. To ensure independence in making correct radiological control decisions, the RCO personnel are accountable to the radiological control manager. RCO support personnel provide radiological engineering support to the facility including, but not limited to, review and implementation of radiological safety in designs, procedures, the application of dosimetry (internal and external), and other aspects identified in HSRCM-1.

RCO personnel and radiological workers have the responsibility and authority to stop work or mitigate the effect of an activity if they suspect initiation or continued performance of a job, evolution, or test will result in the violation of radiological control standards, imminent danger to workers, or unacceptable risk (HSRCM-1, Article 345).

The tank farm RCO managers provide line management supervision for the TWRS facilities radiation protection groups. Qualifications and staffing requirements for RCO personnel are consistent with the requirements contained in 10 CFR 835 and HSRCM-1.

Although many RCO activities are not specific to the hazards identified in Chapter 3.0, the organization is prepared to identify and respond to hazardous conditions with the potential to occur on the Site. For example, routine radiological surveys and monitoring, and the required data reviews allow for early detection of abnormal situations (such as the gradual build up of contaminated material on HEPA filters) which, in turn, allow for radiological protection measures to be taken (e.g., replacement of the filters).

7.4 ALARA POLICY AND PROGRAMS

Maintaining personnel exposures ALARA is a guiding principle of radiological protection programs at all U.S. Department of Energy (DOE) facilities. The legal requirement for establishing an ALARA program at a DOE facility is contained in 10 CFR 835.101. This requirement specifically commits the contractor's organizations to limit radiation exposures to onsite individuals to ALARA. The Radiation Protection Program governing TWRS facility operations follows this policy by implementing ALARA practices into all facets of radiological work. The TWRS ALARA program is described in HNF-IP-0842, *TWRS Administration,* Volume VII, Section 1.2, "Facility ALARA Committee."

TWRS uses three separate ALARA committees to incorporate the ALARA program. The Facility ALARA Committee is comprised of higher level managers and reviews and advises facility management on improving the Facility ALARA Program. Development, approval, and tracking of facility ALARA goals is the responsibility of the Facility ALARA Committee. The ALARA Awareness Committee is a workforce committee that emphasizes radiological program improvement. This committee also assists in the development of facility ALARA goals. The third ALARA committee, the Joint Review Group, is a senior multi-disciplined team that provides independent oversight to ensure high-risk work is thoroughly planned in accordance with applicable procedures.

The contractor's ALARA program implements the eleven primary elements indicated in *U.S. Department of Energy Implementation Guide G-10 CFR 835/B2*, "Occupational ALARA Program" (DOE 1994a), including policy and management commitment, assignment of responsibilities, establishment of Administrative Control Levels (ACLs), radiological and ALARA performance goals and indicators, ALARA training, plans and procedures, internal assessments and audits, optimization methodology, radiological design review, radiological work and experiment planning, and records.

7.4.1 Radiological Work Planning

Radiological work planning, including the unique beta hazard and outdoor work environment, is performed in accordance with HNF-IP-0842, Volume VII, Section 1.1, "ALARA Work Planning." This procedure takes job specific hazards and risk into account in determining the level of rigor to be applied in job planning, work performance, and postjob reviews.

Radiological work is screened by RCO staff and sorted into three categories of risk: Low, Medium, and High. For those work evolutions evaluated as Medium and High risk, a specific ALARA Management Worksheet and Radiological Work Permit (RWP) are prepared. High-risk work is additionally reviewed and approved by the ALARA Joint Review Group.

Prejob and postjob ALARA reviews are conducted as identified in HNF-IP-0842, Volume VII, Section 1.1, and HSRCM-1 requirements.

7.5 RADIOLOGICAL PROTECTION TRAINING

This section provides an overview of the TWRS Radiological Protection Training Program. Chapter 12.0 describes the management aspects of this training program. Requirements for a radiological protection training program are contained in 10 CFR 835. Guidance for implementation of a radiological protection training program are contained in DOE/EH-0256T. Requirements and guidance are incorporated into the HSRCM-1 and Hanford Site Procedures. The training program specifies requirements for training radiological control technicians (RCTs), RCT supervisors/managers and radiological workers (RWs).

Requirements for the Site RCT Training Program are contained in Hanford Site procedures HNF-PRO-386, *Radiological Control Technician Qualification and Training*, and HNF-PRO-071, *Radiological Control Technician Training*. Specific TWRS RCT Training Program requirements are contained in HNF-IP-0842, Volume III, Section 10.10, "Radiological Control Qualification Program Description." The TWRS RCT Training Program contains five elements for RCT qualification: (1) core/Site fundamentals and exam, (2) Site on-the-job training, (3) oral examination boards, (4) facility on-the-job training requirements, and (5) operating experience and lessons learned. Requalification is accomplished on a biennial basis and requires successfully passing a comprehensive knowledge examination, completion of facility on-the-job training, retraining, and completion of a requalification oral examination board.

Training requirements for RCT supervisors/managers are contained in Project Hanford Procedures HNF-PRO-378, *Radiation Protection First-Line Supervisor Qualifications*, and HNF-PRO-386. Specific TWRS RCT Supervisor Training Program requirements are contained in HNF-IP-0842, Volume III, Section 10.10. RCT supervisors must maintain qualification in accordance with the RCT Training Program and complete additional supervisory training. Supervisor oral examination boards are directed at supervisory duties.

RCT supervisors/managers are directly involved in ensuring that the results of personnel training meets their standards and expectations. Oral examination boards for RCTs and supervisors include an RCT manager as a member. RCT managers also review worker training to determine weaknesses and implement corrective actions.

The TWRS RW Training Program requirements are contained in Hanford Site procedures HNF-PRO-329, *Radiological Training*, and HNF-PRO-082, *Radiological Worker Training*. Personnel requiring unescorted access to TWRS radiological areas must meet area specific training and qualification requirements. Program requirements include a knowledge examination and practical evaluation for successful completion of training. Retraining is completed biennially and includes reexamination of knowledge and practical requirements. Annually, all TWRS RWs complete refresher training as part of Hanford General Employee Training.

Radiological training programs for TWRS are administered and maintained in accordance with the requirements of the *Training and Qualification* section of the Hanford Site procedures. The Hanford Site Radiation Protection Center of Expertise maintains responsibility for administration and oversight of all Site procedures pertaining to radiological training. Facility TWRS Radiological Training procedures and requirements are maintained by the TWRS RCO. Completion of Site and facility radiological training requirements is tracked through the Access Control and Entry System (ACES). TWRS employees accessing radiological areas must use ACES to gain access. Personnel who are not current in all radiological training requirements will show on ACES as not meeting entry requirements. More information on ACES is contained in Section 7.6.2.4.

7.6 RADIATION EXPOSURE CONTROL

Radiation exposure controls protect TWRS workers against hazards associated with (1) external exposure to radiation, (2) the spread of contamination, and (3) inhalation or ingestion of radioactive materials. The controls maintain worker radiation exposure ALARA. The radiological practices at TWRS ensure that radiological work is conducted in a safe manner that minimizes exposures, corresponds to industry-wide good practices, and complies with applicable government regulations. When engineered protection against airborne radioactive contaminants may be compromised or is not possible, the respiratory protection program is used to protect against the possible inhalation of airborne contaminants.

The large outdoor contamination areas, which can be found throughout the TWRS complex, pose minimal radiological risk. However, the underground tanks, if improperly handled, present a large radiological hazard. The tank waste mainly comprises wastes produced from the processing of spent nuclear fuel. As exemplified by the 1996 241-AZ-101 thermocouple incident (RL-WHC-TANKFARM-1996-0017, *Personnel Exceeded the Administrative Control Level for Extremity Exposure*), contact with components removed from tank waste may produce high-level beta dose rates. To address this hazard, TWRS establishes detailed work packages, specific extremity radiation monitoring, and careful placement of extremity dosimetry.

7.6.1 Administrative Control Levels and Limits

The contractor has adopted Administrative Control Levels (ACLs) to keep exposures ALARA and to minimize the possibility of exceeding personnel exposure limits. The ACLs are substantially below the regulatory limits and are multitiered with increasing levels of authority required to approve higher ACLs. The ACLs are intended to limit the radiation doses received by individuals, but they are not intended to increase the collective dose received by all workers at the TWRS. The DOE has established an ACL of 2.0×10^{-2} Sv/yr (2.0×10^{3} mrem/yr) per person for all DOE activities and approval for exceeding this value can be obtained from the program secretarial officer or designee (HSCRM-1). The numeric values of the TWRS ACLs for radiological workers (Table 7-1) are published in HSRCM-1.

Minors and members of the public entering a controlled area are limited to 1.0×10^{-3} Sv (1.0×10^{2} mrem) total effective dose equivalent in a year in accordance with 10 CFR 835.

A declared pregnant worker dose equivalent limit for the embryo/fetus, from the period of conception to birth, as a result of occupational exposure is 5.0×10^{-3} Sv (5.0×10^{2} mrem) in accordance with 10 CFR 835.

In emergency conditions, exposures to elevated exposure levels may be necessary to rescue personnel or protect property. Emergency exposures may be authorized according to the provisions in 10 CFR 835. These doses are in addition to and accounted for separately from the doses received during routine or normal operations. The dose limits are shown in Table 7-2.

7.6.2 Radiological Practices

The Radiation Protection Program ensures that radiological work is conducted in a safe manner that minimizes exposures, corresponds to industry-wide good practices, and complies with applicable government regulations. The RWP, which is based on sound radiological practices, contains information concerning the required personal protective equipment, anticipated radiological conditions, and limiting radiological conditions. The work performance document (procedure) ensures good radiological practices are followed. As work progresses, radiological work activities are subject to reviews by the work supervisor, but any worker may initiate a review of the work or even stop the work if conditions warrant such action. Upon completion, radiological work activities meeting the trigger levels of HNF-IP-0842, Volume VII, Section 1.1, are reviewed to identify lessons learned that can enhance the radiological safety of work performed at TWRS.

7.6.2.1 Radiological Work Permits. An RWP is an administrative mechanism used to document radiological controls for intended work activities. An RWP informs workers of radiological conditions, specifies radiological limits, specifies entry requirements, and provides a mechanism for medium- and high-risk work, to relate worker exposure to specific work activities. The association between work activities and RWPs is enhanced by the ACES, which is described in Section 7.6.2.4. At TWRS, RWPs are governed by HSRCM-1 and HNF-PRO-423, *Radiological Work Permits*.

7.6.2.2 Stoppage of Radiological Work. RCTs and their supervisors; line supervisors; and any worker, through their supervisor, have the authority and responsibility to stop radiological work activities for any of the following reasons:

- Inadequate radiological controls
- Radiological controls not being implemented
- Radiological control hold point not being satisfied.

The authority to stop radiological work must be exercised in a justifiable and responsible manner. Once radiological work has been stopped, that work is not resumed until proper radiological control has been reestablished. Resumption of radiological work requires the approval of the line manager responsible for the work and the approval of the radiological control manager.

7.6.2.3 Radiological Area Boundaries, Posting and Controls. The radiation protection posting program identifies radiological work areas based on the radiological conditions. The type of posting assigned to an area depends on external radiation exposure rates, the level of removable radioactive contamination, or the existence of airborne radioactive contaminants. The work areas at TWRS are posted as shown in Table 7-3.

The 10 CFR 835 requires that signs be posted to identify controlled areas to inform TWRS employees of radiation and contamination hazards. Labeling on containers of radioactive material and on other radioactive items is required to provide information needed for radiation protection and for the prevention of inadvertent transfer of radioactive materials to locations outside radiological areas. Criteria for radiological posting and labeling (Table 7-3) are given in HSRCM-1 and *U.S. Department of Energy Implementation Guide G-10 CFR 835/G1*, "Posting and Labeling for Radiological Control" (DOE 1994b).

7.6.2.4 Access Control and Entry System. The contractor has implemented a computerized ACES to help assure that those individuals who enter a radiological area have had training commensurate with the hazards of the workplace; have been informed of those hazards (i.e., have read and signed the RWP); have not exceeded the applicable radiological ACLs; and have the necessary dosimetry and training. The ACES is linked to other Hanford Site databases that contain information concerning radiation exposures (respiratory protective), mask fits, bioassays and physicals, and training. The ACES specifies the requirements for entry into work locations at several levels of detail, including entry into the work location and work being performed (as defined by the RWP). When supplementary dosimetry is required by the RWP, the entry and exit readings of those dosimeters are tracked to monitor an individual's accumulated dose. The ACES is used to control access to all radiological areas at the Hanford Site tank farms. A detailed operating procedure is given in HNF-IP-0842, Volume VII, Section 2.4, "Access Control Entry System Roles Guidance."

7.6.2.5 Shielding. Permanent and temporary shielding may be used at TWRS. Permanent shielding is designed and controlled within the facility configuration management plan and appears on facility drawings. Permanent shielding is secured so that it is not readily installed or removed. Permanent shielding includes the steel that comprises the tank walls and dome, the concrete in support structures (i.e., cover blocks), and the soil that surrounds and covers TWRS components such as tanks and transfer lines.

Temporary shielding is readily installed and removed and is employed for short-term dose reductions as may be necessary during equipment repairs. The design and use of temporary shielding is reviewed to prevent impacts to existing structures, systems, and components. The use, placement, labeling, and surveillance of temporary shielding is in accordance with HSRCM-1.

7.6.2.6 Contamination Control. The primary means of containing the spread of radioactive contamination is containing contamination at its source. This is accomplished by the use of engineered controls in the form of radiological containment devices and detailed work procedures. HNF-IP-0842, Volume VII, Section 3.1, " Radiological Containment," provides detailed radiological containment application, selection, and certification procedures.

7.6.2.7 Personal Protective Equipment and Clothing. Personal protective equipment and clothing reduce the possibility of radioactive contamination of the worker and are used in accordance with the RWP that controls the specific task. The primary types of protective equipment and clothing for radiological purposes are respiratory protective equipment (Section 7.6.4) and anticontamination clothing.

Anticontamination clothing primarily prevents skin contamination when work is performed in contamination areas. Anticontamination clothing includes gloves, coveralls, head coverings, and shoe covers. Requirements for personal protective equipment (PPE) and clothing are specified in work control documentation and/or RWPs, as applicable, and the requirements are discussed with tank farm workers when prejob briefings are conducted. In those instances when PPE is necessary to address both hazardous and radiological concerns, a job hazard analysis is performed as part of the work planning process. The results of the job hazard analysis determine the appropriate PPE.

7.6.3 Dosimetry

A dosimetry program has been implemented to record radiological exposures to TWRS workers and visitors. Because the radiological hazards at TWRS include both external sources of radiation and the possibility of intakes of radioactive material, the dosimetry program contains both external and internal dosimetry components.

7.6.3.1 External Dosimetry. The external dosimetry program makes extensive use of the Hanford External Dosimetry Project administered by the Pacific Northwest National Laboratory (PNNL). The Hanford External Dosimetry Project is accredited by the DOE Laboratory Accreditation Program for personnel dosimetry. Complete descriptions of the external dosimeters used at the Hanford Site are documented in PNL-MA-568, *Hanford External Dosimetry Project Manual*. Dosimeters used at TWRS include the Hanford standard dosimeter, the Hanford extremity dosimeter, and supplementary dosimeters.

Hanford Standard Dosimeter. The Hanford standard dosimeter is issued to TWRS personnel who enter radiological areas. The dosimeter is used to record the shallow dose, deep dose, and eye dose of record in beta and photon radiation fields. The dosimeter has a neutron-sensitive thermoluminescent-600 phosphor for neutron detection capability in case of a nuclear accident.

Neutron Dosimeter. TWRS personnel working with neutron sources can be assigned neutron dosimeters depending on potential dose (HSRCM-1). Neutron dosimeters are issued if there is a potential for the worker to receive greater than 1.0×10^{-3} Sv (1.0×10^{2} mrem) annually from neutrons.

Hanford Extremity Dosimeter. Extremity dosimeters are intended for use by personnel when the anticipated doses to the extremities are significantly greater than those to the whole body. There are two types of extremity dosimeters: the Hanford ring dosimeter and a commercially available thin chip dosimeter system, which is planned to replace the Hanford ring dosimeter. Ring dosimeters are designed to measure electron and photon doses to the extremities. The ring dosimeters are normally issued in pairs, one for each hand, with the thermoluminescent dosimeter elements facing the radiation source.

Supplementary Dosimeter. A supplementary dosimeter may be a self-reading gamma ray pencil or electronic dosimeter. The RWP for a work area will specify the requirements for wearing a supplementary dosimeter. A supplementary dosimeter is used for entry into a high radiation area, when a worker's external radiation could exceed 10% of an ACL in one working day, or for any open radiography operation. These devices are worn in addition to the Hanford standard dosimeters to provide short-term information about an individual's radiation dose. The supplementary dosimeters are returned to radiological control for reading. Exposure information is entered into the ACES database. The electronic dosimeter provides an early warning of elevated exposures based on predetermined alarm set points (HSRCM-1).

7.6.3.2 Internal Dosimetry. The internal dosimetry program uses the Hanford Internal Dosimetry Project administered by PNNL. The services of Hanford Internal Dosimetry Project are documented in PNL-MA-552, *Hanford Internal Dosimetry Project Manual*. The Hanford Internal Dosimetry Project is accredited by the DOE Laboratory Accreditation Program.

The decision concerning which workers require what bioassay is made during the review of the RWP for an activity. The RWP specifies the bioassay requirements based on the radiological work to be performed. The bioassay requirements for radiological work performed at TWRS are based on the criteria contained in HNF-PRO-380, *Internal Dosimetry Program*, HNF-PRO-423, and the facility source term report which is prepared in accordance with HNF-PRO-380 and reviewed annually. For tank farm workers, the minimum bioassay requirement is an annual whole-body count. Some specific work activities may require a ^{90}Sr or Pu urinalysis based on source terms unique to a given task. When necessary, nonroutine bioassays are performed (e.g., potential for significant internal depositions following an accident).

7.6.4 Respiratory Protection

The first level of protection against airborne radioactive contaminants is provided by physical barriers and other engineered safeguards. In cases where entry into areas of airborne

contamination is unavoidable, worker protection is provided by the use of approved respiratory protection equipment according to a set of industry standard procedures. The contractor respiratory protection program is described in HNF-IP-0842, Volume II, Section 2.2., "Respiratory Protection Controls."

HSRCM-1 specifies adherence to ANSI Z88.2, *Respiratory Protection*, and 29 CFR 1910.134, "Respiratory Protection," for implementation of the Respiratory Protection Program and associated training of personnel. Industrial Hygiene personnel have overall responsibility and authority for the respiratory protection program. An evaluation of the program is performed at least annually in accordance with ANSI Z88.2.

The respirators used for radiological protection at TWRS are full-face masks with particulate-filtering cartridges, supplied air respirators, self-contained breathing apparatus, and air line supplied-air suits and hoods. The type of respirator required is identified in the RWP or in the work package for multiple hazard jobs. Respirators are issued only to personnel identified as medically qualified, fitted and trained to wear a respirator. Only respirators that have been approved by the National Institute for Occupational Safety and Health or the Mine Safety and Health Administration are used.

7.7 RADIOLOGICAL MONITORING

The Radiation Protection Program documents the routine monitoring of radiation and contamination levels at TWRS facilities. The 10 CFR 835 and HSRCM-1, Articles 551 through 555, mandate a program for radiological monitoring and surveys.

7.7.1 Facility Monitoring or Surveying

The contractor has a formal program for conducting required radiological surveillances in facilities and areas adjacent to those facilities.

Surveillances are designed to ensure that consistent radiological survey tasks are performed. Survey tasks are conducted on a schedule, and survey reports are completed, posted, and stored. The survey information is used for tracking and trending, planning radiological work, and providing data to monitor the Radiation Protection Program.

The survey task descriptions describe the location and the type of survey needed, indicate the required frequency (which could range from once per shift to annually), list required instrumentation (as described in Section 7.8), and list action levels that would require corrective action. The survey task description, described in HNF-PRO-435, *Required Radiological Surveillances*, provides the framework for periodic monitoring of facilities. A survey task description is completed for each individual facility in TWRS that must have regular surveys.

The manager for radiological control for TWRS facilities is required to ensure that the radiological survey reports are properly completed, reviewed, and compiled. The reports are used to identify trends in radiological conditions and to determine whether any conditions warrant corrective actions. The monitoring results are also made available to line management for use in support of prejob planning and postjob evaluations, for ALARA planning, and for management of radiological control operations. Data from the survey reports determine the total area and level of contamination/high-contamination and radiation/high-radiation areas. This data is used in monitoring the ALARA practices for contamination control in TWRS facilities, migration of legacy contamination, and high-radiation area control.

HNF-PRO-331, *Work Place Air Monitoring*, describes the contractor program for air sampling as a component of facility monitoring. Air sampling is performed in occupied areas where, under normal operating conditions, a person is likely to receive an annual intake of 2% or more of the specified annual limit of intake values (40 derived air concentration hours). An annual intake of 2% of a specified annual limit of intake generally represents a committed effective dose equivalent of approximately 1.0×10^{-3} Sv (1.0×10^{2} mrem) to a person. The data derived from air sampling used to evaluate the contamination and radiological control practices and to track and trend long-term variations in airborne radioactivity levels.

Continuous air monitors (Section 7.8) are used in normally occupied areas (1) where an individual is likely to be exposed to airborne radioactivity exceeding one derived air concentration or (2) where there is a need to alert personnel to an unexpected increase in airborne radioactivity levels (defined as five derived air concentrations averaged over an eight-hour shift).

Many of the radiological work areas in TWRS facilities are outdoors, where air sampling and radioactive contamination control can be complicated by environmental conditions. Procedures for outdoor workplace sampling are included in HNF-PRO-331.

Article 514 of HSRCM-1 specifies that work locations adjacent to radiological areas must be monitored to ensure that radiological conditions are sufficiently low to justify maintaining the adjacent areas as nonradiological areas. The contractor has established an area dosimetry program to accomplish this monitoring. The program uses area dosimeters strategically mounted in locations that will adequately characterize the work area and requires a change-out frequency that will ensure monitoring is current. This program is described in HNF-PRO-382, *Area Dosimetry Program*.

7.7.2 Operational Monitoring of Workers

Workers who enter radiation areas must wear personnel dosimeters (Section 7.6.3.1) that provide the occupational doses of record for the worker and for the organization. The dosimeters of record cannot provide real-time indications of exposure, so a supplementary dosimeter (Section 7.6.3.1) is worn in situations where a real-time personnel dose is needed.

The methods for establishing personnel dose rates in TWRS work areas are described in HNF-PRO-636, *Black Widow and Bumble Bee, CP*, HNF-PRO-635, *Eberline RO-7*, HNF-PRO-637, *XETEX Telescan*, HNF-PRO-636, *William B. Johnson Extender*. The instruments used in TWRS facilities to establish these dose rates are described in Section 7.8. Procedures for instrument operation are given in the applicable HNF-PRO for the instrument.

Contamination areas in TWRS facilities are surveyed routinely. These routine surveys and prejob surveys provide a baseline understanding of the potential for contamination spread, which is used for planning work. HSRCM-1 requires specific monitoring immediately before, during, and after radiological work. Approved personnel survey instructions are posted at all radiological exits requiring personnel surveys to ensure that contamination is not translocated out of the work area. TWRS workers use personnel contamination monitors (PCMs, portable survey instruments) to survey themselves when leaving a radiological area that requires an exit survey. Health Physics Technicians perform personnel surveys when the personnel contamination monitor identifies contamination.

Airborne contamination in the workplace is routinely monitored as described in Section 7.7.1. To support personnel entries into areas with suspected airborne contamination, grab air samples may be taken to characterize the possible airborne contamination in a work area. Grab air samples may be taken as part of prejob preparation and during performance of a job or postjob. Procedures for grab air sampling are given in HNF-IP-0718.

7.7.3 Detection of Material Released External to the Tank Waste Remediation System Facilities

The tank farms have many outdoor radiological areas, and there is potential for releases to the environment or external to a facility. There are no planned or routine liquid releases to the soil column; therefore, TWRS has implemented a monitoring program for airborne releases. Periodic surveys are performed of the areas adjacent to the TWRS facilities. These surveys are performed in accordance with HSRCM-1, Chapter 5, "Radiological Health Support Operations."

Known release points, monitored within TWRS, are addressed by Site environmental services. Monitoring by this organization typically takes the form of stack monitoring of effluents expelled into the environment from the facility. The amount of effluent is controlled through compliance with the environmental air permits issued for the facility from the Washington State Department of Health. The structures and equipment used for environmental monitoring are discussed in Chapter 2.0.

7.7.4 Meteorological Data Sampling

The Hanford Meteorological Data Collection System is operated by staff from PNNL. The monitoring network and parameters monitored are discussed in PNL-6684, *The Data Collection Component of the Hanford Meteorological Monitoring Program* (also see

Chapter 1.0). The extensive network of meteorological towers scattered about the Hanford Site include a 125-m (410-ft) tower between the 200 East and 200 West Areas. Smaller towers are also positioned in the 200 East and 200 West Areas. These towers contain instruments to record atmospheric conditions at several elevations above the ground, thus providing data needed to estimate airborne effluent transport. Fifteen-minute-averaged data is recorded and available real-time on the Hanford Local Area Network for predicting transport of accidentally released airborne plumes. Data averaged over longer time intervals is also available for assessing the transport of routine, long-term airborne releases.

7.7.5 Records and Reports

Data collected during radiological monitoring activities is recorded according to procedure and made available to appropriate staff for responding to action levels, assessing the effectiveness of radiological protection programs, preparing lessons learned information, and archiving. Data reporting and retention procedures for radiological monitoring on the Hanford Site are documented in HNF-PRO-1892, *Documentation of Radiological Surveys*, HNF-IP-0718, *Health Physics Technical Practices and Procedures*; and other approved procedures. Procedures for records management are provided in approved Hanford Site procedures.

7.8 RADIOLOGICAL PROTECTION INSTRUMENTATION

Radiation detection instrumentation is used to implement the radiological monitoring program and to ensure that radiation and contamination exposures are kept ALARA. A variety of instruments is available for surveying areas, measuring surface and personnel contamination, and measuring air concentrations during both routine and off-normal conditions. The Radiation Protection Program makes extensive use of the Hanford Instrument Services Project (HISP) administered by PNNL. The services of the HISP are documented in PNL-MA-563, *Radiation Instrument Calibration*.

7.8.1 Selection and Placement Criteria for Instruments

The Hanford Instrument Evaluation Committee provides sitewide criteria for selection, examination, and testing of radiological protection equipment and instrumentation, following the requirements of ANSI N42.17A, *Performance Specifications for Health Physics Instrumentation–Portable Instrumentation for Use in Normal Environmental Conditions*, and ANSI N42.17B, *Performance Specifications for Health Physics Instrumentation–Occupational Airborne Radioactivity Monitoring Instrumentation*.

The selection of specific instruments and their initial placement are the responsibilities of the RCO. For new facilities, information on facility layout, location of radioactive materials (and

their estimated quantities), and designed airflow patterns is used to determine the initial layout of the fixed monitoring instrumentation. Locations for fixed instruments (e.g., installed workplace air samplers or monitors and area radiation monitors or dosimeters) are reviewed periodically for adequacy.

Personal radiation monitoring equipment is available at the interface locations or step-off pads between contamination areas and noncontamination areas.

Operating and calibration procedures for new types of instruments are prepared and incorporated into the appropriate procedure manuals. All records applicable to the purchased radiological control instruments are retained in project files, purchase requisitions files, and HISP instrument evaluation files.

A summary of the different kinds of radiation protection instruments used in TWRS facilities is presented in Table 7-4. Each instrument's applications, range, and sensitivity are included.

7.8.2 Instrument Calibration

Currently, the HISP is responsible for calibration of radiation measurement instruments and direct-reading and electronic dosimeters. The facility maintenance organization is responsible for the calibration and maintenance of fixed instrumentation. Functional tests are performed by the RCO.

Calibration procedures for radiation measurement instruments and direct-reading and electronic dosimeters are developed by PNNL. These procedures include frequency of calibration, precalibration requirements, periodic performance test requirements, calibration record requirements, and maintenance requirements. The instruments are calibrated at a PNNL-operated, National Institute of Standards and Technology-traceable calibration facility.

Between calibrations, standard radiation sources are used to functional-test instruments in the field for proper response. The exchange of portable radiation or contamination detection instruments between the facility and the calibration group is described in the instrument exchange program of HNF-PRO-436, "Radiation Protection Instrument Program." The control and calibration of portable radiation monitoring equipment is described in PNL-MA-563. New instruments on the approved instrument list received with factory calibration are screened to determine if PNNL calibration is required prior to initial use.

7.8.3 Quality Assurance for Calibration and Maintenance

The PNNL HISP is operated by the PNNL Quality Assurance Program. The oversight provided by the Hanford Instrument Evaluation Committee in the selection of all radiological instrumentation ensures that appropriate instrumentation is used for radiological protection

applications. Radiological instruments are selected to be appropriate for the field conditions and environment in which they are expected to operate, and they are used to measure only the radiation for which their calibrations are valid.

Calibrations are performed by the HISP using National Institute of Standards and Technology-traceable standards and procedures developed for each radiological instrument type in compliance with the requirements of ANSI N323, *Radiation Protection Instrumentation Test and Calibrations.*

A program for preventive and corrective maintenance of radiological instruments is described in PNL-MA-563. The components and procedural recommendations used for preventive and corrective maintenance are at least as stringent as those specified by the manufacturer. After any preventive or corrective maintenance or any adjustment that voids the previous calibration, radiological instruments undergo calibration before use.

7.9 RADIOLOGICAL PROTECTION RECORDKEEPING

The records that relate to radiation doses received by radiological workers at the Hanford Site are maintained by the Hanford Radiological Records Project administered by PNNL. This project is documented in PNL-MA-553, *Hanford Radiological Records Project Manual.*

Radiological protection records that relate to the operation of the radiological protection program (e.g., RWPs, ALARA reviews, radiological surveys, and radiological problem reports) are maintained by the TWRS RCO according to the contractor's document control and quality assurance manuals and approved as discussed in previous sections (safety, quality assurance, RCO, and facility management).

7.10 OCCUPATIONAL RADIATION EXPOSURES

Occupational radiation doses that would result from continued operation of TWRS facilities can be estimated based on recent historical data. Data for the last 9 yr (1990-1998) of tank farms operations is presented in this section. Collective dose levels have been low, increasing only with increases in levels of activity. The number of contamination incidents has also been low. Only minor internal depositions have been recorded, and no exposures exceeding regulatory limits have been recorded.

The Site Performance Measurement Program documents the process for consistently monitoring the effectiveness of the Project Hanford Management Contract (PHMC) Team to ensure continued management involvement. Through the use of performance indicators grouped into areas, the major subcontractors have the ability to rate radiological performance between the major subcontractors and the Site as a whole. The self-assessments and independent inspections that identify deficiencies within the Radiation Protection Program contribute to overall

programmatic improvement. Future operations performed within the requirements and guidelines of the radiation protection program will maintain exposures below guidelines.

7.10.1 Collective External Radiation Doses

The collective external radiation doses received at the tank farms for 1990 through 1998 are plotted in Figure 7-3 from data in Table 7-5. The data for the years before 1992 describe only the external dose equivalent from external sources of radiation and do not include the dose contribution from internal depositions. Beginning in 1993, the dose received from internal depositions was added to the annual totals. The influence of internal depositions on the collective dose equivalent received by tank farm workers is relatively small because these workers have not experienced significant intakes (Section 7.10.3).

The collective external radiation doses data show a reduction of radiation exposure from 1991, with a minimum during the years 1992 and 1993. Radiation exposure then begins to increase in 1994. The radiation exposure data mirrors the extent of work activities at the tank farms. In 1992 and 1993 there was minimal activity at the tank farms and the doses received were associated with routine transfers of waste between tanks. In 1994 major projects associated with infrastructure refurbishment were initiated (e.g., single-shell tank pumping, characterization sampling, refurbishing the pump pits, and installing new valves in the transfer lines). In 1998, there was a significant decrease in dose accumulation due to reduced funding of projects.

7.11 RADIOACTIVE MATERIAL SHIPMENTS

Hanford Site procedures, WHC-SD-MP-SRID-001, *High Level Waste Storage Tank Farms, 242-A Evaporator Standards/Requirements Identification Document*, TWRS S/RIDs and DOE O 460.1A, *Packaging and Transportation Safety* with U.S. Department of Energy, Richland Operations Office (RL) guidance require that all onsite shipments of hazardous materials, hazardous waste and radioactive material comply with the U.S. Department of Transportation regulations, or be conducted with an equivalent degree of safety, or defensible safety basis.

7.12 RESPONSE TO ABNORMAL EVENTS

Abnormal events may vary considerably in magnitude. Some events may be obvious, whereas other events may be detected only by sensitive radiation detection instruments. The response of the RCO to an abnormal event depends on the nature and extent of the event (see Hanford Incident Command System and Event Recognition and Classification, RLEP 1.1, "Emergency Response Procedures").

When specified in the work document, RCO personnel are at the worksite and available to perform surveying or monitoring as required. These individuals can provide an immediate response to an event. Onsite RCO personnel can be contacted 24 h a day by short-wave radio, cellular phone, or pager.

7.12.1 Recognition of the Event

Early detection of an abnormal event may help to reduce the ultimate magnitude of that event. Early detection is made possible through (1) fixed instruments and alarms (where installed), (2) self-reading and alarming dosimetry (when used), and (3) the use of routine monitoring and surveys (Section 7.7) to track the radiological conditions in a work area. Timely detection of personnel exposures is afforded (1) by the use of supplemental dosimeters (Section 7.6.3.1) (which can be read often) and (2) by personnel contamination surveys performed with hand-held instrumentation or personnel contamination monitors (which can detect contamination on the person's skin and clothing). Also, certain activities are continuously monitored by radiation area monitors (which detect external radiation) and continuous air monitors (which detect airborne contamination).

7.12.2 Response to an Event

A general response to any abnormal event, regardless the magnitude, is that work should be halted. If the loss of radiological control is evidenced by alarms (e.g., continuous air monitors or radiation air monitors), all workers evacuate the immediate area. When possible, the radioactive material/radiation generating component is placed in a safe configuration to prevent worsening of the situation. Notifications of the event are made to management. Finally, remediation activities are planned and conducted.

Investigations of events are conducted in accordance with HNF-PRO-058, *Critique Procedure*. This procedure applies to critiques being conducted for drill evaluation, abnormal event investigation, radiological conditions or events evaluation, and evaluation of successful activities. The extent and scope of application are as identified in the facility-specific Conduct of Operations Applicability Matrix or S/RID.

If the event results in contamination being released to the environment, then the RCO will conduct environmental surveys. For example, in the case of a pipe break the immediate area will be surveyed and posted following the posting guidelines identified in Section 7.6.2.3.

If an individual is contaminated by radioactive material, efforts will be made to decontaminate the individual. The decontamination process begins with mild methods and increases in rigor. However, care is always taken to minimize irritation of the skin, which may result in an intake of the material (HNF-IP-0718, *Health Physics Procedures)*. Depending on the magnitude and location of the skin contamination and based on guidance provided in PNL-MA-552, an intake may be presumed. The PNNL exposure evaluator and medical personnel

of Hanford Environmental Health Foundation may become involved with quantifying the intake and consequent radiation dose as well as possible medical actions that should be taken to reduce the intake.

7.13 REFERENCES

10 CFR 820, "Procedural Rules for DOE Nuclear Activities," *Code of Federal Regulations*.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*.

29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*.

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ANSI N323, 1983, *Radiation Protection Instrumentation Test and Calibrations*, American National Standards Institute, New York, New York.

ANSI Z88.2, 1992, *Respiratory Protection*, American National Standards Institute, New York, New York.

DOE O 440.1, 1996, *Worker Protection Management for DOE Federal and Contractor Employees*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE O 460.1A, 1996, *Packaging and Transportation Safety*, Change 0, U.S. Department of Energy, Washington, D.C.

DOE 5400.1, 1990, *General Environmental Protection Program*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE 5400.5, 1993, *Radiation Protection of the Public and the Environment*, Change 2, U.S. Department of Energy, Washington, D.C.

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DOE 5480.4, 1993, *Environmental Protection, Safety, and Health Protection Standards*, Change 4, U.S. Department of Energy, Washington, D.C.

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HNF-IP-0718, 1997, *Health Physics Technical Practices and Procedures*, Rev. 51, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-IP-0842, 1997, *TWRS Administration*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-058, 1997, *Critique Procedure*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-071, 1997, *Radiological Control Technician Training*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-082, 1997, *Radiological Worker Training*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-154, 1997, *Responsibilities and Procedures for all Hazardous Material*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-157, 1997, *Radioactive Material/Waste Shipments*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-329, 1997, *Radiological Training*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-331, 1997, *Work Place Air Monitoring*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-378, 1997, *Radiation Protection First-Line Supervisor Qualification*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-380, 1997, *Internal Dosimetry Program*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-382, 1997, *Area Dosimetry Program*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-386, 1997, *Radiological Control Technician Qualification and Training*, Fluor Daniel Hanford, Inc., Richland, Washington.

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HNF-PRO-435, 1997, *Required Radiological Surveillances*, Fluor Daniel Hanford, Inc., Richland, Washington.

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PNL-6684, 1995, *The Data Collection Component of the Hanford Meteorological Monitoring Program*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington.

PNL-MA-552, 1996, *Hanford Internal Dosimetry Project Manual*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

PNL-MA-553, 1995, *Hanford Radiological Records Project Manual*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington.

PNL-MA-563, 1996, *Radiation Instrument Calibration*, Pacific Northwest National Laboratory, Richland, Washington.

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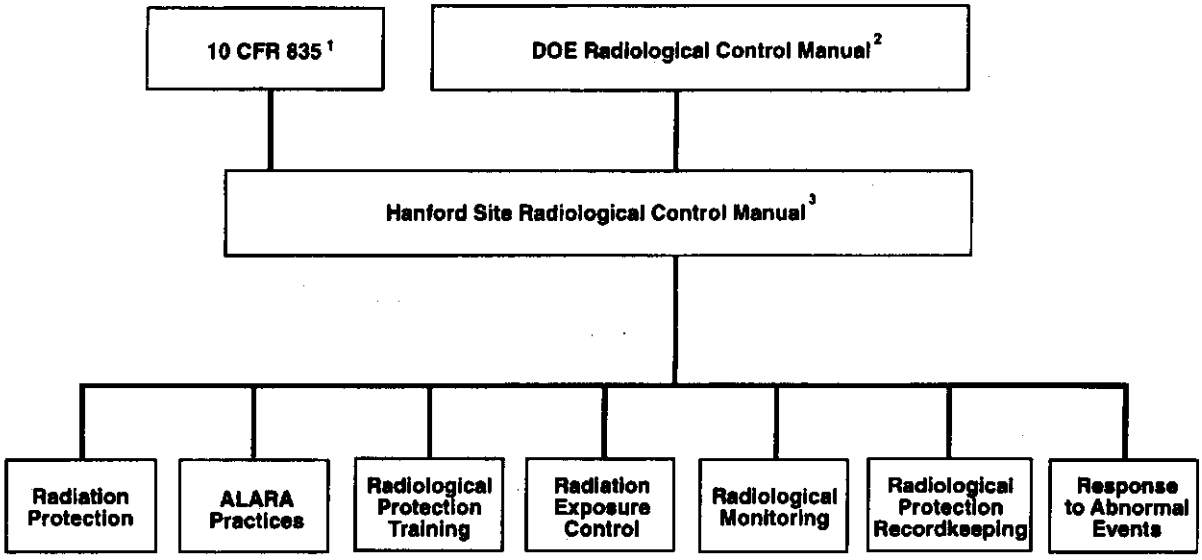
RL-WHC-TANKFARM-1996-0017, 1996, *Personnel Exceeded the Administrative Control Level for Extremity Exposure*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-MP-SRID-001, 1996, *High-Level Waste Storage Tank Farms/242-A Evaporator Standards/Requirements Identification Document*, Rev. 1B, Westinghouse Hanford Company, Richland, Washington.

Figure 7-1. Key Elements of the Radiation Protection Program are Derived from the U.S. Department of Energy Radiological Control Manual and Federal Regulations.



[1] 10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations.*

[2] DOE/EH-0256T, 1994, *Radiological Control Manual*, Rev. 1, U.S. Department of Energy, Washington, D.C.

[3] HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

ALARA = As Low as Reasonably Achievable.
DOE = U.S. Department of Energy.

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Figure 7-2. Collective External Dose (rem) Received by Hanford Tank Farm Workers.

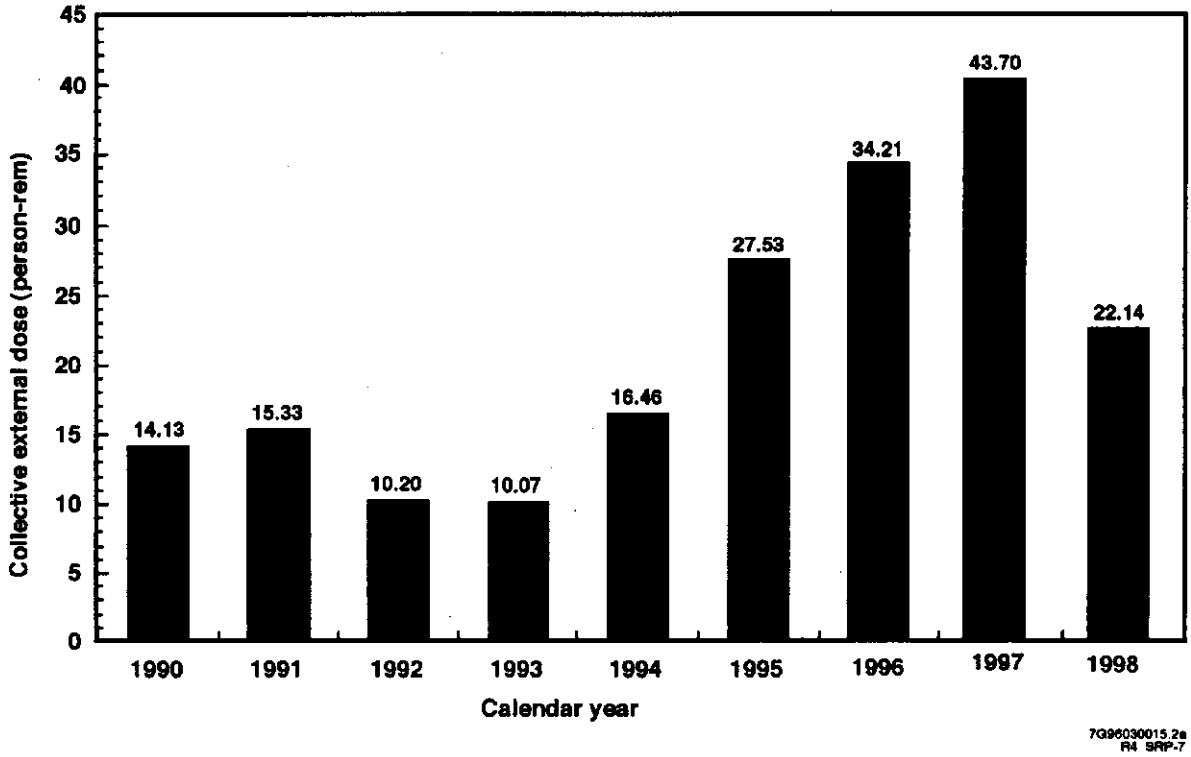

Table 7-1. Tank Waste Remediation System Administrative Control Levels.

Annual maximum dose equivalent Sv (mrem)				
TEDE[a]	Skin and extremity[b]	Lens of eye[b]	Any organ[b]	Approval required to exceed this level[c]
0.005 (500)	0.15 (15,000)	0.045 (4,500)	0.15 (15,000)	Level 3 line manager and RCM
0.01 (1,000)	0.225 (22,500)	0.0675 (6,750)	0.225 (22,500)	Level 2 line manager and RCM
0.015 (1,500)	0.3 (30,000)	0.09 (9,000)	0.3 (30,000)	Contractor senior site executive
0.02 (2,000)				DOE PSO
Age x 0.01 Sv = lifetime TEDE Age x 1,000 mrem = lifetime TEDE				Level 1 line manager and RCM

Source: HSCRM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[a]TEDE = total effective dose equivalent.

[b]Values are based on the nonstochastic limit and are calculated as committed doses.

[c]Approvals are sequential.

DOE = U.S. Department of Energy.

PSO = Program Secretarial Officer.

RCM = radiological control manager.

Table 7-2. Emergency Response Dose Limits and Conditions.

Dose limit TEDE, Sv (rem)	Emergency response	Conditions
0.05 (5)	All	--
0.1 (10)	Protecting major property	Only on a voluntary basis where lower dose limit not practicable
0.25 (25)	Lifesaving or protection of large populations	Only on a voluntary basis where lower dose limit not practicable
>0.25 (>25)	Lifesaving or protection of large populations	Only on a voluntary basis to personnel fully aware of the risks involved

Source: HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Notes: The lens of the eye dose limit is three times the listed values.

The shallow dose limit to the skin of the whole body and extremities is 10 times the listed value.

TEDE = total effective dose equivalent.

Table 7-3. Criteria for Posting Radiation, Contamination, and Airborne Radioactivity Areas.

Area	Dose rate criteria	Posting
Controlled area		
Controlled	<100 mrem/yr to individual in area	"RADIOLOGICALLY CONTROLLED AREA"
Buffer area		
Buffer	<5 mrem/h < Table 2-2 values[a]	"RADIOLOGICAL BUFFER AREA"
Radiation areas		
Radiation	>5 mrem/h and ≤100 mrem/h at 30 cm	"CAUTION, RADIATION AREA" "Personnel Dosimeter Required for Entry"
High radiation area	>100 mrem/h and ≤500 rad/h at 100 cm	"DANGER, HIGH RADIATION AREA" "Personnel Dosimeter, Supplemental Dosimeter and RWP Required for Entry"[b]
Very-high radiation	>500 rad/h at 100 cm	"GRAVE DANGER, VERY HIGH RADIATION AREA" "SPECIAL CONTROLS REQUIRED FOR ENTRY"[a]
Hot spot	5 times general area dose rate and >100 mrem/h	"CAUTION, HOT SPOT"
Contamination areas		
Contamination	Contamination levels (dpm/100 cm^2 >1 times but ≤100 times Table 2-2 values[a])	"CAUTION, CONTAMINATION AREA"
High contamination	Contamination levels (dpm/100 cm^2 >100 times Table 2-2 values[a])	"DANGER, HIGH CONTAMINATION AREA" "RWP required for entry"
Fixed contamination	Removable contamination levels < Table 2-2 removable values and total contamination levels > Table 2-2 total values[a]	"CAUTION, FIXED CONTAMINATION AREA"
Soil contamination		
Soil contamination	Contaminated soil not releasable in accordance with DOE 5400.5	"CAUTION, SOIL CONTAMINATION AREA"
Airborne radioactivity areas		
Airborne radioactivity	Concentrations (uCi/CC) >10% of any DAC value	"CAUTION, AIRBORNE RADIOACTIVITY AREA" "RWP required for entry"

Source: DOE 5400.5, 1993, *Radiation Protection of the Public and the Environment*, Change 2, U.S. Department of Energy, Washington, D.C.

Note: To convert mrem to Sv, divide by 100,000.

[a]See HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[b]Access requirements may be deleted or modified if personnel access is specifically prohibited

DAC = derived air concentration.

RWP = radiological work permit.

Table 7-4. Selected Survey and Area Monitoring Instruments.

Instrument type	Radiation detected	Typical range	Minimum calibration frequency	Remarks
GM counters				
Pancake GM survey meter	β, γ	0 to 100,000 cpm	Annual	Detection: β> 150 keV, x-rays >20 keV
Electronic dosimeter	γ	20 μR/h to 6,000 μR/h	Annual	--
Pocket ion chamber dosimeter	γ, x	1 mR to 200 mR	Annual	--
Ionization chambers				
Ion chamber survey meter	β, γ and x	0.2 to 5,000 mR/h	Annual	--
Ion chamber survey meter	α, β, γ and x	10 mR/h to 500 R/h	Annual	--
Ion chamber survey meter	α, β, γ and x	0.1 to 50 R/h	Quarterly	Sensitive to high levels of β and α surface contamination
High range survey meter	β, γ	0 to 20,000 R/h	Annual	--
Neutron survey meter	neutron	0 to 2,000 mrem/h	Annual	--
Alpha scintillation counter	α	0 to 1 million cpm	Annual	ZnS(Ag)
Portable continuous beta-gamma air monitor	β, γ	10 to 100,000 cpm	Annual	--
Personnel contamination monitors (Half-body counters)	β & γ	Minimum detection range is ~ 5,000 dpm/100 cm^{-2} for mixed fission products	Annual	--
Beta-gamma air and smear sample counter	β, γ	0 to 1 million cpm	Annual	Thin window pancake, sensitive to α
Alpha air and smear sample counter	α	0 to 1 million cpm	Annual	ZnS scintillator

GM = Geiger-Mueller (detector tube).

Table 7-5. Collective External Dose Received by Tank Farm Workers.

Year	Collective external dose (person-rem)
1990	14.13
1991	15.33
1992	10.20
1993	10.07
1994	16.46
1995	27.53
1996	34.21
1997	43.70
1998	22.14

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CHAPTER 8.0
HAZARDOUS MATERIAL PROTECTION

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CHAPTER 8.0
HAZARDOUS MATERIAL PROTECTION

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LIST OF TERMS

ACGIH	American Conference of Government Industrial Hygienists
ALARA	As Low As Reasonably Achievable
CL	chemiluminescence
DOE	U.S. Department of Energy
ES	electrochemical sensor
ESH&QA	Environment, Safety and Health and Quality Assurance
FDH	Fluor Daniel Hanford, Inc.
FID	flame-ionization detector
FL	fluorescence
GC	gas chromatograph
GF	gold film
HASP	*Tank Farm Health and Safety Plan*
HAZWOPER	hazardous waste operation
HEHF	Hanford Environmental Health Foundation
HMP	hazardous materials protection
IDLH	immediately dangerous to life and health
IH	Industrial Hygiene
IR	infrared
IS	Industrial Safety
JSA	job safety analysis
LEL	lower explosive limit
MSDS	material safety data sheet
NA	not applicable
NIOSH	National Institute for Occupational Safety and Health
OS&H	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PHMC	Project Hanford Management Contract
PID	photo-ionization detector
PPE	personal protective equipment
ppb	parts per billion
ppm	parts per million
RPPA	Respiratory Protection Program Administrator
TLV	threshold limit value
TWRS	Tank Waste Remediation System
WKH	Westinghouse Hanford Company/ICF Kaiser Hanford Company

8.0 HAZARDOUS MATERIAL PROTECTION

8.1 INTRODUCTION

The major provisions of the Tank Waste Remediation System (TWRS) Hazardous Materials Protection (HMP) Program are summarized in this chapter.

The TWRS HMP Program is the integration of industrial hygiene and other safety programs designed to provide protection against the type and magnitude of hazards identified in Chapter 3.0, "Hazard and Accident Analyses." The industrial hygiene programs include asbestos control and some elements of 29 CFR 1910, "Occupational Safety and Health Standards," (Parts 1200, "Hazard Communication Program" and 1910 Subpart Z, "Toxic and Hazardous Substances"). TWRS safety programs include conduct of operations, safety analysis, fire protection, worker protection, and facility safety.

"Hazardous material" in the context of this chapter means any nonradiological solid, liquid, or gaseous material that is toxic, explosive, flammable, corrosive, or otherwise physically or biologically threatening to human health. Hazardous materials, as used here, include the various chemicals found inside and outside the underground waste storage tanks within TWRS. This chapter only addresses hazardous materials that are present in quantities that can adversely impact the health and safety of the public or pose a significant risk to workers. The public is protected through effective HMP of onsite personnel. The protection of the public and environment from such events as spills, emissions, and discharges is covered under regulatory and permitting actions, which are handled through Site Environmental Services. The types and quantities of hazardous materials at TWRS do not require imposition of the Occupational Safety and Health Administration (OSHA) Process Safety Management rule (29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals") or the U.S. Environmental Protection Agency Clean Air Act Risk Management rule (40 CFR 68, "Chemical Accident Prevention Provisions").

The process used by TWRS environmental personnel to maintain compliance to current environmental requirements falls into three categories: (1) requirements management, (2) corrective actions management, and (3) contracts management. The TWRS effluent monitoring program for hazardous materials is discussed in Chapter 9.0, "Radioactive and Hazardous Waste Management."

8.2 REQUIREMENTS

Applicable design codes, standards, regulations, and U.S. Department of Energy (DOE) orders relevant to this chapter and required for establishing the safety basis of TWRS facilities are listed in this section. These DOE orders implement 29 CFR 1910 and 29 CFR 1926, "Safety and Health Regulations for Construction."

- DOE 1324.5B, *Records Management Program*, Change 1 (1996)
- DOE 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, Change 4 (1993)[1]
- DOE 5480.8A, *Contractor Occupational Medical Program*, Change 1 (1992)[2]
- DOE 5480.9A, *Construction Project Safety and Health Management*, Change 0 (1994)[3]
- DOE 5480.10, *Contractor Industrial Hygiene Program*, Change 0 (1985)[4]
- DOE 5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities*, Change 0 (1993)[5]
- DOE 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, Change 7 (1990).

An overview of the relationship between the primary regulatory drivers, the implementing documentation (DOE orders), and the resulting contractor industrial hygiene programs is depicted in Figure 8-1.

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[1]Attachment 2, Paragraphs 2c, 2d(2)-(3), 2e(1)-(8) cancelled by DOE O 440.1; Attachment 3 Paragraphs 2c, 2d(2)-(3), 2d(I)-(7) cancelled by DOE O 440.1. Compliance with DOE 5480.4 required until the Contracting Officer directs compliance with DOE O 440.1 or provides other direction to terminate compliance with DOE 5480.4.

[2]Cancelled by DOE N 251.4 and DOE O 440.1. Compliance with DOE 5480.8A is required until the Contracting Officer directs compliance with DOE O 440.1 or provides other direction to terminate compliance with DOE 5480.8A.

[3]Cancelled by DOE N 251.4 and DOE O 440.1. Compliance with DOE 5480.9A is required until the Contracting Officer directs compliance with DOE O 440.1 or provides other direction to terminate compliance with DOE 5480.9A.

[4]Cancelled by DOE N 251.4 and DOE O 440.1. Compliance with DOE 5480.10 is required until the Contracting Officer directs compliance with DOE O 440.1 or provides other direction to terminate compliance with DOE 5480.10.

[5]Chapter II cancelled by DOE 5480.29; Chapter III, Paragraphs 2a, 2b, and 2c cancelled by DOE O 231.1; entire order cancelled by DOE N 251.4 and DOE O 440.1. Compliance with DOE 5483.1A is required until directed by Contracting Officer to comply with DOE O 440.1.

8.3 HAZARDOUS MATERIAL PROTECTION PROGRAM AND ORGANIZATION

The TWRS Environment, Safety and Health and Quality Assurance (ESH&QA) Director is responsible for implementing HMP. The goals of the industrial hygiene programs include, but are not limited to, recognition, evaluation and control of chemical and physical agents and other environmental factors associated with worker operations and worker well-being. The industrial hygiene programs use the OSHA permissible exposure limits (PELs) and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) to provide guidance on controlling exposures and protection for the worker.

The industrial hygiene programs, contractor manuals, and therefore the HMP Program, fulfill the requirements in WHC-CM-4-40, *Industrial Hygiene Manual*, Section 2.1, "Hazard Communication Program"[6]; and WHC-CM-1-11, *Industrial Hygiene Manual*, in which actions compliant with DOE 5480.10 are prescribed. A listing of applicable contractor manuals related to the TWRS industrial hygiene programs down to the contractor-implementing activity level is provided in Table 8-1.

The administrative framework for ensuring compliance with primary requirements for HMP is shown in Figure 8-2. Professional and technical industrial hygiene staff implement industrial hygiene programs at TWRS. Currently, there are industrial hygienists supporting the contractor safety organization. Each tank farm industrial hygienist is supported by industrial hygiene technicians. Industrial hygienists are not required to be certified but are encouraged to obtain and maintain a certified industrial hygiene status. Industrial hygiene technicians are required to complete the industrial hygiene technician training program, which is administered through the industrial hygiene department. Technicians are also encouraged to obtain certification as occupational health and safety technicians. Sections 8.5.1 and 8.5.2 contain additional information on industrial hygiene staff qualifications and training.

The industrial hygiene programs are part of the TWRS ESH&QA Department. The TWRS Safety and matrixed environment, safety and health organizations report to the contractor ESH&QA department. ESH&QA reports directly to the contractor president. In addition to being responsible for industrial hygiene, TWRS Safety directs the activities of industrial safety and Fire Protection programs. Each of these disciplines is involved in HMP at TWRS.

8.3.1 Hazardous Material Protection Organization

The contractor president establishes the company-level policy for implementing the HMP Program by ensuring that the workplace is free of and protected against recognized hazards that cause or are likely to cause sickness, impaired health, significant discomfort, or inefficiency among

[6]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc. (FDH) procedures (e.g., HNF-PRO-XXX).

workers. The president is also responsible for establishing the industrial hygiene program in accordance with DOE requirements and other applicable documents and for providing appropriate resources to support the industrial hygiene and industrial safety programs. The TWRS operating organization has the responsibility for ensuring that the requirements are implemented.

8.3.2 Tank Waste Remediation System Management

TWRS management reports directly to the company president and has responsibilities that are specific to the industrial hygiene and industrial safety programs. Responsibilities include (1) ensuring that employees are enrolled in appropriate medical monitoring programs, are trained to perform assigned tasks, and are aware of hazardous chemicals in the workplace; (2) implementing recommendations from the supporting industrial hygiene staff; and (3) providing funding for industrial hygiene assessment (monitoring) and hazard control on TWRS projects.

8.3.3 Tank Waste Remediation System Line Managers

The TWRS line managers are responsible for recognizing hazard potentials related to facilities and tasks that are their responsibility. Line management is involved in the monitoring and inspection of all field work through two primary processes beginning with the work planning process. Routine tasks are described in controlling procedures. These written procedures must be approved by a cognizant manager and contain steps describing field monitoring or inspection activities conducted by management. Nonroutine work is conducted in accordance with work packages developed by teams including managers, safety and health professionals, and involved craftsmen. A "person-in-charge" is designated for all jobs conducted in accordance with work packages and serves as the management delegate during the execution of the job. The person-in-charge conducts the prejob safety meetings describing, among other topics, the hazardous material protection processes that are to be in place when the work is conducted. The person-in-charge monitors the work as it is conducted and ensures effectiveness of hazardous materials protection controls described in the work package. The person-in-charge reports any nonconformance encountered during the work to upper management.

In addition, the line managers have the following responsibilities:

- Ensure that operations are conducted in such a manner that maximum occupational health standards and limits established by the industrial hygiene programs are not exceeded

- Ensure that periodic hazard assessments are performed to identify potential occupational health hazards, evaluate severity of hazards, and establish priorities for health and safety hazard abatement

- Ensure that employees are trained in regular and prejob safety meetings to recognize hazards and to protect themselves from hazardous chemical exposures

- Provide workers with information regarding hazards of procured hazardous chemicals

- Request industrial hygiene staff assistance when exposure potential exists

- Implement recommendations from the industrial hygiene staff.

8.3.4 Tank Waste Remediation System Safety Manager

The TWRS Safety manager reports to the ESH&QA Director and has the following HMP-related responsibilities within the industrial hygiene and industrial safety programs:

- Coordinate implementation of applicable DOE orders and requirements for industrial hygiene and industrial safety within TWRS

- Ensure that industrial hygiene staff supporting TWRS have appropriate or required training, certifications, and qualifications

- Provide safety and health expertise, assistance, and support for TWRS operations and activities

- Provide industrial hygiene and safety technical assistance and support through qualitative and quantitative assessments

- Monitor TWRS safety and health to assess program effectiveness and define performance and trends

- Administer programs to control and minimize safety and health hazards and promote continuous improvement in safety and health performance through TWRS operations.

8.3.5 Tank Waste Remediation System Employees

TWRS employees are responsible for ensuring that work is conducted in a safe and healthy manner and that on-the-job safety and health concerns are recognized and reported. The responsibilities of TWRS employees include the following:

- Recognize and report unsafe conditions or practices to the manager, job supervisor, or person-in-charge during the performance of work

- Take personal action to correct or mitigate an unsafe condition at the time it is discovered

- Follow written procedures, specified controls, and additional safety instructions contained in work control documents or conveyed by the job supervisor or person-in-charge.

8.3.6 Environment, Safety and Health and Quality Assurance Director

The ESH&QA Director reports directly to the company president and is responsible for developing and administering programs to control and minimize health and safety hazards and to promote continuous improvement in safety and health performance. The ESH&QA Director provides safety and health expertise, assistance, and support for contractor operations and activities, maintains employee safety and health records, and coordinates with Site service organizations as necessary.

The ESH&QA Director's responsibilities include the following:

- Identify and interpret existing and emerging DOE orders and other pertinent requirements for applicability to and impact on the occupational health program

- Interface with DOE, Richland Operations Office, to assess and resolve industrial hygiene concerns

- Establish industrial hygiene programs and health and safety policies

- Review and evaluate sitewide and facility-specific training programs to ensure adequacy of industrial hygiene components with industrial hygiene staff participating, as necessary, as technical experts in training program development and delivery

- Act as the primary contractor liaison with the medical contractor, Hanford Environmental Health Foundation (HEHF), to ensure a coordinated implementation of occupational medicine program requirements (specific activities to coordinate include medical examinations, return to work, work restrictions, claims management, material safety data sheets [MSDSs], work site analysis, exposure monitoring and industrial hygiene analytical services)

- Establish the minimum amount of occupational monitoring data for collecting, reporting, and establishing records-retention requirements for the data

- Ensure that occupational health-related noncompliances, deficiencies, corrective actions, and exemptions are retrievable for tracking and trending.

8.3.7 Tank Waste Remediation System Industrial Hygiene Staff

The responsibilities of the TWRS industrial hygiene staff are as follows:

- Implement and manage overall Site industrial health protection
- Assist TWRS management with implementation of contractor industrial hygiene programs, including hazard monitoring and hazard communication
- Procure and maintain hazardous material monitoring instrumentation used by industrial hygiene staff
- Provide industrial hygiene expertise to the emergency response organization during emergency events and subsequent recovery conditions
- Assist TWRS management with the process of hazard recognition
- Assess exposures when requested by TWRS management and recommend any necessary controls to management
- Assess chemical exposures noted from review of monitoring data and recommend controls to protect employees
- Develop, implement, and maintain WHC-SD-WM-HSP-002, *Tank Farm Health and Safety Plan* (HASP), and assist in compliance verification
- Collect monitoring data and submit findings to the Hanford industrial hygiene exposure database (administered by Fluor Daniel Hanford, Inc. [FDH])
- Notify employees of results from personal monitoring
- Assist TWRS management in defining and resolving safety and health issues.

8.3.8 Hanford Environmental Health Foundation

The HEHF maintains medical monitoring programs for TWRS employees in compliance with OSHA regulations and DOE orders. The responsibilities of HEHF include the following:

- Perform preplacement, periodic, return-to-work, and fitness-for-duty examinations for all workers
- Perform physicals for workers who handle hazardous waste as required by OSHA regulations, DOE orders, and other regulatory requirements

- Maintain medical records
- Provide management consulting
- Manage the MSDS database.

In accordance with DOE 5483.1A, TWRS Safety provides information to HEHF regarding (1) employee exposures to allow HEHF to determine which individuals should be included in medical surveillance programs and (2) data pertaining to health hazards in the workplace. This data is based on assessments of employee exposures to hazardous materials.

8.3.9 Tank Waste Remediation System Operations (Training and Procedures)

Training and Procedures is a project support organization within the TWRS Tank Waste Operations. The organization provides training relevant to HMP for TWRS personnel. Additional information is given in Chapter 17.0, "Management, Organization, and Institutional Safety Provisions."

8.3.10 Fluor Daniel Hanford, Inc. (Integrating Contractor)

FDH is the Project Hanford Management Contract (PHMC) oversight authority. The safety and health organizations within FDH are responsible for PHMC safety and health policy development, Hanford-wide program development for regulatory compliance, and interfacing with regulatory agencies. FDH is tasked with standard interpretation, maintaining safety policies and procedures, developing site-wide training, and conducting safety oversight.

Some of the site functions FDH supports include initiatives for safety awareness, accident statistics and investigations, database maintenance (injury/illness, employee concerns, and industrial hygiene exposure), coordination of Hanford-wide Voluntary Protection Program initiatives, and the Integrated Safety Management System.

8.4 AS LOW AS REASONABLY ACHIEVABLE POLICY AND PROGRAM

There is no formal As Low As Reasonably Achievable (ALARA) program with respect to hazardous materials. However, many of the same concepts as for a radiological ALARA program are employed at TWRS for HMP. The goal of ALARA is to reduce the level of hazardous materials and the effects of those materials at the source and thereby mitigate any effects on workers, the environment, or the public. ALARA also ensures that exposures are kept to the lowest levels and within the limits set by governing authorities (i.e., OSHA PELs and ACGIH TLVs). The HMP program at TWRS ensures exposures are kept to a minimum based on the

requirements and provisions of DOE orders, OSHA regulations, national consensus industrial hygiene standards, and recommended practices.

ALARA concepts, including ALARA goals and attendant performance tracking requirements, were devised to reduce safety and health risks associated with radioactive materials and ionizing radiation. The goals and work practices are required by governing authorities or are part of the recommended industrial hygiene practices and are implemented by the HMP Program at TWRS. The industrial hygiene programs pertaining to HMP at TWRS implement the principles by using engineered controls and features, administrative controls, and PPE. The following industrial hygiene principles are applied at TWRS:

- Worker exposures to hazardous materials are maintained to the limits of OSHA PELs and ACGIH TLVs.
- Workers have access to and use of MSDSs.
- Workers are notified of potential chemical hazards.
- Workers use recommended PPE while engineered and Administrative Controls are being implemented or when the controls are not feasible.
- Workers are trained in, and apply, appropriate on-the-job personal hygiene.

The following work practices are used for HMP at TWRS:

- Prejob planning
- Job monitoring
- Postjob reviews
- Lessons-learned reviews
- Cost-benefit analysis worksheets
- Project/task planning, designs, and reviews.

Chemical exposures in the workplace are further controlled by (1) requirements of the purchasing process for chemical agents, (2) requirements for the handling of chemicals, (3) chemical monitoring, (4) hazard (or hazards) communication program, and (5) records and reporting. Additional discussion on control of hazardous materials exposure is provided in Section 8.6. A summary of the contribution that each practice provides to implementation of ALARA concepts is shown in Table 8-2.

In addition, TWRS oversees contractor and subcontractor construction activities at TWRS facilities to minimize exposures to hazardous materials through worksite inspections following the requirements of DOE 5480.9A.

8.5 HAZARDOUS MATERIAL TRAINING

This section summarizes the industrial hygiene training for TWRS personnel responsible for controlling occupational exposures to hazardous materials. A discussion of general Site training is provided in Chapter 12.0, "Procedures and Training."

The contractor provides workers with onsite and offsite training on industrial hygiene topics on a regular basis. TWRS industrial hygiene staff are trained in the anticipation, recognition, evaluation, and control of hazardous materials exposure to ensure their ability to protect worker health and safety and to implement applicable provisions of DOE 5480.10. The training process follows the precepts of the OSHA safety and health management guidelines and the implementation strategy of 54 FR 3904, "Voluntary Protection Program." TWRS management is responsible for ensuring that employees are trained in the details of the industrial hygiene program and in the safety and health hazards associated with any job-related hazardous material exposure. TWRS management (training and procedures function) provides required Site training and professional development to maintain and enhance staff proficiency. A required reading program ensures that employees are kept current on pertinent issues (e.g., updates of manuals and standards, lessons learned, and other safety-related information). In addition, line management must have sufficient training to be able to recognize the potential for hazardous materials exposures and to implement controls as specified by the professional staff. The professional industrial hygienists provide technical expertise to line managers regarding occupational safety and health hazards and methods to control exposure associated with the jobs assigned to employees.

Managers develop professional development plans that describe the courses or seminars suggested for each staff member. Records on individual training and qualifications are maintained by each individual's manager to satisfy the requirements for records management discussed in Section 8.9.

8.5.1 Safety Staff Qualifications

The TWRS Safety administration determines the basic educational and experience criteria for employees assigned to industrial hygiene staff positions. The staff must have the appropriate education, credentials, and experience to be able to anticipate, recognize, evaluate, and control hazardous materials exposures. The TWRS industrial hygiene personnel must have a Bachelor of Science degree or equivalent education and industrial hygiene safety experience. Area industrial hygiene technicians must have a high school diploma. Certification (certified industrial hygienist or occupational health and safety technician by the American Board of Industrial Hygiene or certified safety professional by the Board of Certified Safety Professionals) is highly desired. Requirements for being a fully qualified safety professional include completion of a contractor qualification program and a minimum of 2 yr related experience.

8.5.2 Training Requirements

8.5.2.1 Industrial Hygiene Training. TWRS management provides training, professional education, and certification opportunities necessary to support, maintain, and enhance industrial hygiene staff proficiency to meet or exceed DOE industrial hygiene training objectives and goals. Program elements include needs assessment, definition of training objectives, training plans, and implementation and evaluation of program effectiveness. Training is appropriate for the assigned tasks and level of responsibilities. Training also addresses hazards described in DOE-prescribed OSHA standards as well as those for which no PEL or other requirement has yet been established. The contractor integrates DOE-mandated training objectives into Site training programs, as appropriate, for each level of qualification for professional industrial hygiene staff, line management and supervision, and other employees.

8.5.2.2 General Training. Personnel whose work may expose them to hazardous materials must have sufficient training to know the physical and chemical hazards presented by the materials in their environment and how to protect themselves from the deleterious effects of exposure. In addition to Hanford General Employee Training, workers who work at a hazardous waste site receive 24- or 40-h hazardous waste operations training per 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response." A list of major training requirements and topics is provided in Table 8-3. Facility-specific training regarding hazardous materials that may be encountered during work in each location is provided to personnel.

8.6 HAZARDOUS MATERIALS EXPOSURE CONTROL

Occupational exposures to hazardous material(s) and the spread of hazardous material contamination are controlled by physical barriers (e.g., hazardous materials containment, encapsulation and abatement [asbestos], high-efficiency particulate air filters, and active ventilation systems) on some waste storage tanks. Hazardous materials are also controlled through the use of plans, procedures, and physical elements of the TWRS HMP Program. A summary of these controls and a specific discussion of levels of control, including how these controls are determined, are provided in this section.

8.6.1 Hazardous Material Identification Program

Hazardous materials in the work environment are identified by several mechanisms as follows:

- Hazard communications program
- Hazardous materials and hazardous waste labeling
- Inventory of chemicals
- Preconstruction and facility modification assessments
- General employee health and safety training
- In-tank hazardous materials characterization activities

- Ongoing and continuous source-monitoring program
- Worker and work area monitoring, where needed
- Potential hazard and accident analyses.

A degree of HMP is attained through the procurement process which requires identification, labeling, and special instructions to accompany procured materials. Procurement of hazardous materials is controlled by the company-wide hazard communications program (as described in WHC-CM-4-40, Section 2.1) and waste minimization programs. The hazard communications program conforms to 29 CFR 1910.1200, "Hazard Communication," and to DOE 5480.10. The program ensures that contractor employees are aware of potential hazards that may exist because of hazardous materials present at TWRS facilities.

Constituents requiring environmental monitoring are identified in WAC 173-303, "Dangerous Waste Regulations"; WAC 173-307, "Pollution Prevention Plans"; and DOE 5400.1, *General Environmental Protection Program*. Note that environmental releases of hazardous materials (spill reporting and permitted releases) are controlled through environmental programs. As discussed in WHC-CM-7-5, *Environmental Compliance*, all spills larger than drips are reported immediately to the facility manager. The facility manager initiates the response actions, including the appropriate initial notifications, response actions and follow-up notifications which may include the Washington State Department of Ecology. The environmental programs for permitted releases are discussed in Chapter 9.0.

Hazardous materials present in existing structures and facilities are identified and controlled to prevent release or exposure to employees, the public, or the environment. Engineered controls, administrative controls, and the use of PPE are used to control the effects of hazardous materials.

Before the start of any work activity, the hazards of that activity, including known and potential chemical hazards, are assessed. Qualitative and quantitative workplace hazard assessments (i.e., "good faith" inspections) are performed by the TWRS industrial hygiene and industrial safety staff as prescribed by the Safety department and industrial hygiene programs (WHC-CM-1-11 and WHC-CM-4-40). The Prejob Planning procedure (HNF-PRO-079) describes the method to be used to identify and control or prevent previously unrecognized hazards through use of the Job Hazard Analysis/Job Safety Analysis process.

The Job Hazard Analysis/Job Safety Analysis process is focused on ensuring the safety of workers for day-to-day activities and operations. Hazards are identified and either eliminated or adequately controlled before the activity commences. Each worker has the additional requirement to follow the master safety rule that states: "If it is not safe, don't do it."

The hazard analysis process is used to assess the risk of operations from an overall TWRS perspective. This process is explained in Section 3.3.1 and illustrated in Figures 3.3.1-1 and 3.3.1.5-1. Where feasible, with regard to existing facility conditions and cost benefit analyses, the hazardous conditions are eliminated. When prevention is not feasible, the consequence of an unacceptable event is mitigated by controls.

These periodic and job-specific hazard assessments are required by DOE orders and DOE-prescribed OSHA standards. As required by 29 CFR 1910.120, assessments and evaluations of operations and emergency response activities are incorporated into the HASP. The results of quantitative assessments are retained in the Hanford industrial hygiene exposure database, which is managed and maintained by Fluor Daniel Hanford, Inc. Guidelines for exposure assessments, such as those performed by the contractor, can be found in *A Strategy for Occupational Exposure Assessment* (Hawkins et al. 1991).

Information derived from the TWRS characterization of tank contents and the gases and vapors emitted from the tanks is used to identify areas requiring further HMP monitoring and surveillance. In addition, the TWRS industrial hygiene also conducts an ongoing source-monitoring program to identify locations where hazardous gases may escape from tanks and pose a risk to employees or the public. Area and worker monitoring is performed when there is a potential for overexposure of personnel working in the vicinity of the tanks.

Procedures also ensure that hazards inherent to the use of instruments to detect, monitor, or characterize tank contents are recognized and either eliminated or controlled. For example, the ammonia detection system (Section 4.4.16.2) includes a component that directs a laser beam through a sample of the tank exhaust vapor. Worker safety is ensured because the laser beam is relatively low power and workers are not exposed to the beam. The detector is in an instrument cabinet and is operated automatically. No spare parts are stocked, and no maintenance is performed by TWRS personnel. When servicing is needed, the vendor performs the necessary activities.

Chemical hazards resulting from postulated accidents (e.g., fires and explosions) are identified and quantified in the hazard and accident analysis section (Chapter 3.0).

For example, the results of the caustic spray leak analysis (Section 3.3.2.4.9) determined that a caustic spray release during a pressurized transfer could adversely impact facility workers and recommended the following controls:

- Plastic sleeving around delivery piping
- Caustic delivery system pressure ≤ 125 lb/in.^{2} gauge.
- Caustic transfer piping wall thickness ≥ 0.109 in.

These controls would be required in addition to other protective measures (e.g., PPE, monitoring) mandated for all caustic transfers (i.e., unpressurized liquid transfers, solids additions).

8.6.2 Administrative Limits

The HASP establishes requirements, general guidelines, and farm- and facility-specific hazard communication information and exposure control. The objective of the HASP is to minimize health and safety risks to workers and other onsite personnel. As discussed in the

HASP, normal tank farm operations are required to comply with 29 CFR 1910.120, because the tank farm is a *Resource Conservation and Recovery Act of 1976* facility. The TWRS industrial hygiene/industrial safety is responsible for developing and implementing the HASP. In addition, as discussed in the HASP, industrial hygiene personnel are responsible for evaluating the adequacy of prescribed health and safety procedures and the levels of protection provided for work activities. For example, if the level of PPE required in the job package is inadequate for the actual Site conditions, industrial hygiene personnel ensure the job is discontinued until corrective actions are implemented.

The HASP, in addition to providing routine tank farms and facilities access controls (e.g., PPE, training requirements), is used as a reference during the planning of work activities at the tank farms. The following is a list of general activities performed at TWRS with the level of hazard analysis required:

- **Routine Tank Farms and Facilities Access Activities**. These activities do not require a detailed written procedure. The specific controls necessary to protect the worker are described in the HASP and implemented by TWRS operations. These activities include operator surveillances, radiation monitoring, industrial hygiene monitoring, industrial safety or quality assurance surveillance, and activities performed in accordance with approved plant operating procedures.

- **Corrective Maintenance**. Activities planned and approved for later or repeated use typically include preplanned, preventive, and predictive maintenance; calibrations; other periodic work that is recalled; and corrective maintenance work that may recur in the future. In addition to the industrial hygiene requirements established in the HASP for the protection of the worker during routine activities, a job hazard analysis may be required depending on the risk and complexity of the task. The job hazard analysis is performed by industrial hygiene/industrial safety personnel.

- **Hazardous or Complex Activities.** Jobs for which performance of work is hazardous, complex, or having a higher potential for adversely affecting the environment or equipment operability may require more detailed planning. In addition to the industrial hygiene requirements established in the HASP for the protection of the worker during routine activities, a job hazards analysis is required. These activities cannot be preapproved.

- **Routine Activities**. The controls necessary to protect the worker during routine tasks (e.g., relamping incandescent and fluorescent lights, adding lubricating oils to rotating equipment, changing out gas bottles) are described in the HASP.

- **Activities Using Approved Operating Procedures**. Typical activities in this category include startup, operation, and shutdown of tank farms equipment using approved procedures. Transfer of waste into or between tank farms is also a

typical activity in this category. The specific controls necessary to protect the worker are described in the specific procedure and the HASP.

The job hazards analysis includes an evaluation of any safety issues and hazards associated with the planned work. Throughout the job hazard analysis process, the potential for significant exposure is emphasized. Industrial hygiene staff note potential hazard exposures on the documentation, and any needed followup is performed. Followup includes determining exposure limits and the need for exposure controls. In the field, these limits and controls are imposed as a part of the work plan.

In most instances, TWRS industrial hygiene controls hazardous chemical exposures (1) by following OSHA PELs and ACGIH TLVs (Section 8.11) and (2) as required by DOE 5480.10. Where OSHA and ACGIH have not established limits, recommendations by other agencies, such as National Institute for Occupational Safety and Health (NIOSH) and the American Industrial Hygiene Association, will be considered in developing an exposure limit. A guideline on evaluation and control is developed (as required by DOE 5480.10) using the best available information and the professional judgment of the industrial hygienist. In the absence of any recommended limits, nonroutine exposure limits are prescribed on a case-by-case basis for the particular material. The industrial hygiene staff conservatively establish these limits using a combination of factors derived from experience, data, knowledge, and an assessment of the situation.

8.6.3 Occupational Medical Programs

The HEHF provides medical surveillance services for the contractor employees. HEHF services to the contractor and contractor employees include the following:

- Preplacement health appraisals
- Periodic health examinations
- Health education programs
- Site presence for first-aid and medical referral
- Specific, appropriate examinations for employees who work with, or are exposed to, hazardous materials including analysis of workers' blood for lead and zinc protoporphyrin and analysis of urine for mercury
- Imposition of medical restrictions for employees wherever warranted through examination findings and notification of the restricted employee's management.

On the basis of qualitative and quantitative exposure assessments, TWRS industrial hygiene recommends to applicable managers the personnel to be included in specific medical

surveillance programs. Data regarding health hazards in the workplace is made available to HEHF through industrial hygiene programs. This data is based on hazards defined through assessments regarding workplace conditions such as high noise, extreme temperatures, or exposure to carcinogens or chemicals.

8.6.4 Respiratory Protection

To protect employees from exposure to hazardous atmospheric contaminants (radioactive and nonradioactive), the contractor uses engineering controls (when feasible), administrative controls, and PPE (as a last resort when engineering controls are not feasible). The controls are administered by the contractor respiratory protection program, which is written to comply with the respiratory protection standards published in ANSI Z88.2, *Respiratory Protection*. The Respiratory Protection Program Administrator (RPPA), who reports to the ESH&QA Director, has the ultimate authority and responsibility for the program.

8.6.4.1 Selection of Respiratory Protection Equipment. Respiratory protection equipment is procured only with the approval of the RPPA and a sitewide respiratory protection committee. The contractor uses only respirators that have been approved by the NIOSH or the Mine Safety and Health Administration.

Although many types of respiratory protection equipment are available on the Hanford Site, adequate protection for the user is maintained only if the proper respirator and cartridge combination is chosen. Respiratory protective equipment is prescribed by industrial hygienists according to the strict protocol described in the company respiratory protection program.

Emergency use of respiratory protection equipment is governed by facility emergency management plans as required by DOE 5500.3A, *Planning and Preparedness for Operational Emergencies*, and DOE/RL-94-02, *Hanford Emergency Response Plan*, as implemented by WHC-CM-4-43, *Emergency Management Procedures*, and WHC-IP-0263-TF, *Tank Farms Building Emergency Plan*. Note that 29 CFR 1910.38, "Employee Emergency Plans and Fire Prevention Plan"; 40 CFR 265.56, "Emergency Procedures"; and WAC 173-303 all require facilities to have building emergency plans that include discussion of and provision for respiratory protection.

8.6.4.2 Inspection of Equipment. Following each use, respirators are returned to a respiratory protection maintenance facility for inspection, repair, cleaning, and repackaging. The Hanford Fire Department manages the facility for servicing self-contained breathing apparatus equipment. Interstate Nuclear Services, under direct contract with DOE, Richland Operations Office, services air-purifying respirator and air line equipment. Individual facilities are responsible for maintaining powered air-purifying respirators. Respirator users are responsible for inspecting their equipment before using it in the field. All respirators are inspected during regular cleaning and maintenance after each use. Random inspections of stored respirators are performed by the RPPA. Facility

managers are responsible for ensuring that all respirators designated for emergency use are inspected regularly. All respirators failing user inspections are reinspected by the RPPA to assess the need for programmatic alterations.

8.6.4.3 Control, Issuance, and Use of Respirators. Respiratory protection equipment is issued from and returned to assigned facilities in several areas within TWRS. Respirator custodians are assigned by facility managers to control and issue equipment. Respiratory equipment control and use must comply with the requirements of WHC-CM-1-11. Equipment is issued on the basis of the written recommendations of industrial hygienists contained in the work control documentation or the written requirements included in radiation work permits prepared by the Radiological Control organization. All industrial hygienists are qualified to select respiratory protection devices.

All respirator users must have a physical examination and subsequent medical clearance before being quantitatively fit-tested for a particular respirator model and size. All TWRS employees who may be required to use respirators as part of their job activities are fit-tested and required to complete the basic training course for respirator users. All respiratory users must pass this course. Personnel requesting respiratory protection must present proof of training and certification to the respirator custodian before a respirator will be issued.

The users are also required to pass annual refresher courses. Supervisors of individuals who wear respirators must complete the training courses. Respirator custodians who issue respirators in the field must also complete the basic training course, which includes information on storage, handling, and issuing of equipment. All training programs operate under the direct approval of the RPPA or DOE with input from the RPPA.

Users of special respiratory protection equipment must have specialized training. The advanced training includes courses in air line equipment, self-contained breathing apparatus, powered air-purifying respirators, or air-fed hoods.

8.6.4.4 Associated Records. Permanent records of training and fit testing are retained by the training facility and inspected by the RPPA. Medical examination records are retained by HEHF. Records of issue are retained at the facility issue station and inspected by the RPPA. Records of respiratory prescription are retained in work control documents, as a facility record in the forms of permits, hazard analyses, and memoranda.

8.7 HAZARDOUS MATERIAL MONITORING

The TWRS hazardous material monitoring and control programs conducted inside and outside facility boundaries are summarized in this section. Reporting and recordkeeping are discussed in Section 8.9. Monitoring and sampling for hazardous materials are performed (1) to determine potential sources of material release and (2) to measure actual worker exposures to hazardous materials.

8.7.1 Tank Monitoring

Tank headspace monitoring is being conducted at several tank farms to speciate and quantify levels of the following materials in each tank:

- Volatile and semivolatile organic contaminants
- Ammonia
- Hydrogen cyanide and acid gases
- Oxides of nitrogen and sulfur
- Hydrogen
- Methane.

Tank farm operations personnel began the process of sampling tank headspace contents in August 1992. Tank headspace monitoring of toxic materials is performed to determine the potential for vapor release and subsequent employee exposure. Data obtained from tank headspace sampling is used to determine monitoring needs of employees near the tanks.

Flammable gases within the tank headspace of flammable gas Watch List tanks are monitored to comply with the requirements of the Public Law 101-510, *National Defense Authorization Act for Fiscal Year 1991* (the Wyden Bill) and NFPA 69, *Explosion Prevention Systems*. The Wyden Bill requires tanks, which have a high potential to release high-level waste because of uncontrolled increases in temperature or pressure, be continuously monitored to detect a release or excessive temperature or pressure. NFPA 69 requires control of flammability levels for systems susceptible to flammable atmospheres.

8.7.2 Air Monitoring in the Workplace

Workplace monitoring requirements for hazardous materials associated with tank waste are specified in the HASP. Monitoring for workplace hazards that are not directly related to tank wastes are described in routine industrial hygiene and safety department programs (as prescribed in WHC-CM-1-11 and WHC-CM-4-40). These programs include the following:

- Control of regulated materials (i.e., asbestos, lead, carcinogens)
- Confined space entry
- Respiratory protection
- Hazard communication.

Workplace monitoring is performed to quantitatively assess actual and potential employee exposures to hazardous materials. Monitoring is conducted by sampling air spaces according to safety department implementing procedures. Monitoring for workplace hazards is conducted for any operation that can reasonably be expected to result in employee exposures equal to or greater than an administrative action level or PEL. The action level established by TWRS industrial health and safety is half of the PEL or half of the TLV, whichever is most restrictive. Samples

may be collected as either bulk, source, area, or personal samples. Personal sample results are provided to employees after the sample analysis is completed (Section 8.9.4.3).

Monitoring equipment is selected on the basis of the anticipated hazard detected during a qualitative risk assessment. The monitoring tools commonly used in TWRS to perform exposure assessments are described in Section 8.8.

Sampling is initiated by the industrial hygienist who reviews the work control documents, baseline hazard assessment, or other indicators of potential employee exposure. The sampling is conducted either by an industrial hygienist or by an industrial hygiene technician under the direction of an industrial hygienist.

Monitoring data is reviewed by an industrial hygienist and compared with established safe levels (the occupational exposure limit). Engineering controls are implemented or PPE is issued if monitoring data suggests workers could be exposed at a level exceeding the occupational exposure limit. Data review and action for dermal exposure to chemical agents and exposure to physical agents in the tank farms are completed by following OSHA standards (29 CFR series) and ACGIH guidelines.

All industrial hygiene monitoring data is compiled in the Hanford industrial hygiene exposure database controlled by Fluor Daniel Hanford, Inc. The data is available to medical support organizations so that physicians can determine the hazards employees may be exposed to and the physical requirements for various jobs. Medical services for contractor employees are provided by HEHF.

8.7.3 Environmental Monitoring

The environmental monitoring plan at TWRS provides the bases and operational criteria for monitoring and sampling programs. The environmental monitoring plan also provides guidance with respect to the extent and frequency of monitoring and sampling. The equipment or systems available for monitoring activities are described in Chapter 2.0, "Facility Description." Environmental monitoring of activities near TWRS facilities is performed by the Near Facility Monitoring organization. This organization is responsible for monitoring releases to the environment, which typically involves stack monitoring of effluents expelled into the environment from a facility or known release points. The amount of effluent is controlled through compliance with the environmental air permits issued for the facility from the Washington State Departments of Health and Ecology.

Environmental monitoring of hazardous materials outside the TWRS facilities is performed by the Site Environmental Services organization. This monitoring includes sampling of air, surface water, soil, and vegetation. The data is reported in an annual environmental report. Monitoring of environmental media on and off the Hanford Site is performed to detect and quantify potential releases of hazardous materials and to assess the environmental and human health impacts of these materials. The air monitoring program is part of the preoperational and

operational activity of a large facility. The environmental monitoring programs are described in greater detail in WHC-EP-0479, *Facility Effluent Monitoring Plan for the Tank Farm Facility*.

Environmental surveillance or monitoring in support of sitewide activities is performed and documented by Pacific Northwest National Laboratory. An annual report that provides an annual summary of the total detectable nonradiological releases to the environment (e.g., airborne, soil column) is issued. In addition, the annual report provides an assessment of known plume migrations.

8.8 HAZARDOUS MATERIALS PROTECTION INSTRUMENTATION

The detectors and monitoring equipment used in the HMP Program are discussed in this section. Organizations responsible for selection, calibration, maintenance, and placement criteria are also indicated.

8.8.1 Types of Instrumentation

The HMP instrumentation comprises direct-reading instrumentation and personal monitors. Other specialized types of instrumentation are also available and include devices (e.g., sorption tubes) that colorimetrically indicate the concentration of air contaminants (for detection of contaminants such as NH_3, gross organics, HCN, acid gases, NO_2, SO_2, H_2, CH_4, and CO_2).

Direct-reading instrumentation and equipment are maintained in an onsite industrial hygiene instrument pool. The instruments in the pool are treated as a sitewide resource and are loaned to TWRS personnel on an as-needed basis. The industrial hygiene staff assist industrial hygienists and technicians with preuse and postuse calibrations. A database is used to track the status and location of industrial hygiene instruments being used, and status-indicating tags are used to control instruments requiring service and repair.

Periodic routine maintenance of the direct-reading instrumentation within the pool is the responsibility of the instrument pool organization. Calibrations are performed at an onsite laboratory or approved offsite laboratory using National Institute of Standards and Technology traceable standards. The types of standards (e.g., calibration gases, thermometers) and calibration technique, if performed onsite, meet manufacturers' specifications.

In addition to direct-reading field instruments, many types of personal monitors that require field sampling followed by laboratory analysis of samples are used. Field-sampling equipment is controlled in the same manner as the direct-reading instruments.

Typical direct-reading instruments available for workplace monitoring are listed in Table 8-4. For several of the analytes listed, various types of instruments are available for sampling and monitoring.

Industrial hygienists determine instrument use, number of instruments, and placement, drawing upon their skills and experience and using data from a qualitative hazard analysis or baseline hazard assessment. Other factors considered include type of work being performed, the contaminant to be sampled or monitored, and the regulatory requirements (PELs or TLVs) for the contaminant. Direct-reading instruments are used for personal and area monitoring while work activities are being performed. Personal breathing zones are sampled using sorbent or filter media to confirm that exposure levels are within the regulatory exposure levels.

8.8.2 Samples and Sample Analysis

Standard OSHA or NIOSH methods are used to collect samples that require laboratory analysis. Samples collected in the field are transported under chain-of-custody procedures to the analytical laboratory and analyzed by standard OSHA and NIOSH procedures. Most samples are analyzed onsite at the Waste Sampling and Characterization Facility laboratory. However, because of time and method constraints, some samples may be sent to qualified external laboratories. Only laboratories accredited by the American Industrial Hygiene Association are used for analysis. Typical laboratory instrumentation that supports the HMP sample collection and analysis activity includes atomic absorption spectrophotometers, gas chromatographs, mass spectrometers, inductively coupled plasma spectrophotometers, and high-pressure liquid chromatographs.

When a potential health hazard is identified that has no assigned PEL, a guideline on evaluation and control is developed based on the best available information, as required by DOE 5480.10.

8.9 HAZARDOUS MATERIAL PROTECTION RECORDKEEPING

Compliance of TWRS industrial hygiene HMP recordkeeping with applicable occupational safety and health standards is summarized in this section. The relationship of field monitoring data and activities and record keeping requirements is discussed.

8.9.1 Hazardous Material Protection-Related Databases

To support the HMP Program, FDH Occupational Safety and Health (OS&H) maintains a laboratory and field sample database compiled from field sampling and monitoring of TWRS personnel. FDH OS&H maintains a dedicated inventory of monitoring and sampling equipment. Industrial hygiene HMP field support personnel rely on the industrial health database as a basis for

protecting workers from exposure to industrial hazards. Other databases used by industrial hygiene field support personnel include medical information supplied by HEHF and industrial accident and illness data maintained by TWRS Safety. The relationship of industrial hygiene HMP database entry, custodian elements, and data users is depicted in Figure 8-3.

8.9.2 Records Content and Type

The contractor maintains the following records that support HMP processes:

- Health hazard assessment data
- Monitoring reports
- Drawings and facility descriptions
- Cancelled work control permits for completed activities
- Calibration reports
- Employee training reports.

8.9.3 Records Management and Retention

The contractor implements the requirements of applicable DOE orders through the records and procedures contained in WHC-CM-3-5, *Document Control and Records Management Manual*. Specific groups and locations charged with maintaining records are as follows:

- Contractor Central Document Control
- Facility industrial hygiene field and shift office(s)
- FDH Occupational Safety and Health
- Contractor central training offices
- TWRS training
- Facility records.

Essential drawings are used as reference for HMP field activity and are maintained at the field or shift office responsible for each facility. Facility-description documents also can be found at these offices, although the documents are not necessarily updated. Document Control maintains all active drawings and any engineering change notices filed against the drawings. Health hazard assessments, occupational monitoring reports, source monitoring reports, and industrial hygiene instrument calibration records are retained by the industrial hygiene programs office. Employee training reports for Hanford General Employee Training, confined space training, asbestos training, behavior-based safety training, hazard recognition training, basic and advanced respirator training, respiratory fit testing, OSHA 24- and 40-h hazardous waste operations and emergency response, and other courses covering hazardous materials are retained by training services. Facility-specific training reports, such as employee orientation training and person-in-charge training, are retained by TWRS training. Records of routine safety meetings are retained in the facilities conducting the meetings. Records of prejob safety meetings, job hazard

analyses, and work control permits are retained as integral portions of work packages and are retained as permanent facility records.

8.9.4 Record Document Processing

Data generated to provide information on worker and public HMP are reviewed for adequacy by qualified personnel, authorized for release and use by management, and distributed to personnel who require the information.

8.9.4.1 Review for Adequacy. Occupational and source monitoring data collected during tank farm operations is reviewed and interpreted by an industrial hygienist. This process is applied to all data generated in accordance with industrial hygiene work control documents (e.g., tank farms health and safety plans, work permits) during the course of confined space entries, intrusive work on waste tanks, or other work in which there is a potential for workers to be exposed above the occupational exposure limit. The reviews encompass: data validation (to ensure that appropriate monitoring methods were employed), confirmation that instruments used were within calibration specifications, and data transcription checks to ensure that the data is free of technical and clerical errors. The data is interpreted by comparing the validated monitoring data with recognized national standards to assess compliance and to determine whether engineering, administrative, or personal protective controls are needed to protect workers from assessed hazards.

Training records are reviewed by the trainer and submitted for records retention. Programs, plans, procedures, and other work control documents are reviewed by appropriate technical experts prior to release. The activity cognizant engineer is responsible for ensuring that review procedures are followed and appropriate technical review has occurred.

8.9.4.2 Authorization. Occupational monitoring data is reviewed by an industrial hygienist prior to inclusion in the Hanford industrial hygiene exposure database. The authorizing signature indicates that the data is valid and may be used as an accurate indicator of employee exposure to hazardous materials.

Before use, documents that issue work instructions—plans, procedures, work packages, and other forms of work control documentation—are authorized by the appropriate level of management. Technical experts authorize specific portions of documents (e.g., job hazard analyses and hazardous work permits) before use.

8.9.4.3 Distribution. Occupational monitoring data is reported directly from the industrial hygienist to the personnel monitored (Section 8.7.2). OSHA regulation 29 CFR 1910.20, "Access to Employee Exposure and Medical Records," requires an employer to provide an employee, or the employee's representative, access to the employee's record within 15 days of a request. Distribution of personal exposure monitoring data is governed by 29 CFR 1910 and

29 CFR 1926. Specific requirements may vary depending on the type of hazardous material involved. These requirements are stated in the industrial hygiene documents WHC-CM-1-11 and WHC-CM-4-40. Industrial hygiene data is distributed in accordance with the requirements of WHC-IP-0030, *Safety Department Administrative Manual*.

Work control documents generated from authorized data (e.g., HASP, plant operating procedures, work permits, and job hazard analyses) are distributed in conformance with the contractor document control procedures to ensure that worker access is provided and that work is conducted in a manner that prevents hazardous material injuries to workers and to the public.

8.10 HAZARD COMMUNICATION PROGRAM

The TWRS hazard communication program for obtaining MSDSs, providing employees with HMP information and training, and conveying information about routine chemical hazards and nonroutine task conditions is summarized in this section. Elements of the hazard communication program are derived from 29 CFR 1910.1200 and are incorporated into the standards of the Site manuals (WHC-CM-1-11 and WHC-CM-4-40).

The hazard communication program is maintained by the FDH OS&H office. This program outlines the general methods of HMP communication, including methods for procuring and labeling procured hazardous materials and obtaining MSDSs.

A facility-specific program that includes TWRS operations has been developed by Tank Waste Project. The hazard communication program is contained in the HNF-IP-0842, *TWRS Administration*, Volume I, Section 4.6, "Hazard Communication Program," and is available to personnel through electronic distribution. Hard copies of the document are available in the tank farm shift offices at the 200 East and 200 West Areas.

8.10.1 Hazard Evaluation

Managers of personnel who may procure potentially hazardous materials are responsible for notifying TWRS Safety so that an industrial hygienist can conduct an evaluation of the need to do a formal assessment. If a hazard assessment is needed, the industrial hygienist conducts the assessment in accordance with contractor Safety department administrative procedures. Results of the hazard assessments, including recommendations regarding appropriate chemical hazard information to be given to employees who may be exposed to the hazard, are sent to facility managers.

8.10.2 Hazardous Chemical List

The hazard communication program requires facility managers, with the support of environmental and IH personnel, to maintain current lists of procured hazardous chemicals

located in their facilities. These lists function as an index for hazardous chemicals requiring MSDSs. The line organization, with support from the environmental group, is responsible for performing physical inventories of purchased chemicals and for collecting and providing MSDS for the chemical. The industrial hygiene personnel provide consultation services, including training in developing and maintaining a database of the hazardous chemicals within their facility.

8.10.3 Hazards Warning Labeling

The hazard communication program requires that warning labels be placed on incoming chemicals by the manufacturer. When chemicals are decanted, a Hazardous Materials Identification System label is applied to the secondary container.

8.10.4 Material Safety Data Sheets

The hazard communication program requires that MSDSs be readily available to all employees. In addition to the MSDS files retained in the 200 East and 200 West Areas in buildings 272-AW, 272-WA, 242-A, 204-AR, and 209-E, a sitewide MSDS library is maintained by HEHF. The library contents are available both electronically and as hard copy to employees on the Hanford Site.

8.10.5 Information and Training

Employees receive basic worker right-to-know training during Hanford General Employee Training. This training covers such topics as the workers rights to be informed about hazardous chemicals in the workplace and how to find information regarding chemical hazards. Site-specific information and training is provided by the managers of the facility where the employee is assigned and covers two major topics: routinely encountered chemical hazards and nonroutine tasks.

8.10.5.1 Training for Routinely Encountered Chemical Hazards. New employees are trained to understand the specific hazards of chemicals that may be encountered during routine work. New employees also learn how the presence of hazards is detected and how to protect themselves from the hazards. Managers are responsible for performing this training during the facility orientation. Training includes showing the new employee the locations of common facility safety equipment, hazard communication programs, chemical inventory lists, and MSDSs. Retraining of employees occurs at regularly scheduled safety meetings.

8.10.5.2 Training for Nonroutine Tasks. Line managers are responsible for ensuring that the appropriate chemical hazard analysis has been performed before commencement of nonroutine tasks. These managers are also responsible for conducting prejob safety meetings to discuss hazards with employees who may be exposed to the hazards during the course of their work.

The training identifies steps of the planned task where hazard potential exists and identifies engineering, administrative, and personal protective control mechanisms.

8.10.6 Notification of Hazards to Subcontractors

The contractor hazard communication program requires that facility managers inform subcontractors of chemical hazards located in the facility where work will be conducted. The program also places a responsibility on the subcontractors, requiring the subcontractors to inform facility managers of any chemical hazards that subcontractors bring into the facility. The requirement is repeated in the administrative procedure. Forms to provide documentation of the process are included in the contractor procedures.

8.11 OCCUPATIONAL CHEMICAL EXPOSURES

Information about predicted and actual hazardous material exposures to workers at TWRS, for normal operations, is provided in this section. Chapter 3.0 discusses and evaluates potential exposures to workers from accident conditions. Values from reference and historic exposure data are used to predict potential exposures for planned tasks. These predicted exposures are then revised in response to current sampling data to create a more appropriate exposure control plan and to determine protective measures for current conditions. Note that while some limited trending of hazardous material exposures may be conducted using the industrial hygiene database, tracking of annual exposures (a requirement for radiological exposures) is not required for nonradiological materials and is not conducted at TWRS. There have been no lost time accidents from chemical hazardous material exposure in the last 5 yr.

Although the potential exists for TWRS employees to be exposed to the hazardous materials above the governing levels (PELs/TLVs), the HMP and industrial hygiene controls ensure that such overexposure does not occur. In addition, facility engineered and administrative controls (e.g., active ventilation, barricades, HASP) and personal sampling have been implemented to ensure that overexposure does not occur in the future.

8.11.1 Tank-Related Chemical Exposures

Varying degrees of tank vapors (varying both in species and quantity) have been shown to exist in all 177 waste tanks within the tank farms. Characterization of tank vapor headspaces has been performed and is still in progress. Analyses of vapor samples reveal that high levels of ammonia, nitrous oxide, and various organic compounds exist in the headspace of many tanks. A summary of the data for the first 43 tanks sampled is contained in WHC-SD-WM-ER-514, *Headspace Gas and Vapor Characterization Summary for the 43 Vapor Program Suspect Tanks*. Data pertaining to the selection of chemicals to be sampled and to sampling criteria is contained in WHC-SD-WM-DQO-002, *Data Quality Objective for Tank Hazardous Vapor Safety Screening*. The highest levels of vapors observed for those chemicals at significant levels (as compared with

the PELs for the chemicals) in the tanks analyzed to date are shown in Table 8-5. The NIOSH immediately dangerous-to-life-and-health levels and the lower of the OSHA PELs or ACGIH TLVs are also shown in Table 8-5.

One tank with headspace concentrations of ammonia, organic, and nitrous oxide vapors is Tank 241-C-103. The measures taken to ensure worker health and safety are contained in the HASP. To date, all personnel exposures to gases and vapors have been well within established standards.

The Worker Safety and Health subcommittee of the High-Level Waste Tank Advisory Panel reviewed the controls for Tank 241-C-103 in July 1997. The conclusion was that workers, the public, and the environment are safe using the current controls, which are administrative, not engineered. The subcommittee also concluded that the administrative controls are more cost-effective and safer than engineered controls.

Monitoring conducted at vapor release points within the tank farms indicates that vapor concentrations escaping from the tanks are similar to the concentrations observed in the headspace of the tanks. Engineered control is the first line of defense in protection of workers from potentially harmful vapors or gases. Engineered controls have been implemented when feasible, as required by OSHA. The primary engineered control is containment of the vapors inside the tanks. Care is taken to seal all extraneous gas release points. On many tanks, the active ventilation systems are effective at reducing the concentration of harmful gases in the headspace of the tanks and removing the vapors from the breathing zone of the employees, in much the same manner as a fume hood. Other temporary job-specific engineered controls, such as using plates to cover openings between entries during extended jobs, are used as the task allows. Administrative Controls have been implemented in the form of barricades around known release points. The barricades limit employee access to areas where vapor concentrations could potentially reach harmful levels. Vapor monitoring or respiratory protective equipment is required when employees enter these areas. PPE, when appropriate as indicated by monitoring, is used as the third and least desirable line of defense against exposure. Monitoring is also conducted whenever tank containment is broken, and a potential exists for exposure to hazardous constituents. The monitoring ensures that employee exposure levels are minimized. All results from personal industrial hygiene samples that have been collected within the tank farms are currently stored in the Hanford industrial hygiene exposure database. Since 1993, data pertaining to tank farm vapor samples has been entered into the Hanford industrial hygiene exposure database. To date, approximately 350 tank farm personal vapor samples have been entered and the project is ongoing.

Personal samples are more indicative of actual employee exposure than monitoring performed at tank release points. To evaluate employee exposure levels, approximately 350 personal samples were collected from employees during routine and nonroutine operations in single- and double-shell tank farms. These samples were analyzed to determine exposure levels to ammonia, nitrous oxide, and up to 30 organic compounds. All personal samples collected to date show employee exposure levels below the lower of the PELs or TLVs for all chemicals monitored, including those in Table 8-5.

Actual personnel exposures are maintained in the Hanford industrial hygiene exposure database (Section 8.7.2). Table 8-6 provides an estimate of the potential exposure received by an individual based on the results of the 350 personal samples. An estimated maximum 8-h personnel exposure level (Table 8-6) was calculated using the results, which included samples for tasks that varied in length from 20 min to over 5 h. This estimate can be compared to the ACGIH TLV. Also shown in Table 8-6 is an estimated maximum short-term exposure level (15 min), which can be compared to the OSHA short-term exposure level. The calculated 8-h and estimated 15-min maximum exposure levels are less than 10% of the TLV and less than 30% of the short-term exposure level.

8.11.2 Other Chemical Exposures

Occupational exposures to chemicals other than the tank vapors are also monitored. Small amounts of activity-specific products are used during routine maintenance activities at the tank farms. These chemical products typically include consumer-packaged products such as paints, lubricants, adhesives, and solvents. Personal monitoring is performed for individuals using these products. Chemical exposures to lead (and other metals) and asbestos are recognized and routinely monitored.

8.12 RESPONSE TO ABNORMAL EVENTS

Abnormal events may vary considerably in magnitude. Some events may be obvious while other events may be detected only by sensitive detection instruments. The response of the contractor industrial hygiene personnel to an abnormal event is dependent on the nature and extent of the event (HNF-IP-0718, *Health Physics Technical Practices and Procedures,* Part 2, Section ER-02, "General Emergency Response Guidelines and Checklists"). Industrial hygiene personnel also provide support during actual emergencies and drills.

As discussed in Chapter 15.0, "Emergency Preparedness Program," the Hanford Fire Department is the designated hazardous material incident command agency responsible for control of all hazardous materials incidents on the Hanford Site. The Hanford Fire Department is responsible for fire control, hazardous materials cleanup, and personnel rescue response activities associated with an emergency. However, during emergency response action industrial hygiene personnel are available for consultation to assess the event with respect to hazardous chemicals present and to protection of personnel.

8.12.1 Recognition of the Event

Early detection of an abnormal event may help to reduce the ultimate magnitude of the event. Early detection is made possible through the use of periodic and job-specific hazards analyses (Section 8.6.1) that allow workers to determine whether hazardous (and other) conditions are within predetermined limits and the use of routine monitoring and surveys

(Section 8.7) that are used to track the conditions in a work area. Timely detection of personnel exposures is afforded by the workplace air monitoring program (Section 8.7.2). Also, certain work areas are continuously monitored based on the potential hazard. The monitoring equipment and use of the equipment are discussed in Section 8.8.

8.12.2 Response to an Event

The general response to any abnormal event of any magnitude is a work stoppage. Any worker has the authority to stop work whenever conditions are not in control. If the loss of hazardous material control is indicated by alarms, all workers evacuate the immediate area. When possible, the hazardous material is placed in a safe configuration to prevent worsening of the situation. Notifications of the event are made to management. Finally, remediation activities are conducted.

Investigation of abnormal events follows the guidelines provided in WHC-CM-1-5, *Standard Operating Practices*, Section 6.0, "Investigation of Abnormal Events." Notifications of the appropriate management and regulatory entities are described in WHC-CM-1-5, Section 7.0, "Notifications." Investigation of events and notifications are performed primarily by line and operations management and are discussed in Chapter 15.0.

If the event results in contamination being released to the environment, then the Site Environmental Services organization, which is separate from industrial hygiene, will conduct environmental surveys (HNF-IP-0718, Part 2, Section ER-02) and offsite surveys.

If an individual has been chemically contaminated, immediate effort will be made to decontaminate the individual provided that the individual does not require immediate medical care which is always the first priority. Decontamination procedures are to be discussed in the prejob meeting or during hazard communication training. Care is always taken to minimize irritation of the skin that may result in an intake (from injection) of the material. Industrial hygiene and medical personnel will assess absorption potential and potential systemic toxicological effects to the contaminated individual.

8.13 REFERENCES

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*.

29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*.

29 CFR 1926, "Safety and Health Regulations for Construction," *Code of Federal Regulations*.

40 CFR 68, "Chemical Accident Prevention Provisions," *Code of Federal Regulations*, as amended.

40 CFR 265.56, "Emergency Procedures," *Code of Federal Regulations*.

54 FR 3904, "Voluntary Protection Program," *Federal Register*.

ACGIH, 1996, *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

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DOE 1324.5B, 1996, *Records Management Program*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE 5400.1, 1990, *General Environmental Protection Program*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE 5480.4, 1993, *Environmental Protection, Safety, and Health Protection Standards*, Change 4, U.S. Department of Energy, Washington, D.C.

DOE 5480.8A, 1992, *Contractor Occupational Medical Program*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE 5480.9A, 1994, *Construction Project Safety and Health Management*, Change 0, U.S. Department of Energy, Washington, D.C.

DOE 5480.10, 1985, *Contractor Industrial Hygiene Program*, Change 0, U.S. Department of Energy, Washington, D.C.

DOE 5480.29, 1993, *Employee Concerns Management System*, Change 0, U.S. Department of Energy, Washington, D.C.

DOE 5483.1A, 1993, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities*, Change 0, U.S. Department of Energy, Washington, D.C.

DOE 5484.1, 1990, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, Change 7, U.S. Department of Energy, Washington, D.C.

DOE 5500.3A, 1992, *Planning and Preparedness for Operational Emergencies*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE N 251.4, 1995, *Cancellation of Directives*, U.S. Department of Energy, Washington, D.C.

DOE O 231.1, 1995, *Environment, Safety, and Health Reporting*, Change 2, U.S. Department of Energy, Washington, D.C.

DOE O 440.1, 1996, *Worker Protection Management for DOE Federal and Contractor Employees*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE/RL-94-02, 1995, *Hanford Emergency Response Plan*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Hawkins, N. G., S. K. Norwood, and J. C. Rock (eds.), 1991, *A Strategy for Occupational Exposure Assessment*, American Industrial Hygiene Association, Fairfax, Virginia.

HNF-IP-0718, 1997, *Health Physics Technical Practices and Procedures*, Rev. 51, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-IP-0842, 1997, *TWRS Administration*, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-PRO-079, 1997, *Pre-Job Safety Planning*, Rev. 1, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-HSP-002, 1999, *Tank Farms Health and Safety Plan*, Rev. 3B, Lockheed Martin Hanford Corporation, Richland, Washington.

HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

NFPA 69, 1992, *Explosion Prevention Systems*, Rev. 0, National Fire Protection Association, Quincy, Massachusetts.

Public Law 101-510, 1990, Section 3137, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," *National Defense Authorization Act for Fiscal Year 1991*.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901, et seq.

WAC 173-303, 1995, "Dangerous Waste Regulations," *Washington Administrative Code*.

WAC 173-307, 1995, "Pollution Prevention Plans," *Washington Administrative Code*.

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WHC-CM-1-3, 1992, *Management Requirements and Procedures*, Rev. 168, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-5, 1996, *Standard Operating Practices*, Rev. 19, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-10, 1996, *Safety Manual*, Rev. 14, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-11, 1996, *Industrial Hygiene Manual*, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-3-5, 1996, *Document Control and Records Management Manual*, Rev. 35, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-40, 1996, *Industrial Hygiene Manual*, Rev. 12, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-41, 1996, *Fire Protection Program Manual*, Rev. 21, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-43, 1996, *Emergency Management Procedures*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-46, 1996, *Safety Analysis Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-34, 1996, *Solid Waste Disposal Operations and Administration*, Rev. 79, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-5, 1997, *Environmental Compliance*, Rev. 88, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-EP-0479, 1995, *Facility Effluent Monitoring Plan for the Tank Farm Facility*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0030, 1992, *Safety Department Administrative Manual*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0263-TF, 1994, *Tank Farms Building Emergency Plan*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-1043, 1995, *WHC Occupational ALARA Program*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DQO-002, 1995, *Data Quality Objective for Tank Hazardous Vapor Safety Screening*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-514, 1995, *Headspace Gas and Vapor Characterization Summary for the 43 Vapor Program Suspect Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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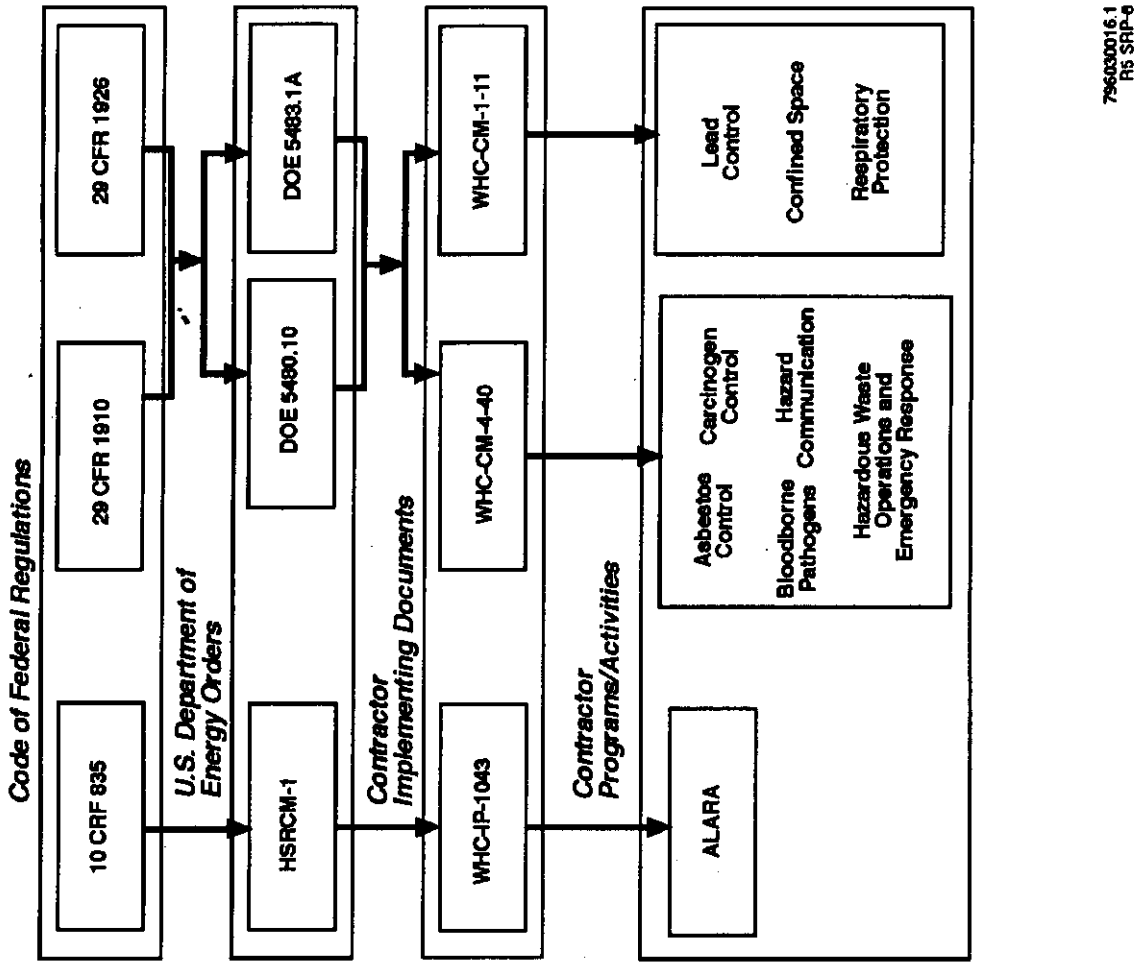
Figure 8-1. Code of Federal Regulations, U.S. Department of Energy Orders, and Contractor Industrial Hygiene Hazardous Material Protection Requirements and Implementing Documents.



10CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations.*

29 CFR 1910, "Occupational Safety and Health Standards, "*Code of Federal Regulations.*

29 CFR 1926, "Safety and Health Regulations for Construction," *Code of Federal Regulations.*

DOE 5480.10, 1985, *Contractor Industrial Hygiene Program*, Change 0, U.S. Department of Energy, Washington, D.C.

DOE 5483.1A, 1993, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities*, Change 0, U.S. Department of Energy, Washington, D.C.

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WHC-CM-4-40, 1996, *Industrial Hygiene Manual*, Rev. 12, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-1043, 1995, *WHC Occupational ALARA Program*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

ALARA = As Low As Reasonably Achievable.

Figure 8-2. Administrative Framework for Ensuring Compliance with Primary Requirements for Hazardous Material Protection.

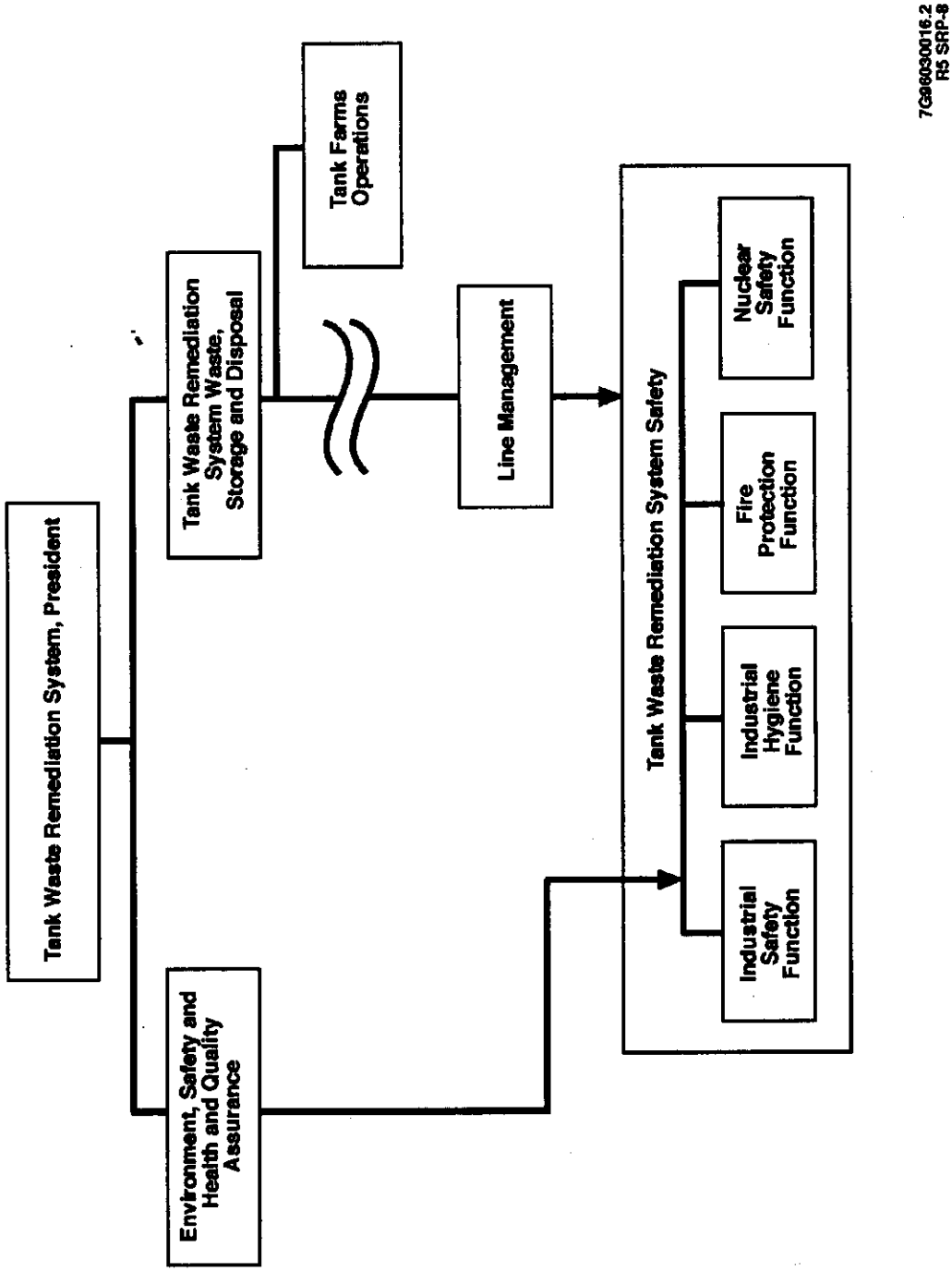

Figure 8-3. Relationship Among Industrial Hygiene Hazardous Material Protection Database Entry, Custodian Elements, and Data Users.

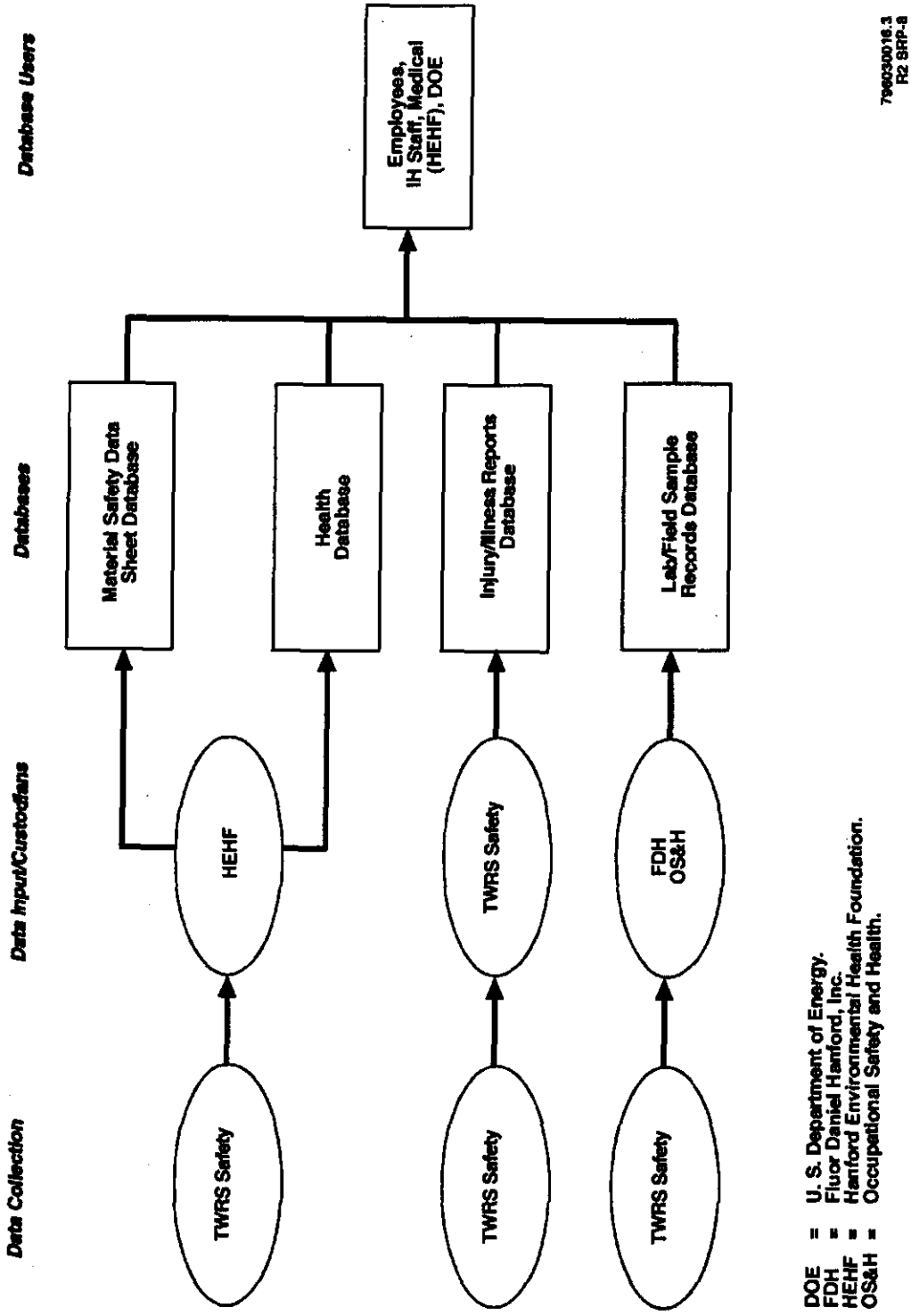

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Table 8-1. Contractor Manuals Applicable to Industrial Hygiene and Hazardous Material Protection.

Manual No.	Title/description
HNF-IP-0842	*TWRS Administration*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington, 1997
WHC-CM-1	*Company Policies and Charters*, Rev. 22, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-1-3	*Management Requirements and Procedures*, Rev. 168, Westinghouse Hanford Company, Richland, Washington, 1992
WHC-CM-1-10	*Safety Manual*, Rev. 14, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-1-11	*Industrial Hygiene Manual*, Rev. 3, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-3-5	*Document Control and Records Management Manual*, Rev. 35, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-4-40	*Industrial Hygiene Manual*, Rev. 12, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-4-41*	*Fire Protection Program Manual*, Rev. 21, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-4-43	*Emergency Management Procedures*, Rev. 2, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-4-46	*Safety Analysis Manual*, Rev. 20, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-CM-5-34	*Solid Waste Disposal Operations and Administration*, Rev. 79, Westinghouse Hanford Company, Richland, Washington, 1996
WHC-IP-0030	*Safety Department Administrative Manual*, Rev. 0, Westinghouse Hanford Company, Richland, Washington, 1992
WHC-IP-0263-TF	*Tank Farms Building Emergency Plan*, Rev. 2, Westinghouse Hanford Company, Richland, Washington, 1994
WHC-IP-1043	*WHC Occupational ALARA Program*, Rev. 0, Westinghouse Hanford Company, Richland, Washington, 1995
WHC-SD-WM-HSP-002	*Tank Farm Health and Safety Plan*, Rev. 2, Westinghouse Hanford Company, Richland, Washington, 1995

Note: Controlled Manuals refer to those created by Westinghouse Hanford Company, Richland, Washington.

*See Chapter 11.0, "Operational Safety," for a discussion of fire protection.

ALARA = As Low As Reasonably Achievable.

Table 8-2. As Low As Reasonably Achievable Implementing Practices and Job-Related Activities.

Support activity	Description/main features of activity
Prejob planning	• Job hazard analysis or JSA forms are used to identify potential hazards. • Qualitative hazard assessments are performed to follow up potential hazards.
Job monitoring	• Used when historical data is insufficient to predict exposure. • Ensures that exposures are quantified. • Ensures that job follows plans and procedures. • Ensures awareness of known or potential hazards addressed through engineered and administrative controls. • Includes recording of job events that can be used to evaluate job during the post-job review.
Postjob review	• Validates quantitative data. Provides evidence of actual exposure levels. • Identifies problems encountered during the job, including evaluation of hazardous materials controls. • Provides input to lessons learned for future jobs/tasks. • Ensures use and adequacy of PPE for planned tasks.
Lessons-learned review	• Ensures awareness and incorporation of information from previous, similar work/activities.
Project/task planning, design, and review	• Periodic review of the current procedures minimizes hazardous material exposure by using known methods for containment and controls. • The use of appropriate, experienced, and knowledgeable safety staff ensures that hazardous materials design criteria contain the ALARA concepts.
ALARA awareness and hazard communication program	• Hazard communication training reinforces ALARA concepts through communications to workers. • Uses communication tools (e.g., MSDSs, product labeling, chemical inventories, training).
ALARA, HAZWOPER, and hazard communication training	• Includes contractor training programs such as Hanford General Employee Training, new employee orientation, visitor training, facility-specific training, emergency preparedness training, hazardous materials training, and operator training.

Source: WHC-IP-1043, 1995, *WHC Occupational ALARA Program Manual*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

ALARA = As Low As Reasonably Achievable.
HAZWOPER = hazardous waste operation.
JSA = job safety analysis.
MSDS = material safety data sheet.
PPE = personal protective equipment.

Table 8-3. Major Contractor Training Requirements for Industrial Hygiene Hazardous Material Protection Work Assignments.

Hazardous material protection program element	Training driver	Contractor's source of training requirement
Respiratory protection	29 CFR 1910.134[a], "Respiratory Protection"	WHC-CM-1-11[b], WKH 15, "Respiratory Protection Program"
Confined spaces	29 CFR 1910.146[a], "Permit-required Confirmed Spaces" 29 CFR 1926.21[c], "Safety Training and Education"	WHC-CM-1-11[b], WKH 5, "Confined Space Program"
Hazard communication	29 CFR 1926.59[c], "Hazard Communication" 29 CFR 1910.1200[a], "Hazard Communication"	WHC-CM-4-40[d], Section 2.1, "Hazard Communication Program"
Hazardous waste and emergency response	29 CFR 1910.120[a], "Hazardous Waste Operations and Emergency Response"	WHC-CM-4-40[d], Section 2.19, "Health and Safety for Hazardous Waste Field Ops"
Asbestos	29 CFR 1910.1001[a], "Asbestos" 29 CFR 1926.58[c], "Asbestos"	WHC-CM-4-40[d], Section 2.3, "Asbestos Control Program"
Lead	29 CFR 1910.1025[a], "Lead" 29 CFR 1926.62[c], "Lead"	WHC-CM-1-11[b], WKH 14, "Lead Control Program"
Blood-borne pathogens	29 CFR 1910.1030[a], "Bloodborne Pathogens"	WHC-CM-4-40[d], Section 4.1, "Occupational Exposure to Blood borne Pathogens"
Carcinogens	29 CFR 1910.1000[a], "Air Contaminants"	WHC-CM-4-40[d], Section 2.2, "Carcinogen Control Program"

Sources:

[a]29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*.

[b]WHC-CM-1-11, 1996, *Industrial Hygiene Manual*, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

[c]29 CFR 1926, "Safety and Health Regulations for Construction," *Code of Federal Regulations*.

[d]WHC-CM-4-40, 1996, *Industrial Hygiene Manual*, Rev. 12, Westinghouse Hanford Company, Richland, Washington.

WKH = Westinghouse Hanford Company/ICF Kaiser Hanford Company.

Table 8-4. Hazardous Chemical Monitoring Instrumentation for Personnel Protection.

Detector type	Analyte(s)	Sensitivity/ range	Specificity
ES	NH_3	ppm	Specific
ES	LEL, O_2, toxics	%/ppm	Specific
ES	NO_2	ppm	Specific
ES	LEL,O_2	%	Specific
ES	LEL,O_2, toxics	%/ppm	Specific
ES	LEL,O_2	%	Specific
PID	Aromatic organics, halogenated organics	ppm	General
PID/FID	Organic compounds	ppm	General
FID	Organic compounds	ppm	General
IR	Organic compounds	ppm	Specific
GC*	Volatile organic compounds	ppm	Specific
FL	Mercury	ppb/ppm	Specific
GF	Mercury	ppb/ppm	Specific
CL	NO_2	ppm	Specific
Multiple	Dust, CO_2, temperature, relative humidity	Variable	Specific

*The GC instrument is portable in principle, but because of its weight, it is typically used in a laboratory setting.

CL = chemiluminescence.
ES = electrochemical sensor.
FID = flame-ionization detector.
FL = fluorescence.
GC = gas chromatograph.
GF = gold film.
IR = infrared.
LEL = lower explosive limit (e.g., for oxygen, hydrogen and methane).
PID = photo-ionization detector.
ppb = part per billion (range of 1 to 1,000 parts per billion by volume).
ppm = part per million (range of 1 to 1,000 parts per million by volume).
Toxics = CO_2, HCN, CO, NO_2, H_2S, SO_2, and NH_3.

Table 8-5. Major Tank Headspace Contaminants.

Contaminant	Maximum Concentration (ppm)	PEL/TLV (ppm)	IDLH (ppm)
Carbon dioxide	1,556	5,000	40,000
Nitrous oxide	956	50	NA
Ammonia	1,140	25	300
1-Butanol	63	50 - ceiling	1,400
2-Propanone	11	750	2,600
Carbon monoxide	17	25	1,200

Source: ACGIH, 1996, *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

IDLH = immediately dangerous to life and health.
NA = not applicable.
PEL = permissible exposure limit.
TLV = threshold limit value.
ppm = parts per million.

Table 8-6. Maximum Personal Exposure Levels Based on the Results of 350 Personal Samples.

Contaminant	Calculated 8-h exposure level (ppm)	Estimated 15-min short-term exposure level	IDLH (ppm)
Ammonia	2.6	10.3	300
Nitrous oxide	3.9	9	NA
1-Butanol	0.4	1.5	1,400

Source: ACGIH, 1996, *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

IDLH = immediately dangerous to life and health.
NA = not applicable.
ppm = parts per million.

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CHAPTER 9.0
RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

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CHAPTER 9.0
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LIST OF TERMS

ALARA	As Low As Reasonably Achievable
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
EDE	effective dose equivalent
ID	identification
LMHC	Lockheed Martin Hanford Corporation
MEI	maximally exposed individual
ND	none detected
PCB	polychlorinated biphenyl
RCRA	*Resource Conservation and Recovery Act of 1976*
TRU	transuranic
TSD	treatment, storage, and disposal
TWRS	Tank Waste Remediation System
WIPP	Waste Isolation Pilot Plant
WMH	Waste Management Federal Services of Hanford, Inc.

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9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

9.1 INTRODUCTION

The essential features of the Radioactive and Hazardous Waste Management Program that provide for safe control, collection, and handling of wastes generated during routine operations, upgrades, and clean-up activities at the Tank Waste Remediation System (TWRS) facilities are described in this chapter. The objectives, plans, procedures, and training are described. These features are relied upon as administrative barriers in the hazard analyses (Chapter 3.0, "Hazard and Accident Analyses") to ensure safe normal operations (i.e., prevent unwanted releases to the environment). Radioactive and hazardous waste streams and sources are also identified.

TWRS manages eight treatment, storage, and disposal (TSD) units that function to manage the various solid, liquid, and gaseous wastes contained in the facility. The scope of this chapter is limited to TWRS in its capacity as a generator of waste and the relationship of essential program features to facility safety.

9.2 REQUIREMENTS

TWRS controls wastes pursuant to the requirements of applicable federal and state regulations and U.S. Department of Energy (DOE) orders in a manner that protects the public and the environment. The following list provides the basis for the operational and safety procedures for TWRS:

- **Solid wastes**:

  40 CFR 260, "Hazardous Waste Management System: General"

  40 CFR 261, "Identification and Listing of Hazardous Waste"

  40 CFR 262, "Standards Applicable to Generators of Hazardous Waste"

  40 CFR 263, "Standards Applicable to Transporters of Hazardous Waste"

  40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"

  40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"

  40 CFR 266, "Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities"

40 CFR 268, "Land Disposal Restrictions"

40 CFR 279, "Standards for the Management of Used Oil"

DOE 5820.2A, *Radioactive Waste Management*, Change 0 (1988)

Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1996)

WAC 173-303, "Dangerous Waste Regulations" (1998)

- **Hazardous materials**:

40 CFR 370, "Hazardous Chemical Reporting: Community Right-To-Know"

40 CFR 372, "Toxic Chemical Release Reporting: Community Right-To-Know"

40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions"

40 CFR 763, "Asbestos"

- **Water quality**:

Consent Order DE-91NM-177 (1991) (see WHC-CM-7-5, *Environmental Compliance*, Appendix E)

DOE 5400.1, *General Environmental Protection Program*, Change 1 (1990)[1]

DOE 5400.5, *Radiation Protection of the Public and the Environment*, Change 2 (1993)

WAC 173-200, "Water Quality Standards for Ground Waters of the State of Washington" (1995)

WAC 173-216, "State Waste Discharge Permit Program" (1995)

WAC 173-218, "Underground Injection Control Program" (1995)

[1]Chapter II, Paragraphs 2b, 4b, and 4c and Chapter III, Paragraphs 2d and 3b, cancelled by DOE O 231.1, *Environment, Safety, and Health Reporting*. Compliance required until directed by Contracting Officer to terminate compliance.

- **Air quality**:

  40 CFR 60, "Protection of Environment"

  40 CFR 61, "National Emission Standards for Hazardous Air Pollutants"

  WAC 173-400, "General Regulations for Air Pollution Sources" (1995)

  WAC 173-460, "Controls for New Sources of Toxic Air Pollutants" (1995)

  WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides" (1995)

  WAC 246-247, "Radiation Protection - Air Emissions" (1995)

- **Spill reporting**:

  40 CFR 302, "Designation, Reportable Quantities, and Notification"

  WAC 173-303, "Dangerous Waste Regulations" (1995)

- **Transportation**:

  49 CFR 171, "General Information, Regulations, and Definitions"

  49 CFR 172, "Hazardous Material Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements"

  49 CFR 173, "Shippers – General Requirements for Shipments and Packagings"

  DOE 1540.2, *Hazardous Material Packaging for Transport - Administrative Procedures*, Change 1 (1988)[2]

  DOE 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*, Change 0 (1985)[3]

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[2]Cancelled by DOE O 460.1A, *Packaging and Transportation Safety*, and DOE O 460.2, *Departmental Materials Transportation and Packaging Management*. Compliance to DOE 1540.2, *Hazardous Material Packaging for Transport - Administrative Procedures*, is required until DOE O 460.1A or DOE O 460.2 is issued for compliance.

[3]Paragraph 2e cancelled by DOE O 231.1; entire order cancelled by DOE O 460.1, *Packaging and Transportation Safety*, and DOE N 251.4, *Cancellation of Directives*. Compliance required until DOE O 460.1A is issued for compliance.

9.3 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT PROGRAM AND ORGANIZATION

The organization structure and management for the TWRS Radioactive and Hazardous Waste Management Program are described in this section (Figure 9-1).

Waste sources and characteristics within TWRS vary considerably in terms of the radiological and toxicological chemical forms, characteristics, and physical properties. This variation is addressed on an operational basis by HNF-EP-0063, Revision 5, *Hanford Site Solid Waste Acceptance Criteria*. As such, this FSAR does not provide details of the varying form of the radiological and toxicological components. The details of obtaining this information are addressed in Sections 9.3.2 and 9.3.3 (and the references cited therein).

9.3.1 Objectives

The contractors' waste management program focuses on (1) protecting the workers, the public, and the environment; (2) ensuring proper management of waste from point of generation to final disposition; (3) ensuring compliance with applicable federal and state regulations; and (4) ensuring that radioactive and toxic material exposure is As Low As Reasonably Achievable (ALARA). To accomplish these objectives, the waste management program contains the following elements:

- Plans and procedures governing waste designation, segregation, packaging, monitoring, treatment, storage, transportation, disposal, recordkeeping, and reporting

- Policies and programs for employee training, audits, and inspections

- Waste minimization practices that reduce the volume of radioactive and hazardous waste and the spread of contamination.

9.3.2 Waste Management Plans

The TWRS Hazardous and Radioactive Waste Management Program is administered through program areas for solid waste. Each program area is further administered through end functions or activities as shown in Table 9-1 and described in the following sections.

9.3.2.1 Solid Waste Management Plans. TWRS generates and accumulates hazardous and radioactive solid waste at the tank farm facilities. The waste is accumulated at various locations in the tank farms. When full or no longer needed, waste packages are transported to the 209E 90-day storage pad or low level waste storage pad. While being accumulated or stored at the 90-day storage areas, the waste is managed in accordance with the requirements of the Washington State Department of Ecology Administrative Code (WAC), WAC-173-303. At the storage pads

waste is characterized, designated, and reviewed to ensure it meets the acceptance criteria of the onsite or offsite storage/disposal or treatment facilities. The waste packages are then marked, labeled, and shipped off to the appropriate facility.

Tank farm operations as a waste generator has certain responsibilities under DOE Order 5820.2A. These responsibilities are defined in HNF-EP-0063, Revision 5, which identifies the requirements that the generator must meet to ensure acceptance of the waste at the Hanford Site TSD units. TWRS is required to implement a waste certification program. This program is established and maintained by Waste Management Federal Services of Hanford (WMH) Generator Services-Operating Facilities and TWRS Environmental group.

The waste certification program is comprised of the following:

- Profile Sheets: For each waste stream, the generator must have a profile sheet. The profile sheet describes the generating process, composition of waste and container and provides physical, chemical and radiological characterization of the waste stream.

- HNF-SD-WM-PLN-119, *Tank Farms Solid Waste Characterization Guide with Sampling and Analysis Plan Attachment.* HNF-EP-0063, Revision 5, requires that the generator determine the physical and chemical characteristics of the waste with sufficient accuracy and details to properly designate waste in accordance with the unit-specific acceptance criteria and all applicable regulations. This document describes the current methods used to characterize hazardous constituents in waste generated in tank farms facilities. The emphasis of this plan is on sampling and analysis methods used to verify hazardous chemicals in the waste.

- WHC-SD-WM-PLN-115, *Waste Shipment Engineering Radionuclide Characterization Program Plan.* This document describes the overall approach to radionuclide characterization of waste streams generated in tank farms facilities. HNF-EP-0063, Revision 5, requires that the major radionuclides and associated concentrations be established with sufficient sensitivity and accuracy to properly classify and manage the waste streams in accordance with the TSD units specific radiological limits. This program plan establishes the methods used in identifying and quantifying the major radionuclides present in waste generated at the tank farms facilities. These methods also provide adequate sensitivity and accuracy to ensure that waste is correctly categorized.

- Quality Assurance Program. The overall quality assurance and quality control program for the management of the waste generated at the tank farms facilities is defined in HNF-IP-0842, Volume XI, section 1.1, *LMHC Quality Assurance Program Plan*, and HNF-SD-WM-QAPP-036, *QUALITY ASSURANCE PROGRAM PLAN for Waste Management Federal Services of Hanford, Inc.* Both program plans implement the requirements of the HNF-MP-599, *Project Hanford Quality Assurance Program Description.*

- Waste Minimization Program: WHC-DS-WM-EV-090, *Tank Waste Remediation System Minimization/Pollution Prevention Plan*, describes the overall waste control, and waste segregation. It also provides guidance and instruction on prevention and minimization of waste generating activities that could pose a hazard to human health and/or the environment.

- Waste Forecast: Tank farms provide an annual waste forecast of the waste streams that will be shipped to Hanford Site TSD.

9.3.2.2 Liquid and Gaseous Effluent Management Plans. The liquid and gaseous effluent management programs comprise the following plans:

- WHC-EP-0479, *Facility Effluent Monitoring Plan for the Tank Farm Facility*. This program facility effluent monitoring plan is used for monitoring and characterizing radioactive and nonradioactive hazardous materials discharged in the tank farm facility effluents. The plan includes requirements for gaseous and liquid effluent monitoring systems for radioactive and nonradioactive hazardous pollutants that could be discharged under routine or abnormal conditions. The airborne and liquid effluent paths and the associated sampling and monitoring systems for the tank farm facilities are described. Information is provided on the effluent characteristics and the effluent monitoring systems for use in assessing compliance with requirements. Adequate details are supplied so that radioactive and hazardous material source terms may be related to specific effluent streams. These, in turn, are related to discharge points and compared to the effluent monitoring system capability.

  WHC-EP-0479 fulfills requirements of DOE 5400.1 for a facility effluent monitoring plan on each tank farm facility containing hazardous materials that could affect employee and public safety or the environment. A facility effluent monitoring plan is required for facilities that (1) have a total projected radionuclide dose in excess of 0.1 mrem effective dose equivalent from any one discharge point, (2) if any one regulated material discharged from the facility exceeds 100% of a reportable quantity (40 CFR 302.4, "Designation of Hazardous Substances") or a permitted quantity, or (3) if a liquid effluent is regulated by the National Pollutant Discharge Elimination System and contains radionuclides that will cause any person consuming that effluent to receive an effective dose equivalent greater than 4.0 mrem/yr.

9.3.3 Waste Minimization Plan

Waste minimization is product substitution, any source reduction, or recycling activity that results in reduction of total volume of waste, as long as that reduction is consistent with the general goal of minimizing present and future threats to human health and the environment. The

hierarchy of waste management practices places highest priority on waste minimization, followed by recycling, volume reduction, then TSD.

Federal and state regulations require hazardous waste generators and TSD facilities to have a waste minimization program (the *Resource Conservation and Recovery Act of 1976* [RCRA]; 40 CFR 264; WAC 173-303; WAC 173-307, "Pollution Prevention Plans"; DOE 5400.1; DOE 5820.2A). The contractor formalized a waste minimization program by issuing "Pollution Prevention" in WHC-CM-7-5[4] and by establishing a Waste Minimization and Source Reduction organization. HNF-EP-0496, *Project Hanford Management Contract Pollution Prevention Program Implementation Plan*, specifies activities and methods that will reduce the quantity and toxicity of waste generated.

The waste minimization program targets all waste types--radioactive, hazardous, mixed, and nonregulated. The plan describes present and future activities that reduce the volume (i.e., compaction) and toxicity of wastes and applies to all facilities and groups within the 200 East and 200 West Areas directed by TWRS.

The program has been effective for minimization of nonregulated waste through recycling, reusing, and excessing of material and equipment. Minimization of regulated waste is guided by a graded approach. Where possible, noncontaminated waste is separated for disposal using approved procedures. However, when contaminated waste is produced, ALARA considerations for worker protection take precedence over strictly waste minimization considerations. For example, radioactive waste that requires shielding to reduce exposure may require more packaging material and a larger container.

9.3.4 Waste Management Procedures

Waste management procedures are developed, prepared, reviewed, approved, issued, and maintained according to HNF-IP-0842, *TWRS Administration*. TWRS and WMH procedures are in place for anticipated operations, maintenance, tests, and abnormal or emergency situations. Chapter 12.0, "Procedures and Training," contains a more complete description of the TWRS procedure program. When necessary, as discussed in Chapter 12.0, new procedures will be developed in response to the accident analysis or unplanned events.

9.3.5 Waste Management Training

WHC-CM-7-5 requires that TWRS employees who handle hazardous, radioactive, or mixed waste receive annual training in accordance with a RCRA training program. The training

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[4]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table, for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc. (FDH), procedures (e.g., HNF-PRO-XXX).

program is designed to provide training to TWRS personnel in compliance with WAC 173-303 and is described in detail in HNF-SD-WM-TR-026, *Tank Farm Transition Projects Dangerous Waste Training Plan*.

Training requirements are specified by the employee's specific job duties as determined by a management assessment or job analysis. The identified training requirements are based on worker categories and job titles as described in Sections 4.0 and 5.0 of HNF-SD-WM-TR-026. All new employees will receive this training within 6 mo of employment and will be supervised until completion of the training. Employees specifically responsible for hazardous and radioactive waste handling activities receive additional training. This training includes 40-h hazardous worker (Occupational Safety and Health Administration compliant) and radiation worker (HSRCM-1, *Hanford Site Radiological Control Manual*, and 10 CFR 835, "Occupational Radiation Protection" compliant) training. Emergency response training is consistent with emergency responses outlined in HNF-IP-0263-TF, *Tank Farms Building Emergency Plan*. See Chapter 12.0 for more training information.

9.3.6 Organizational Structure

The organizational structure as outlined in Figure 9-1 administers the Radioactive and Hazardous Waste Management Program within TWRS. TWRS facility personnel, as waste generators, have the responsibility to ensure that all newly generated wastes are handled, stored, and packaged in accordance with DOE orders; Washington Administrative Codes; HNF-EP-0063, Revision 5; and HNF-PRO-455, *Solid Waste Management*.

9.3.6.1 Facility Managers. Facility managers are responsible for daily functional activities and regulatory compliance associated with those activities for TSD facilities (i.e., inspecting, sampling, analyzing, handling, packaging, storing, shipping, and disposing of wastes); ensuring compliance to employee training programs and approved procedures; ensuring adherence to approved plans, recordkeeping, reporting, and groundwater monitoring activities; supporting inspections by regulatory agencies; responding to regulatory findings; and ensuring permitted activities are performed. To assist the facility manager on waste management issues, an Environmental Compliance Officer is permanently assigned to each facility manager.

9.3.6.2 Environmental Compliance Officers. The TWRS Environmental Compliance Officer is responsible on behalf of the facility manager for regulatory compliance within TWRS.

9.3.6.3 Hazardous Materials Specialist. The Hazardous Materials Specialist approves all requests for chemical products to ensure the least hazardous materials are used and administers the Chemical Management System for TWRS.

9.3.6.4 WMH Generator Services-Operating Facilities. The group ensures that tank farm waste is generated and managed in a safe and efficient manner and in compliance with the applicable DOE-RL, state, and federal requirements. Personnel provide guidance and technical support to tank farm field operation for the disposal of waste generated at the tank farm facilities,

procure containers, and ensure that waste packages meet the acceptance criteria of the TSD. The group also establishes and maintains a waste certification program to fulfill requirements of the acceptance criteria. The group issues waste shipment documentation; prepares waste designations and radiological characterization; supports preparation of operating procedures; provides waste status reports; performs waste forecasting; and maintains records.

WMH Solid Waste Project Operation (SWPO) supports Generator Services-Operating Facilities by providing services related to container issuance, delivery, and pickup, container weekly inspections, waste sampling and repackaging, waste pad operations, and waste container shipments.

9.3.6.5 Pollution Prevention. The pollution prevention group develops, coordinates, and implements a program to minimize the generation of wastes to the extent economically practical and in compliance with WHC-CM-7-5.

9.3.6.6 TWRS Environmental. TWRS Environmental provides guidance on waste designation issues, as requested, and conducts assessments to ensure compliance with environmental control requirements.

9.3.6.7 Hanford Analytical Services Management and Mobile Sampling. Hanford Analytical Services management and Mobile Sampling provides guidance regarding the number of samples, sample type, sample quantity, and types of analyses required; reviews sample and analysis plans received from the waste owners for consistency with requests for laboratory services and capabilities; and provides data validation and verification and coordination of laboratory support.

9.3.6.8 Tank Waste Remediation System Facility Personnel. Each employee is responsible for promptly notifying management of events and conditions that could have adverse safety significance or environmental implications, including releases to the environs. Personnel trained in facility operations or processes have the authority to stop work if an unsafe condition or a potential for adverse impact to the environment exists.

9.4 RADIOACTIVE AND HAZARDOUS WASTE STREAMS AND SOURCES

Solid, liquid, and gaseous waste streams and sources, including estimated inventories, are summarized in this section. The waste management and waste handling process or treatment system for each of the following waste types, with the exception of "nonregulated waste," is identified (nonregulated waste is solid, liquid, or gaseous material that is not useable or regulated under RCRA, WAC 173-303, or *Atomic Energy Act of 1954*). This includes radioactive,

hazardous, or mixed waste and any item that is no longer useable that has come in contact with any of these waste types:

- **Radioactive Waste**—Radioactive waste is solid, liquid, or gaseous material that contains radionuclides regulated under the *Atomic Energy Act of 1954*, as amended. Radioactive waste is subdivided into three categories.

  - **High-Level Waste**—High-level waste is the highly radioactive waste material that results from the reprocessing of spent nuclear fuel (including liquid waste produced directly in reprocessing and any solid waste derived from the liquid) and contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

  - **Low-Level Waste**—Low-level waste is waste that contains radioactivity and is not classified as high-level waste, transuranic waste, spent nuclear fuel, or 11e(2) byproduct material as defined by DOE 5820.2A. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste provided the concentration of transuranics is less than 100 nCi/g.

  - **Transuranic Waste**—Transuranic waste is waste, without regard to source or form, that is contaminated with alpha-emitting transuranic radionuclides with half-lives greater than 20 yr and concentrations greater than 100 nCi/g at the time of assay. DOE can determine that other alpha-contaminated wastes, peculiar to a specific site, must be managed as transuranic waste.

  TWRS operations are not expected to generate any high-level waste or large volumes of transuranic waste.

- **Hazardous Waste**—Hazardous waste is solid, liquid, or gaseous material that is regulated under the RCRA, as amended. A waste is hazardous waste if it (1) is specifically listed in RCRA (called a "listed waste"), (2) exhibits hazardous characteristics (i.e., ignitability, corrosivity, reactivity, or toxicity), or (3) meets the dangerous waste criteria established by the state of Washington in WAC 173-303.

- **Mixed Waste**—Mixed waste is solid, liquid, or gaseous material that contains both radioactive and hazardous constituents as defined in *Atomic Energy Act of 1954*, RCRA, or WAC 173-303.

9.4.1 Waste Management Process

The TWRS Hazardous and Radiological Waste Management Process is described in the following sections.

9.4.1.1 Solid Waste Management Process. Solid waste generally comprises waste created during routine maintenance, cleanup, or upgrades of equipment or facilities. The TWRS solid waste management process is provided in HNF-IP-0842, Volume VI, Section 4.1, "Waste Generating Plan." The waste is handled, segregated, and packaged in accordance with TO-100-052, *Perform Waste Generation, Segregation, and Accumulation*. WMH picks up the waste packages and transfers the packages to the 90-day storage area. The packages are characterized, designated, and shipped within 90 days. Regulated wastes, as determined by Solid Waste Acceptance Services, will be shipped to the appropriate storage facility within 90 days of accumulation.

The solid waste management process is based on the following elements:

- Control solid waste to the applicable regulations and permits (Section 9.2)
- Collect, treat, store, and dispose of all radioactive, hazardous, and mixed waste in a safe, economical, and environmentally acceptable manner
- Manage all radioactive waste management operations consistent with the policies established in DOE 5820.2A
- Package hazardous solid waste for disposal at approved hazardous waste sites, as applicable
- Package transuranic waste for disposal at approved offsite disposal areas and package low-level waste for disposal at existing approved onsite burial areas
- Minimize radioactive waste as required by DOE 5820.2A, and mixed waste as required by RCRA
- Segregate radioactive, hazardous, and mixed waste as required by DOE 5820.2A and as described by contractor procedures.

HNF-EP-0063, Revision 5, requires that the generator segregate waste to prevent cross-contamination of radionuclides or hazardous constituents.

HNF-IP-0842, Volume VI, Section 4.1, provides guidance to ensure the identified elements are met. This document meets the requirements specified in the appropriate DOE orders, Hanford Site requirements, federal and state regulations, and industry standards. Requirements for contact-handled solid wastes including transuranic, low-level, and radioactive-mixed waste comply with the requirements of DOE 5820.2A and the appropriate

DOE 5400 series orders. HNF-EP-0063, Revision 5, also identifies requirements for radioactive wastes and dangerous wastes as defined in WAC 173-303.

9.4.1.2 Air Quality Waste Management Process. The TWRS airborne effluent program is discussed in WHC-EP-0479. The overall program for effluent monitoring is described in WHC-CM-7-5. This manual interprets a requirement in 40 CFR 61.92, "Standards," that emissions to the air from all emission sources at the Hanford Site shall be low enough that no member of the general public will receive an effective dose equivalent greater than 10 mrem/yr. Each facility is required to determine whether or not potential releases are high enough to warrant continuous monitoring; if releases are potentially significant, a facility effluent monitoring plan must be filed. This plan documents the required monitoring and alarm capabilities. The plan addresses operation and maintenance of monitoring equipment, handling of measurement records, and plans for responding to action levels that may be triggered by the alarm or monitoring results. The program for monitoring gaseous effluents from TWRS facilities is further described in WHC-EP-0479.

The air quality management process is based on the following elements (taken from WAC 173-400-030 and WAC 173-400-040):

- Control airborne emissions to the environment to ALARA and the applicable regulations and permits (Section 9.2)
- Use reasonably available control technology for all sources
- Limit releases to contaminants with no more than 20% opacity from any source for more than 3 min/h
- Limit particulate matter emissions in a manner that does not allow the particulate matter to be deposited beyond the Hanford Site boundary in sufficient quantity to interfere unreasonably with the use and enjoyment of the offsite property
- Use reasonable precautions to prevent the emission of air pollutants from fugitive emissions
- Reduce odors that unreasonably interfere with offsite property use or enjoyment to a reasonable minimum by using recognized good practices and procedures
- Prohibit and eliminate any air pollutant emission that causes detriment to the health, safety, or welfare of any offsite person or causes damage to offsite property or businesses
- Allow no source to emit a gas containing sulfur dioxide from any emission unit in excess of 1,000 parts per million of sulfur dioxide on a dry basis, corrected to 7% oxygen for combustion sources, based on the average of 60 consecutive minutes

- Use no means that conceals any action taken to reduce the observed or measured concentrations of a pollutant in a gaseous effluent while, in fact, not reducing the total amount of pollutant discharged or masks an emission of an air contaminant that would violate any federal, state, or local regulation or standard

- Minimize fugitive dust generation caused by construction or related activities or by operation activities, using every reasonable precaution to prevent fugitive dust from becoming airborne

- Ensure monitoring equipment is designed, maintained, and operated according to WHC-CM-7-5, Section 2.0 (Chapter 2.0 contains descriptions of monitoring equipment)

- Ensure that a facility effluent monitoring plan is issued and that annual reviews are provided according to WHC-EP-0438, *A Guide For Preparing Hanford Facility Effluent Monitoring Plans*, and effluent monitoring.

Criteria provided in WHC-CM-7-5 identifies the requirements of the DOE 5400 series orders with emphasis on DOE 5400.5.

9.4.1.3 Water Quality Waste Management Process. The Hanford Site tank farms have many outdoor radiological areas, and there is a potential for material leaking out of tanks into the ground below. Thus, there is a particular concern to have an adequate program for monitoring the release of radioactive material to the environment. The requirements for monitoring these releases are in DOE 5400.5 and DOE 5400.1. Part of the program for monitoring material released to the environment is intended for emergency applications, as described in "Offsite Radiological Surveys," Section ER-01 of HNF-IP-0718, *Health Physics Technical Practices and Procedures*. TWRS facilities also operate a substantial program of routine monitoring of releases to the environment (WHC-EP-0479).

The elements of the water quality waste management program are as follows:

- Ensure compliance with requirements of regulatory codes and applicable permits (Section 9.2)

- In accordance with WHC-CM-7-5, notify the Waste Information Database System custodian of the following:

  - Existence of nonradioactive liquid effluent disposal facilities (e.g., location, construction)

  - Operational status of disposal facility or change in status

  - Method of deactivation for out of service facilities.

- Ensure that training is provided for personnel who collect samples; verify and maintain personnel qualification records

- Ensure proper use of sewage systems through strict adherence to operating procedures, conspicuous labeling of sinks and sewer lines, and frequent inspection of those operations with a potential to misuse the sewers

- Control the acquisition, storage, use, and disposal of chemicals to ensure compliance with the provisions of WHC-CM-7-5, Section 8.0, "Water Quality"

- Provide prompt notifications in accordance with WHC-CM-7-5 of any releases that exceed the requirements defined in WHC-CM-7-5, Section 5.3, "Spills and Release Reporting"

- Provide prompt notifications in accordance with WHC-CM-7-5 of the following:

  - Failure to obtain necessary samples
  - Failure of sampling or monitoring equipment.

- Ensure that new equipment and facilities or modifications to existing equipment and facilities (1) are designed and constructed using the best available technology or all known available and reasonable technology, (2) are economically achievable, and (3) comply with the requirements of WHC-CM-7-5, Section 8.0

- Ensure that a chain of custody is established and maintained for recording liquid effluent monitoring samples

- Ensure that required effluent samples are collected and promptly delivered for analysis

- Ensure that adequate records document that requirements for monitoring, sampling, and procedural compliance activities are met

- Ensure that all waste water sent to a common collection system is disposed of according to acceptance criteria established by the receiving facility and agreed to by the generating facility

- Initiate issuance of permits and permit modifications for the TWRS facility from the Washington State Department of Ecology

- Ensure that monitoring equipment is designed, maintained, and operated according to WHC-CM-7-5, Section 8.0 (see Chapter 2.0 for descriptions of monitoring equipment)

- Ensure (where required for liquid discharges) that a facility effluent monitoring plan is issued and that annual reviews are provided according to WHC-EP-0438 and effluent monitoring

- Ensure that septic systems are located, designed, installed, operated, maintained, and permitted according to WAC 246-272.9.4.1, "Waste Management Process."

9.4.2 Waste Streams Description

At TWRS, waste is generated by the ventilation systems used to exhaust the headspace of the waste storage tanks, by tank waste transfer and other operating processes, and by decontamination and maintenance activities. Solid wastes may be solid, liquid, or gaseous and may be hazardous, radioactive, mixed, or nonregulated. As defined in HNF-EP-0063, Revision 5, a solid or solid waste is a material that has a vertical flow of 50 mm (2 in.) or less within 3 min or separation of 1 g or less of liquid when determined in accordance with ASTM-D 4359-84, "Standard Test Method for Determining Whether a Material is a Liquid or Solid."

9.4.2.1 Solid Waste Streams and Sources. A waste stream is identified and classified based on type (e.g., radioactive, nonradioactive, hazardous), form (e.g., solid, liquid, gas), and generating facility. That is, Facility A may consistently generate radioactive solid wastes; therefore, Facility A would be recognized as generating a solid radioactive waste stream (called Facility A Solid Radioactive Waste). This same approach would be used for a complex of facilities (e.g., Complex B), that is, the complex would be recognized as generating a solid radioactive waste stream (called Complex B Solid Radioactive Waste). Significant changes in the facility process or radioactive material inventory are evaluated to determine if the waste stream identification (e.g., Facility A Solid Radioactive Waste) remains appropriate.

The solid waste types and quantities expected to be generated by TWRS operations are reported annually. Table 9-2 provides a summary of the solid waste shipped for disposal in fiscal year 1996 by receiving facility, waste type container, and volume. As shown in Table 9-2, the total volume of solid waste shipped in fiscal year 1996 was greater than the expected minimum and best estimate volumes but less than the estimated maximum. The following sections describe these wastes by source and discuss the approved disposal options for waste management. The waste streams identified in the subsections are examples of the main waste streams under the identified waste type but they are not the only waste streams. Small volume (less than 55-gal drum), unique waste streams (e.g., lab packs, lead, mercury) are generated and managed on an as-generated basis according to the requirements established by the waste management program. It is the responsibility of the generator to ensure proper handling and disposal of non-leaking polychlorinated biphenyl (PCB) light ballasts. Site utilities responds to spills of PCBs.

9.4.2.1.1 Low-Level Waste. Radioactive wastes produced by TWRS operations primarily comprise contaminated equipment, construction waste, compactable and

noncompactable containerized waste from radiological control areas,[5] decontamination waste, miscellaneous waste (i.e., generated by off-normal events such as spills or equipment failures, wastes generated during surveillance and monitoring operations, and drainage from receiver tanks, pumps, and other equipment), and used containers. These radioactive wastes may be designated as either low-level waste or mixed waste. TWRS low-level waste is evaluated for suitability for compaction. Low-density, high-volume wastes are sent to an offsite contractor for supercompaction.

The low-level waste stream comprises debris from tank farms and related facilities that is radiologically contaminated but has not come into contact directly or indirectly with tank waste. Low-level waste is radioactive waste that is not classified as high-level waste, TRU waste, or spent nuclear fuel or byproduct waste as defined by DOE 5820.2A. Waste may be classified as low-level waste provided the concentration of transuranic is less than 100 nCi/g (DOE 5820.2A). Low-level waste can be packaged intact, or compacted, or in the case of large items, can be dismantled and packaged into smaller intact or compacted packages. Low-level radioactive waste is shipped to the low-level waste burial ground for disposal. Low-level waste equipment that has been unconditionally released may be used as radioactive scrap. In accordance with DOE 5400.5, equipment that is not contaminated, does not have a potential to be contaminated, or has residual radioactive material that does not exceed the authorized limits or approved supplemental limits, may be transferred for use by an offsite user, or decontaminated. The activities that produce low-level waste include the following:

- **Routine Surveillance and Maintenance Activities**—Tools, protective clothing and equipment used during routine tank surveillance and maintenance may create a waste stream.

- **Construction, Demolition, and Facility Upgrades**—Maintenance and removal of facility components and equipment that have not come into direct contact with tank waste generate a variety of low-level waste debris, including tools, wood, concrete, asphalt, decontamination materials, and containment materials (e.g., tents and glovebags).

- **Disposal of Contaminated Equipment**—Equipment that has not come into contact with tank waste (not considered low-level waste) and is no longer usable is packaged for disposal. Most waste from this source will not be compacted, but where possible the equipment will be dismantled using mechanical (hand tools) or thermal (plasma torch) methods.

  - **Disposal of Contaminated Vegetation**—In addition to low-level waste generated during operations activities, onsite vegetation may become radiologically contaminated. Vegetation collected outside of radiologically

[5]Nonregulated waste that can be unconditionally released is accumulated in containers designated for nonregulated waste generated outside the tank farms. Nonregulated waste that cannot be unconditionally released must be handled as radioactive waste.

controlled areas is surveyed and disposed of based on the results of the survey, as non-radiological waste (i.e., survey results are less than the radiological limits specified in DOE 5400.5) or as low-level waste (i.e., survey results are greater than the radiological limits specified in DOE 5400.5). Vegetation collected within tank farms and other contaminated areas generally cannot be surveyed adequately to meet release criteria. All potentially contaminated vegetation is collected, packaged, and disposed of at the low-level waste burial grounds.

9.4.2.1.2 Mixed Solid Wastes. Mixed waste is defined in DOE 5820.2A as that containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act. Mixed solid wastes produced by TWRS operations primarily comprise contaminated equipment, containerized waste, decontamination waste, maintenance waste, miscellaneous waste (generated by off-normal events such as spills or equipment failures, generated during surveillance and monitoring operations, and generated by drainage from receiver tanks, pumps, and other equipment), used containers, and chemical waste.

Mixed waste contaminated equipment is managed in compliance with the generator requirements of WAC 173-303 to the maximum extent possible. Certain items present unusual management problems, particularly because of size and high radiation exposure, which prevent compliance with some of the generator requirements. Management of noncompliant equipment will be negotiated with the Washington State Department of Ecology on a case-by-case basis. Mixed solid wastes are transferred to Solid Waste Disposal for treatment or permitted for disposal at the Central Waste Complex.

Tank-Contacted Debris (F-Listed)[6]. Tank-contacted debris is any debris that has come into direct contact with tank waste, condensate, or rinsate. Tank-contacted debris is generated by a variety of activities, including the following:

- **Sampling**—Tank sampling (auger sampling, core sampling, or bottle and string sampling) produces debris such as drill strings, sludge weights, sample containers, and decontamination and containment materials.

- **Tank and Facility Maintenance and Upgrades**—Maintenance and removal of tank components and equipment that have come into direct contact with tank waste generate tank-contacted debris waste, including tools, tank monitoring equipment, decontamination materials, and containment materials (e.g., tents and glovebags). Oily debris can be generated during equipment cleaning or degreasing or during maintenance activities (e.g., changing oil in compressor systems and other permanently installed equipment) and could become F-Listed by contact with tank waste.

[6]F-Listed. Tank waste has been assigned nonspecific source codes beginning with the letter F.

- **High-Efficiency Particulate Air Filter Replacement**—Changeout of high-efficiency particulate air filters on passive and active tank ventilation systems produces waste high-efficiency particulate air filters and related debris. High-efficiency particulate air filters are managed as mixed waste if they are contaminated to levels where sampling is not feasible (ALARA) or sample results dictate a hazardous designation.

- **Disposal of Contaminated Equipment**—Equipment that is contaminated with tank waste and is no longer usable is packaged for disposal. Examples include used jumpers, pumps, and piping.

Contaminated Soil (F-Listed)[5]. F-listed soil is generated by the following three activities conducted within tank farms and related tank farm facilities.

- **Soils from Contamination Control**—Regularly scheduled radiological surveys are conducted to limit worker exposure and control the spread of radiological contamination. When surface soils exceed acceptable contamination levels, contaminated soils are shoveled into plastic bags and placed in drums for disposal.

- **Soils from Excavation**—Maintenance, modification, and construction of waste tank systems sometimes require excavation to access subsurface equipment (e.g., transfer lines). When radiological surveys indicate that these soils contain excessive radiological contamination, the soils are placed into drums for disposal rather than being returned to the excavation.

- **Tank Waste and Oil and Fuel Spills**—Spills of tank waste, condensate, or rinsate to the soil occur infrequently. In addition, spills of fuels, oils, and other products into soil occur occasionally. These soils are cleaned up to prevent further contamination to the environment by hazardous materials.

Used Respirator Mask Filter Cartridges. Respirator masks are worn by workers as protection from ammonia vapors in certain areas. The respirator masks use double mask filters. The filter is approximately 3 in. in diameter and 2 in. thick. One section of the filter is a paper high-efficiency particulate air filter, and the other section contains activated carbon impregnated with sulfuric acid. Ammonia vapors contact the saturated activated carbon and produce ammonium sulfate as a neutralization product. The filter cartridges are removed and packaged as mixed waste after a single use and transferred to the Solid Waste Disposal facility.

9.4.2.1.3 Transuranic Solid Wastes. Transuranic (TRU) wastes produced by TWRS operations primarily are similar to the low-level solid wastes generated by TWRS. Transuranic wastes are defined as waste contaminated with alpha-emitting TRU radionuclides (i.e., atomic number greater than 92) with half lives greater than 20 yr and in concentrations greater than 100 nCi/g (HNF-EP-0063, Revision 5). This concentration limit applies to a single waste package. That is, the concentration cannot be reduced by grouting the waste package.

Transuranic wastes are packaged in accordance with the Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria (WIPP-DOE-069, *TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant*: DOE 5820.2A). The packaged TRU waste is stored on an interim basis at the Central Waste Complex and will be sent to WIPP when WIPP becomes operational.

9.4.2.1.4 Nonradioactive Dangerous Wastes. Dangerous wastes produced by TWRS operations primarily are maintenance waste, miscellaneous waste (generated by off-normal events such as spills or equipment failures, wastes generated during surveillance and monitoring operations, and drainage from receiver tanks, pumps and other equipment), and chemical waste. Wastes are designated by WAC-173-303 as solid waste in accordance with 40 CFR 261 and regulated as dangerous waste by the EPA.

Dangerous solid wastes are segregated, packaged, and containerized by the generator. The onsite waste management contractor collects and manages the waste at the 209-E Facility before shipping the waste to a contracted offsite TSD facility. An example of dangerous waste is oily solid waste, which is described below.

Oily Solid Waste. Oily debris is generated by maintenance and cleanup activities. This debris has been designated as dangerous waste because of the chemical constituents identified on the material safety datasheet or from analytical analysis. Any of the following activities can generate this waste.

- **Routine Operational Activities**—Cleaning and degreasing of equipment systems produce oily and greasy rags and absorbents.

- **Routine Operational Activities**—Changing oil in compressor systems, crane hydraulics, generators, and other permanently installed equipment creates a waste stream of hydraulic and engine oils and other lubricating fluids on systems outside of a radiologically controlled area and are not radiologically contaminated. These oils are absorbed in organic sorbent.

- **Off-Normal Occurrence Activities**—Spills occurring outside a tank farm facility in a non-radiologically controlled area, depending on the material spilled, may result in dangerous waste designation. Debris from cleanup of oil and diesel spills may include absorbent sheets, rags, small amounts of cat litter-type absorbent, and personal protective equipment.

9.4.2.1.5 Non-Regulated Waste. The non-regulated waste produced by TWRS operations includes non-regulated rags, non-regulated paint-related waste, empty paint containers (non-aerosol), and fluorescent tubes (crushed). Non-regulated waste is managed in accordance with HNF-PRO-455. Non-regulated waste that is not recycled is shipped to Waste Management of Kennewick.

9.4.2.1.6 Recyclable Material . The recyclable waste produced by TWRS operations includes partially full and empty aerosol cans, lubricating oils, paper, paper products, building

insulation, fluorescent light bulbs, non-PCB light ballasts, non-leaking PCB light ballasts, batteries (alkaline, lead acid, gel cell), precious metals (gold, silver, platinum, palladium, iridium, osmium, rhodium, ruthenium). Recyclable material is managed in accordance with HNF-PRO-455 and is collected at different points at the tank farms facilities and then shipped to the Consolidation/Recycling Center.

9.4.2.2 Liquid Effluents and Sources. Depending on where a liquid effluent is discharged, different regulations apply. These regulations are implemented through the issuance of permits by federal, state, or local agencies. The Washington State Department of Ecology controls discharges to ground and surface water under WAC 173-216 and issues permits for discharges. The permitting program discussed in WAC 173-216 is designed to prevent the disposal of wastes that present a risk to human health including the potential, chronic effects of lifetime exposure to waste materials. In addition, DOE policy requires facility operators to limit liquid effluent discharge to ensure private or public drinking water systems downstream do not exceed the 40 CFR 141, "National Primary Drinking Water Regulations," drinking water radiological limits (i.e., 4 mrem/yr).

Each type of discharge permit identified typically will contain discharge limitations and monitoring requirements. Before applying for any permit, the applicant must know the source and the destination of waste water discharges. Liquid effluent streams identified in DOE/RL-93-61, *State Waste Discharge Permit Application for Industrial Discharges to Land, 200 East Area W-252 Streams,* and generated from TWRS routine operations are listed below. Table 9-3 provides calendar year 1995 liquid effluent discharges. In future years, the liquid effluent streams identified below will be transferred to the Treated Effluent Disposal Facility for disposal.

- **Cooling Water from 244-AR Vault to 216-B-3 Expansion Lobes**—The source of this stream is the cooling water or steam condensate from process and vessel ventilation systems and other miscellaneous sources.

- **Surface Condenser Cooling Water from 241-A Tank Farm to 216-B-3 Expansion Lobes**—Cooling water from the surface condensers for the 241-AY/AZ Tank Farms ventilation system is collected in this waste stream.

- **Miscellaneous Streams**—Several miscellaneous nonradioactive, nonhazardous streams discharge small amounts of water (less than 3.8 L/min [1 gal/min]). These discharges are primarily from steam trap, air condenser, and storm water drains. In addition, water from hydrostatic testing, construction, and maintenance is discharged occasionally.

9.4.2.3 Gaseous Effluents and Sources. In the 200 Areas, both radioactive and nonradioactive airborne effluents are discharged to the atmosphere. Nonradioactive airborne effluent releases are monitored if there is a potential for an airborne release from a point source in excess of the reportable quantities contained in 40 CFR 302. There are no airborne effluent streams identified in the facility effluent monitoring plan with potential to exceed the 40 CFR 302 reportable

quantities. Thus there is no nonradioactive airborne effluent monitoring. However, for all accidents except the postulated caustic spray leak detailed in Section 3.3.2.4.9, the release of toxicological material occurs in conjunction with a release of radiological waste material. The waste material composites developed for use in TWRS safety analyses, along with unit liter doses, are listed in Table 3.4.1-9. For the postulated caustic spray leak, the facility worker is protected by Administrative Controls 5.14, "Emergency Preparedness," and 5.23, "Caustic Transfer Controls" (HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*), and standard industrial hygiene practices.

Radioactive airborne effluents are regulated in accordance with 40 CFR 61, Subpart H, "National Emission Standards for Hazardous Air Pollutants," and WAC 173-401, "Operating Permit Regulation." DOE/RL-95-07, *Hanford Site Air Operating Permit Application,* meets the WAC 173-401 requirement and includes tank farm emission points and pollutant emissions. A brief, comprehensive description of the major radiological emission points (potentially causing an offsite public dose exposure of 0.1 mrem/yr or greater) is provided in WHC-EP-0479.

In 40 CFR 61, Subpart H, the radionuclide emission limit is set for the entire Hanford Site to a limiting offsite public dose exposure of 10 mrem/yr. The regulation also contains the requirement that if any one emission point could potentially cause any member of the public to be exposed to greater than 0.1 mrem/yr, then that emission point must be measured continuously in accordance with those methods and standards specified in the regulation. If the emission point is shown to potentially result in less than 0.1 mrem/yr, then only periodic confirmatory measurements are required. WHC-EP-0479 provides more detail on the major emission points of concern (i.e., emission points that are determined to have the potential for radionuclide emissions that could cause an offsite public dose exposure of 0.1 mrem/yr or greater). WHC-SD-WM-EMP-031, *Tank Farm Stack NESHAP Designation Determinations,* documents these determinations.

Descriptive information for all the existing TWRS emission points and estimated emission quantities for all known emission points are summarized in DOE/RL-95-07. Passively ventilated, actively ventilated, and fugitive-type emissions are addressed. Tables 9-4 and 9-5 provide a summary of airborne radioactive emissions from point sources (i.e., active ventilation system exhaust stacks) determined to have the potential for radionuclide emissions that could cause an offsite public dose exposure of 0.1 mrem/yr or greater for calendar year 1995.

Annual doses are calculated for actively ventilated single-shell tanks, double-shell tanks, double-contained receiver tanks, and catch tanks with exhausters and exhaust monitoring systems. The methodology used to calculate annual doses is provided in WHC-SD-WM-EMP-031. Figure 9-2 provides calculated annual doses to offsite individuals from routine or normal operations.

9.4.3 Waste Handling or Treatment Systems

Currently, no newly generated waste is treated by TWRS operations. The waste is collected, characterized, placed in the appropriate waste container, and transferred to Solid Waste Disposal for treatment, packaging, and disposal offsite or at the appropriate onsite facility. Regulated wastes will be shipped to the appropriate storage or disposal facility within 90 days of accumulation. Nonregulated wastes will be shipped for disposal if no recycling or reuse opportunities are available.

9.5 REFERENCES

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations.*

40 CFR 60, "Protection of Environment," *Code of Federal Regulations.*

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations.*

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations.*

40 CFR 260, "Hazardous Waste Management System: General," *Code of Federal Regulations.*

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations.*

40 CFR 262, "Standards Applicable to Generators of Hazardous Waste," *Code of Federal Regulations.*

40 CFR 263, "Standards Applicable to Transporters of Hazardous Waste," *Code of Federal Regulations.*

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations.*

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations.*

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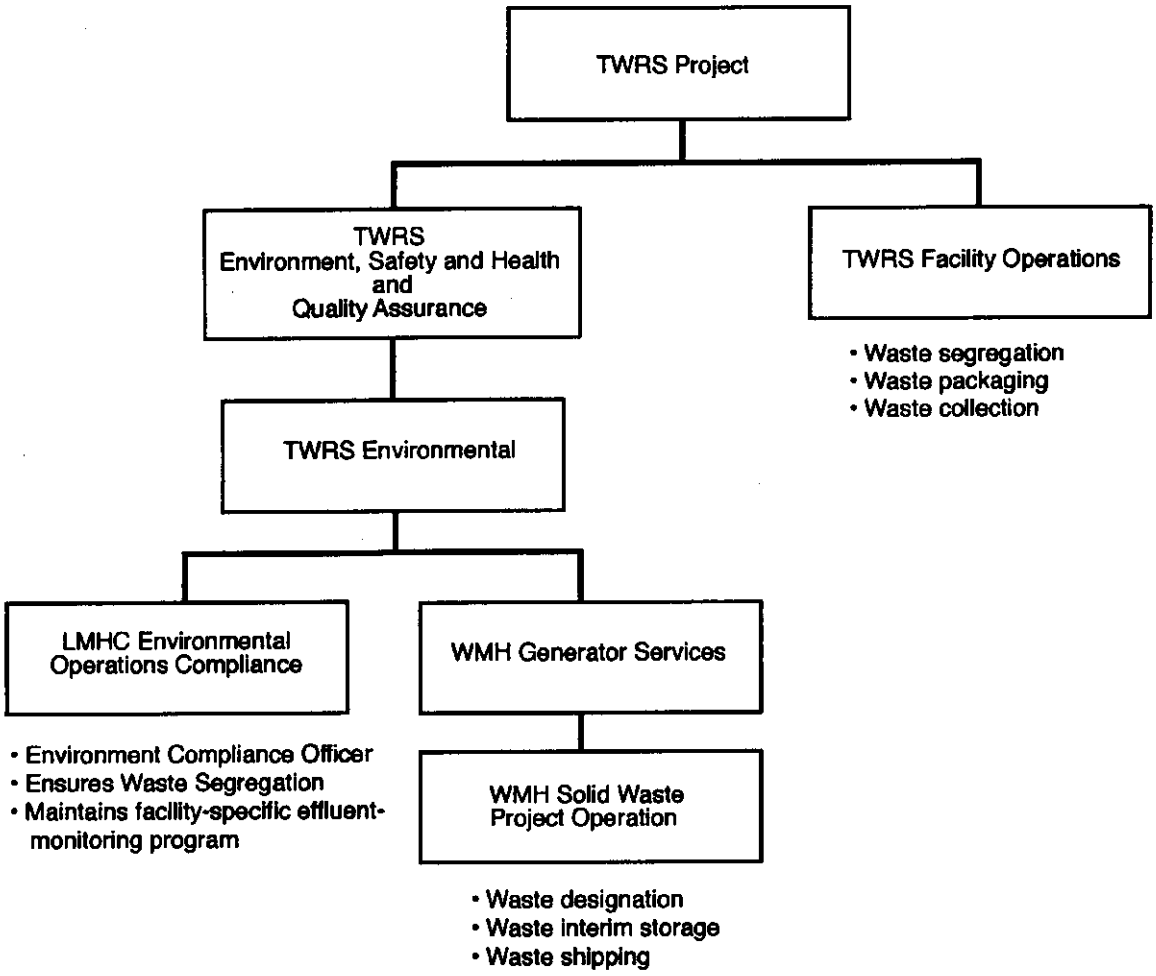
Figure 9-1. Tank Waste Remediation System Radioactive and Hazardous Waste Management Program Organizational Structure.



LMHC = Lockheed Martin Hanford Corporation.
TWRS = Tank Waste Remediation System.
WMH = Waste Management Federal Services of Hanford, Inc.

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Figure 9-2. Historical Effective Dose Equivalent to the Maximally Exposed Individual.

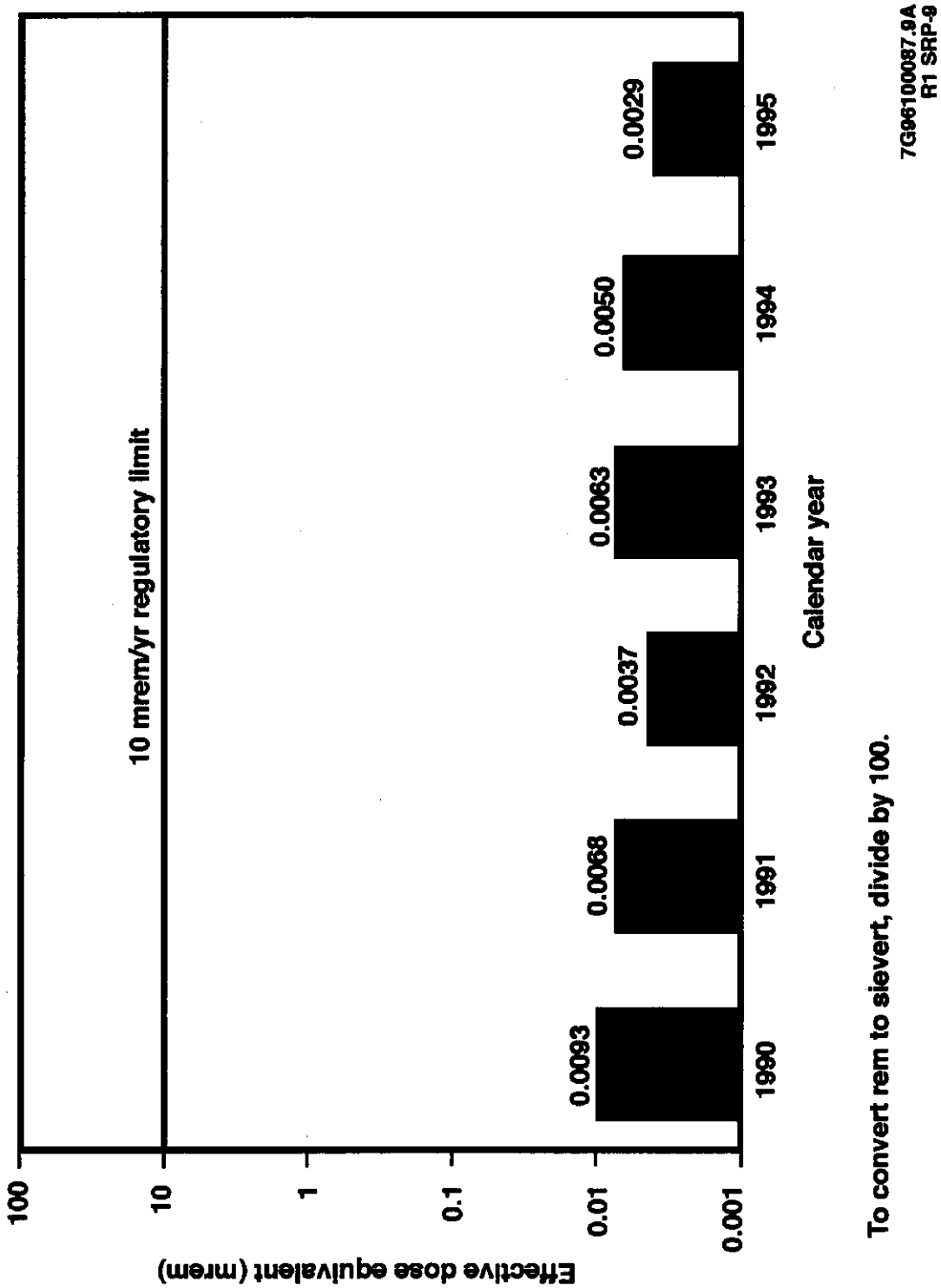

Table 9-1. Tank Waste Remediation System Hazardous and Radioactive Waste Management Program Plans.

Solid waste program	Liquid and gaseous effluent programs	Other
HNF-SD-WM-PLN-119	WHC-EP-0479	WHC-SD-WM-TR-026
WHC-SD-WM-PLN-115	WHC-SD-LEF-RPT-001	WHC-SD-WM-EV-090
HNF-EP-0063-5	—	--
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WHC-SD-WM-TR-026, 1996, *Tank Farm Transition Projects Dangerous Waste Training Plan*, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

Table 9-2. Tank Waste Remediation System Fiscal Year 1996 Estimated and Actual Waste Shipments to Solid Waste.

Solid waste facility	General waste type	Estimated waste volumes by waste type (m^3)[a,b]	Waste container description		
			Number of boxes[c]	Number of barrels/drums	Volume (m^3)
Central Waste Storage Complex	Mixed waste, unspecified	150	44	282	210
		187			
		187			
Low-Level Waste Burial Grounds	Low-level radioactive waste	179	41	221	350
		299			
		1,133			
T Plant	Mixed waste, equipment	[d]	[d]	[d]	27

Note: To convert m^3 to ft^3 multiply by 35.31.

[a]Taken from WHC-EP-0865, 1995, *1995 Solid Waste 30-Year Volume Summary*, Westinghouse Hanford Company, Richland, Washington.

[b]First value shown is minimum expected, second value is best estimate, and third value is estimated maximum.

[c]Size and dimensions unspecified.

[d]Waste container and estimated volume not specified. Typically these items are too large for standard packaging and are sent to T Plant for decontamination, dismantling, and repackaging.

Table 9-3. Calendar Year 1995 Tank Waste Remediation System Radionuclide Liquid Effluent Data.

Liquid effluent stream[a]	Discharge disposal site	Total flow (L)	Radionuclide[b]	Average concentration (µCi/mL)[c]	Annual release (Ci)[c]
241-A Tank Farm cooling water	216-B-3 expansion lobes	8.3 E+08	^{60}Co	2.0 E-09	1.7 E-03
			^{90}Sr	ND	ND
			^{106}Ru	4.1 E-08	3.4 E-02
			^{113}Sn	1.0 E-09	8.5 E-04
			^{125}Sb	ND	ND
			^{134}Cs	1.1 E-09	9.0 E-04
			^{137}Cs	1.5 E-09	1.2 E-03
			^{238}Pu	9.6 E-12	8.0 E-06
			$^{239/240}Pu$	2.2 E-11	1.8 E-05
			^{241}Am	1.0 E-10	8.6 E-05
			Total alpha	4.0 E-10	3.3 E-04
			Total beta	3.6 E-10	3.0 E-04
244-AR Vault cooling water	216-B-3 expansion lobes	4.8 E+06	^{60}Co	4.4 E-09	2.1 E-05
			^{90}Sr	ND	ND
			^{106}Ru	5.1 E-08	2.4 E-04
			^{113}Sn	2.3 E-09	1.1 E-05
			^{125}Sb	8.3 E-09	4.0 E-05
			^{134}Cs	3.2 E-09	1.6 E-05
			^{137}Cs	3.1 E-09	1.5 E-05
			^{238}Pu	2.9 E-11	1.4 E-07
			$^{239/240}Pu$	7.6 E-11	3.7 E-07
			^{241}Am	6.9 E-11	3.3 E-07
			Total alpha	5.3 E-10	2.5 E-06
			Total beta	5.2 E-10	2.5 E-06

Source: WHC-EP-0527-5, 1996, *Environmental Releases for Calendar Year 1995*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[a]Miscellaneous streams with discharge rates less than 1 gal/min are not shown.

[b]Total alpha and total beta do not include the other listed radionuclides (e.g., total beta concentration and annual release do not include ^{60}Co).

[c]1 µCi/mL = 3.7 E+10 Bq/m^3; 1 Curie = 3.7 E+10 Becquerel.

ND = none detected.

Table 9-4. Calendar Year 1995 Tank Waste Remediation System Radionuclide Air Emissions Data for Major Point Sources. (4 sheets)

(Major point sources have the potential of >0.1 mrem/y EDE to nearest offsite resident)[a]		
Source ID[b] (stack number)	Radionuclide[c]	Annual emissions (Ci)[d]
241-AY/AZ Tank Farms (296-A-17 296-P-26 [backup])	^{90}Sr	5.4 E-06
	^{106}Ru	4.0 E-06
	^{113}Sn	5.3 E-07
	^{125}Sb	9.5 E-07
	^{129}I	2.7 E-04
	^{134}Cs	1.8 E-08
	^{137}Cs	6.2 E-05
	^{152}Eu	ND
	^{154}Eu	8.8 E-09
	^{155}Eu	3.1 E-08
	^{238}Pu	4.6 E-09
	$^{239,240}Pu$	1.4 E-08
	^{241}Am	1.2 E-08
244-A DCRT (296-A-25)	^{90}Sr	3.2 E-08
	^{106}Ru	ND
	^{113}Sn	ND
	^{125}Sb	4.0 E-10
	^{134}Cs	4.0 E-11
	^{137}Cs	1.4 E-06
	^{152}Eu	ND
	^{154}Eu	1.4 E-10
	^{155}Eu	ND
	^{238}Pu	5.7 E-11
	$^{239,240}Pu$	1.7 E-10
	^{241}Am	4.1 E-10
241-AP Tank Farm (296-A-40)	^{90}Sr	4.3 E-09
	^{106}Ru	8.1 E-07
	^{113}Sn	9.8 E-08
	^{125}Sb	2.0 E-07
	^{129}I	1.6 E-05
	^{134}Cs	4.5 E-10
	^{137}Cs	2.7 E-08
	^{152}Eu	1.4 E-09
	^{154}Eu	ND
	^{155}Eu	ND
	^{238}Pu	ND
	239,240Pu	5.8 E-11
	^{241}Am	4.9 E-10

Table 9-4. Calendar Year 1995 Tank Waste Remediation System Radionuclide Air Emissions Data for Major Point Sources. (4 sheets)

(Major point sources have the potential of >0.1 mrem/y EDE to nearest offsite resident)[a]		
Source ID[b] (stack number)	Radionuclide[c]	Annual emissions (Ci)[d]
244-BX DCRT (296-B-28)	^{90}Sr	1.2 E-08
	^{106}Ru	ND
	^{113}Sn	4.2 E-10
	^{125}Sb	4.8 E-10
	^{134}Cs	ND
	^{137}Cs	2.7 E-09
	^{152}Eu	3.1 E-10
	^{154}Eu	ND
	^{155}Eu	4.2 E-10
	^{238}Pu	ND
	$^{239,240}Pu$	7.1 E-11
	^{241}Am	1.3 E-10
244-CR Vault (296-C-5)	^{90}Sr	2.7 E-07
	^{106}Ru	ND
	^{113}Sn	1.7 E-09
	^{125}Sb	6.4 E-09
	^{134}Cs	4.1 E-09
	^{137}Cs	2.8 E-07
	^{152}Eu	ND
	^{154}Eu	3.5 E-11
	^{155}Eu	3.4 E-09
	^{238}Pu	4.6 E-10
	$^{239,240}Pu$	3.7 E-09
	^{241}Am	2.2 E-09
Tank 241-C-105/106 (296-P-16)	^{90}Sr	4.2 E-07
	^{106}Ru	ND
	^{113}Sn	ND
	^{125}Sb	3.7 E-09
	^{134}Cs	ND
	^{137}Cs	1.4 E-06
	^{152}Eu	1.7 E-09
	^{154}Eu	ND
	^{155}Eu	4.6 E-09
	^{238}Pu	1.1 E-09
	$^{239,240}Pu$	1.9 E-10
	^{241}Am	6.8 E-09

Table 9-4. Calendar Year 1995 Tank Waste Remediation System Radionuclide Air Emissions Data for Major Point Sources. (4 sheets)

(Major point sources have the potential of >0.1 mrem/y EDE to nearest offsite resident)[a]		
Source ID[b] (stack number)	Radionuclide[c]	Annual emissions (Ci)[d]
241-SX Tank Farm (296-S-15)	^{90}Sr	6.6 E-08
	^{106}Ru	ND
	^{113}Sn	2.1 E-09
	^{125}Sb	ND
	^{134}Cs	1.7 E-09
	^{137}Cs	1.1 E-07
	^{152}Eu	2.7 E-09
	^{154}Eu	5.4 E-09
	^{155}Eu	6.5 E-09
	^{238}Pu	5.4 E-10
	$^{239,240}Pu$	1.8 E-09
	^{241}Am	2.7 E-09
244-S DCRT (296-S-22)	^{90}Sr	2.1 E-08
	^{106}Ru	ND
	^{113}Sn	ND
	^{125}Sb	3.2 E-10
	^{134}Cs	ND
	^{137}Cs	4.2 E-10
	^{152}Eu	ND
	^{154}Eu	ND
	^{155}Eu	5.0 E-10
	^{238}Pu	ND
	$^{239,240}Pu$	1.4 E-10
	^{241}Am	4.1 E-10
244-TX DCRT (296-T-18)	^{90}Sr	1.0 E-10
	^{106}Ru	ND
	^{113}Sn	ND
	^{125}Sb	ND
	^{134}Cs	2.3 E-10
	^{137}Cs	2.6 E-10
	^{152}Eu	ND
	^{154}Eu	ND
	^{155}Eu	6.2 E-10
	^{238}Pu	2.1 E-11
	$^{239,240}Pu$	1.0 E-09
	^{241}Am	5.8 E-10

Table 9-4. 1995 Tank Waste Remediation System Radionuclide Air Emissions Data for Major Point Sources. (4 sheets)

Source: WHC-EP-0527-5, 1996, *Environmental Releases for Calendar Year 1995*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[a]Determining the state of compliance with 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, for each point source involved using nearest offsite residences, which differed from the MEI.

[b]ID = Identification, i.e., the alpha-numeric designator for the respective point source.

[c]Only those radionuclides that could contribute greater than 10% of the potential EDE from that release point are identified.

[d]ND = none detected (i.e., either the radionuclide was not detected in any sample during the year, or the average of all the measurements for that given radionuclide or type of radioactivity made during the year was below background levels).

DCRT = double-contained receiver tank.

EDE = effective dose equivalent for the MEI.

MEI = maximally exposed individual.

Table 9-5. Calendar Year 1995 Tank Waste Remediation System Radionuclide Air Emissions Data for Minor Point Sources. (2 sheets)

Minor point sources have the potential of <0.1 mrem/yr EDE to nearest offsite resident.[a]		
Source ID[b]	Radionuclide	Annual emissions (Ci)[c]
244-AR Vault Cell and Canyon (296-A-13)	(did not operate)	
Tank 241-AY-102 (296-A-19)	(did not operate)	
241-AZ Tank Farm (296-A-20)	total alpha total beta	1.1 E-08 3.1 E-08
204-AR Waste Unloading Facility (296-A-26)	total alpha total beta	7.2 E-09 2.4 E-08
241-AW Tank Farm (296-A-27)	^{90}Sr ^{106}Ru ^{113}Sn ^{125}Sb ^{129}I ^{137}Cs ^{238}Pu $^{239/240}Pu$ ^{241}Am	ND 1.3 E-06 1.2 E-07 3.5 E-07 1.4 E-05 2.5 E-09 ND 1.7 E-10 8.2 E-10
241-AW Tank Farm Annulus (296-A-28)	total alpha total beta	4.6 E-08 3.9 E-07
241-AN Tank Farm (296-A-29)	^{90}Sr ^{137}Cs ^{154}Eu ^{238}Pu $^{239/240}Pu$ ^{241}Am	2.0 E-08 1.9 E-10 9.4 E-10 3.0 E-11 1.1 E-10 1.1 E-09
241-AN Tank Farm Annulus (296-A-30)	total alpha total beta	2.1 E-08 1.8 E-07
241-AP Tank Farm (296-A-41)	total alpha total beta	2.4 E-08 1.1 E-07
209-E Facility (296-P-31)	total alpha total beta	6.4 E-09 4.2 E-08
241-SY Tank Farm Annulus (296-P-22)	total alpha total beta	1.7 E-09 1.8 E-08

Table 9-5. Calendar Year 1995 Tank Waste Remediation System Radionuclide Air Emissions Data for Minor Point Sources. (2 sheets)

Minor point sources have the potential of <0.1 mrem/yr EDE to nearest offsite resident.[a]		
Source ID[b]	Radionuclide	Annual emissions (Ci)[c]
241-SY Tank Farm	^{90}Sr	1.3 E-07
(296-P-23)	^{106}Ru	4.0 E-09
(296-P-28 [backup])	^{113}Sn	6.0 E-10
	^{125}Sb	3.4 E-09
	^{134}Cs	4.0 E-10
	^{137}Cs	4.0 E-06
	^{152}Eu	1.7 E-09
	^{155}Eu	2.4 E-09
	^{238}Pu	3.9 E-10
	$^{239/240}Pu$	1.7 E-09
	^{241}Am	3.9 E-09
213-Waste Compactor	total alpha	1.4 E-08
(296-W-3)	total beta	5.9 E-08

Source: WHC-EP-0527-5, 1995, *Environmental Releases for Calendar Year 1995*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[a]Determining the state of compliance with 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, for each point source involved using nearest offsite residences, which differed from the maximally exposed individual.

[b]ID = Identification, i.e., the alpha numeric designator for the respective point source.

[c]Only those radionuclides that could contribute greater than 10% of the potential EDE from that release point are identified.

[d]1 Curie = 3.7 E+10 Becquerel.

EDE = effective dose equivalent.

ND = none detected (i.e., either the radionuclide was not detected in any sample during the year, or the average of all the measurements for that given radionuclide or type of radioactivity made during the year was below background levels).

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CHAPTER 10.0
INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

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CHAPTER 10.0
INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

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LIST OF TERMS

DOE	U.S. Department of Energy
M&TE	measuring and test equipment
PMT	post-maintenance testing
QAP	quality assurance program
SSC	structure, system, and component
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System

10.0 INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

10.1 INTRODUCTION

Essential features of the initial testing, in-service surveillance, and maintenance programs operated under the Tank Waste Remediation System (TWRS) are described in this chapter. These programs ensure that Safety-Class structures, systems, and components (SSCs), Safety-Significant SSCs, identified in Chapter 4.0, and other SSCs, including Defense-in-Depth items, are available when needed. This chapter demonstrates that a well-defined program with a programmatic commitment to surveillance, testing, and maintenance is an integral part of the overall safety assurance philosophy at TWRS.

10.2 REQUIREMENTS

Initial testing, in-service surveillance, and maintenance policies and programs addressed in this chapter are regulated by the following U.S. Department of Energy (DOE) orders:

- DOE 4330.4B, *Maintenance Management Program*, Change 0, (1994)[1]
- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1 (1992)
- DOE 5480.31, *Startup and Restart of Nuclear Facilities*, Change 0, (1993)[2]
- DOE-76-45/1, *Occupancy/Use Readiness Manual* (1992).

The requirements of initial testing, in-service surveillance, and maintenance programs reflect the Safety-Class assignments of SSCs for protection of the public, personnel, and the environment as discussed in Chapter 4.0.

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[1]This Order was cancelled by DOE O 430.1, 1995, *Life Cycle Asset Management*, Change 1, U.S. Department of Energy, Washington, D.C. Compliance with DOE 4330.4B is required until the conditions for implementation of DOE O 430.1 are fulfilled by agencies external to the contractor.

[2]This Order was cancelled by DOE O 425.1, 1995, *Startup and Restart of Nuclear Facilities*, Change 1, U.S. Department of Energy, Washington, D.C. Compliance with DOE 5480.31 is required until the Contracting Officer directs compliance with DOE O 425.1 or provides other direction to terminate compliance with DOE 5480.31.

10.3 INITIAL TESTING PROGRAM

The initial testing program ensures the operability of systems and facilities. The TWRS organization is ultimately responsible for all testing performed in support of TWRS. All testing programs have similar procedures. However, for new facilities or modifications involving Safety-Class and Safety-Significant systems, additional initial testing requirements are identified. These additional requirements are necessary to ensure the SSC performs its safety function as identified in Chapter 4.0. The same is true for Defense-in-Depth SSCs (Chapter 3.0).

10.3.1 Tests

The initial testing program includes testing of all SSCs to ensure compliance with design safety specifications and acceptance criteria. Construction tests, acceptance tests, manufacturer initial factory acceptance tests, and operational tests are included in the testing program. These tests are specified as quality assurance requirements in WHC-CM-4-2[3], *Quality Assurance Manual*, and WHC-CM-6-1, *Standard Engineering Practices*.

Construction Tests—Requirements for construction tests are typically included in project-specific regulations, codes, standards, and procurement specifications, and are prepared, approved, and conducted by the construction contractor in accordance with the construction contractor quality assurance program (QAP). The prime contractor provides oversight of construction tests in accordance with the general and project-specific QAP. Construction testing for permanent equipment, systems, and facilities encompasses nondestructive examinations, hydrostatic and pneumatic tests, equipment alignment, and rigging and lifting equipment tests.

Acceptance Tests—Acceptance testing, which is performed before contractor acceptance of new facilities or facility modifications, normally proceeds in three phases: equipment, system, and integrated system testing. The phases can overlap. Some equipment tests require that the system be operating. Some system functions can only be demonstrated during integrated system testing. These acceptance tests confirm that equipment and systems are capable of performing design functions at rated conditions. These tests also confirm that the equipment or system has the ability to respond to changes in process or environmental conditions, provide status information as required, respond to abnormal conditions, and transfer from automatic to manual control as required.

Acceptance tests may be performed by the manufacturer if the tests are witnessed by contractor personnel or an independent organization. Subsequent acceptance tests in the field focus on interfaces with other system equipment.

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[3]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," for crosswalk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Flour Daniel Hanford, Inc. (FDH), procedures (e.g., HNF-PRO-XXX).

Manufacturer Factory Acceptance Tests—Manufacturer factory acceptance tests are performed by the equipment manufacturer or its suppliers. These tests ensure that the equipment meets procurement specification requirements. These tests typically are prepared, approved, and conducted by the manufacturer according to the manufacturer QAP before delivery. Oversight of these tests is provided by the contractor according to the general and the project-specific QAP.

Preoperational Testing—Preoperational testing is performed in preparation for operational testing. During preoperational testing, SSCs are operated at defined parameters to ensure they are ready for full operational testing. When the SSCs have been tested sufficiently at the defined parameters to indicate that normal operating parameters can be achieved, they are tested at designated higher parameters. At the completion of preoperational testing, the test results are evaluated, and a determination to move into operational testing is made.

Operational Tests—Operational tests involve an integrated assessment to demonstrate that the system or facility can achieve and maintain expected operating parameters, including safety parameters. This testing is normally done in two phases. In the first phase, the facility is operated within the desired or achievable parameters with simulated radioactive or hazardous materials. In the second phase, some or all of the first-phase tests are repeated using radioactive or hazardous materials.

10.3.2 Test Procedures

All test procedures are developed, reviewed, and approved in accordance with HNF-IP-0842, *TWRS Administration*, Volume I, Section 2.11, "Technical Procedure Control and Use." The cognizant engineering organization typically issues a test specification or plan to the testing organization. The testing organization identifies test objectives, test methods, test conditions, applicable cautions, and acceptance criteria. The testing organization prepares a test document that clearly describes test performance (e.g., initial conditions, sequence of testing, acceptance criteria, recovery actions). Appropriate contractor oversight organizations must review and approve the test document before it is issued and used.

In those instances, where the cognizant engineering organization is the test organization, test specifications are developed similar to the test specifications developed for the testing organization. The test specifications are prepared, approved, and issued by the TWRS Engineering and Nuclear Safety (for design-bases documents) or the cognizant engineer (for all others). Test reviews are conducted before, during, and after testing to confirm identified test requirements, to ensure proper test performance, and to verify the results of the conducted tests. These reviews are performed by the cognizant engineering organization and operations, safety, and quality assurance. Test-related documentation is reviewed and approved by the facility manager or line manager performing the test.

10.3.3 Test Performance

Initial tests are performed by qualified test directors with the concurrence and under control of the facility shift supervisor in accordance with the conduct of operations plan. Provisions are provided for stopping testing and placing equipment in a safe condition when testing does not proceed as expected.

10.3.4 Review, Evaluation, and Approval of Initial Test Results

The construction contractor shall submit to the operating contractor all documentation and operating data required for safe and efficient operation of new equipment and facilities on formal turnover. The documentation and data shall demonstrate compliance with applicable codes, standards, and programmatic functional requirements.

Program work shall not be started or resumed in nuclear facilities until the facility has been brought to a state of readiness to safely conduct that program work, and the state of readiness to operate has been verified. This verification is accomplished through readiness reviews. Readiness reviews are disciplined, systematic, documented, performance-based examinations of facilities, equipment, personnel, procedures, and management control systems designed to ensure that a facility will be operated safely within its approved safety envelope as defined by the facility safety basis. A critical element of the readiness process is the examination of test results.

Test results are evaluated per the appropriate test procedures and accepted once test requirements have been completed. In addition, particularly complex tests may be evaluated and a test report prepared by the cognizant engineering organizations. On review of all test requirements, acceptance is granted in accordance with applicable engineering and operational readiness orders and standards.

The applicable orders and standards are implemented through WHC-CM-1-5, *Standard Operating Practices*. This manual requires the execution of a formal readiness process designed to verify that management has brought the facility to a state of readiness to commence or resume program work. The process outlines roles and responsibilities for involved organizations. These organizations include the independent reviewers, whose task it is to provide an unbiased cross-check of testing activities to ensure completion of all requirements. Subsequent to all verification steps, authorization to proceed with startup or restart is given from the designated approval authority. See Chapter 11.0 for further information on the readiness process.

10.4 IN-SERVICE SURVEILLANCE PROGRAM

In-service surveillance and inspections at TWRS are performed according to DOE 4330.4B using a graded approach. Program requirements include periodic inspections to ensure that proper conditions, cleanliness, and housekeeping are maintained to support safe and reliable facility operations.

The in-service surveillance program is conducted in conjunction with the maintenance and testing program. Together, these programs ensure continued operation of Safety-Class and Safety-Significant SSCs at TWRS. The in-service surveillance program, including provisions for testing and calibrations, control and calibration of measuring and test equipment (M&TE), trending of test results, programmatic review, and training of surveillance personnel are described in the following sections.

10.4.1 Provisions for Testing and Calibrations

The TWRS program for in-service surveillance, inspection, and testing activities ensures that equipment needed for safe, reliable facility operation performs as required and that the program responds to the requirements of DOE 4330.4B. TWRS Technical Operations and Engineering is responsible for planning and documenting surveillance tests and other tests as discussed in Chapter 17.0.

The cognizant engineer develops the schedule for in-service surveillance and testing using nationally recognized standards, Technical Safety Requirement (TSR) controls, vendor recommendations, and operational history as a basis for in-service surveillance and testing intervals. Where standards are not available, the cognizant engineer and the maintenance and testing organization, using available data and SSC performance requirements (Chapters 3.0 and 4.0) for Defense-in-Depth, Safety-Significant, and Safety-Class, respectively, develop in-service surveillance testing requirements. These requirements include intervals and SSC performance requirements. These requirements and the actual in-service surveillance and testing are reviewed and approved by the cognizant engineering organization and operations, safety, and quality assurance. Test-related documentation is reviewed and approved by the facility manager or line manager performing the test.

The in-service surveillance requirements for the Safety-Class and Safety-Significant items are identified in the TSRs. The in-service surveillance requirements identified, are developed to ensure the Safety-Class and Safety-Significant items perform their safety function should an accident occur. The bases for the in-service surveillances are provided in Chapter 5.0 and the TSR controls. In-service surveillance requirements for Defense-in-Depth items are provided in Chapter 3.0 and where not provided, the requirements are established based on national standards or engineering judgment.

In-service surveillance procedures are documented in a computerized maintenance management system database. In-service surveillance activities performed by crafts personnel are recalled from the maintenance management system. Specific maintenance and in-service surveillance programs for selected equipment are outlined in the following paragraphs.

Cranes and Lifts–Detailed requirements for the inspection, maintenance, and testing of cranes and lifts are found in DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*. This manual specifies requirements for activities, including the following:

- Determination of inspection procedures and frequencies
- Inspection of wire ropes, chains, hooks, and cranes
- Load and operational tests
- Inspection, maintenance, and test records.

Fire Protection Systems–Tests are required for fire protection equipment based on National Fire Protection Association guidance and the requirements of WHC-CM-4-41, *Fire Protection Program Manual*. This controlled manual provides requirements for fire protection system testing/maintenance procedures and for the periodic inspection, testing, and maintenance of all fixed fire alarm and suppression equipment.

Radiological and Environmental Monitoring Equipment–Requirements for the maintenance and inspection of radiation monitoring equipment are provided in Chapters 5.0 and 7.0 of the HSRCM-1, *Hanford Site Radiological Control Manual*. A program for preventive and corrective maintenance of radiological instruments is described in PNL-MA-563, *Radiation Instrument Calibration* (Chapter 7.0). Requirements for the maintenance and inspection of environmental sampling and monitoring equipment are provided in WHC-CM-7-5, *Environmental Compliance*.

Surveillance Requirements of Safety-Class and Safety-Significant SSCs–Surveillance requirements have been established for selected Safety-Class and Safety-Significant SSCs whose functional requirements can be verified through testing. These requirements provide assurance that the necessary quality of systems and components relied on in the safety analyses is maintained and is based on manufacturers' recommendations, vendor data, and national consensus standards. Certain Safety-Class and Safety-Significant SSCs, such as passive design structures (e.g., waste tanks) do not have surveillance requirements because testing of their functional safety criteria is impractical. Verification of the functional criteria of these SSCs is better managed through other Administrative Controls such as configuration management processes. Surveillance requirements for TSR control-related SSCs are discussed in the TSR Bases. Surveillance requirements of some Safety-Class and Safety-Significant SSCs are not identified in the TSR Limiting Condition for Operation but are managed by a program identified in the TSR Administrative Control 5.19 "Process Instrumentation and Measuring Test Equipment." This program is further discussed in Section 10.4.2. Some of the monitoring systems that have surveillance requirements are temperature and leak detection. The operation of active Safety-Class and Safety-Significant SSCs are tested at facility start-up as part of the acceptance or operational test (Section 10.3) or as part of the operational readiness review or assessment process (Chapter 11.0).

The TSR controls, in the Limiting Condition for Operation section, identify two types of surveillance tests: calibrations and functional tests. Calibration surveillances are developed to ensure components perform according to manufacturers' and engineering specifications. Calibration surveillances are performed on a less frequent basis than functional tests because they are done on single components which are normally more reliable than an entire system. Calibrations surveillances are also performed on process measuring and test equipment, as noted above. Functional tests are developed to evaluate the performance of the Safety-Class or Safety-Significant SSCs. Functional tests are performed on selected Safety-Class and Safety-Significant

SSCs where it is practical to verify system functional safety criteria. An example of this is the functional test of the leak detection system. The functional safety criteria of the leak detection system is to either automatically stop the operation of related transfer pumps or notify continuously manned operations in the event of a transfer line leak. Testing of this criterion is done by simulating a leak condition as close to the leak detector probe as practical and monitoring either the interlock or alarm for proper system response.

No functional tests are defined for active ventilation systems because the safety function is only to maintain a small flow rate within the tank to alleviate flammable gas buildup. Hardware surveillance activity is managed instead through the process measurement and test equipment Administrative Control in the TSRs because several calibratable instrument components can be used to demonstrate that the tank headspace is being swept by ventilation.

As noted in the preceding paragraph, no routine functional tests are defined for active ventilation systems. However, each time significant changes to the hardware, performance, or configuration of a ventilation system occurs, the ability of the changed ventilation system to mitigate the steady state accumulation of flammable gas needs to be validated. The ventilation system shall be considered successful at maintaining tank flammable gas concentrations within acceptable levels if the flammable gas concentration is less than 25% of the lower flammability limit.

Surveillance Requirements of General Service SSCs—Surveillance requirements have been established for general service SSCs, including those Defense-in-Depth items identified in Chapter 3.0. The surveillance requirements are developed to ensure that the general service SSCs function according to vendor data, manufacturers' recommendations, and national consensus standards and to ensure the system requirements, as identified by TWRS Technical Operations and Engineering, including the design authority and cognizant engineer or facility manager are being met. Some of the general service SSCs that have surveillance requirements are non-Safety-Class transfer lines that have not been used in the past year, miscellaneous pumps, and electrical systems.

10.4.2 Control and Calibration of Measuring and Test Equipment

The control and calibration of M&TE are discussed in Section 10.5.5. The guidelines of DOE 4330.4B and HNF-IP-0842, Volume V, "Maintenance/Production Control," also apply to M&TE used for in-service surveillance.

10.4.3 Trending of In-service Surveillance Test Results

Trending of in-service surveillance data, for Safety-Class and Safety-Significant SSCs identified in the TSR controls and other SSCs (including Defense-in-Depth SSCs) deemed important to safety or plant operation within a facility, is performed following the graded approach in the Maintenance Implementation Plan. When necessary (e.g., data or status

inconsistencies) the past in-service surveillance reports can be accessed. These reports, in conjunction with current operations, can help determine data or status inconsistencies. .

10.4.4 Programmatic Review

Inspections, audits, reviews, investigations, and self-assessments are necessary for an effective surveillance and maintenance program. It is recommended in DOE 4330.4B that senior managers periodically review and assess elements of the maintenance program to assist line managers and supervisors in identifying and correcting program deficiencies. Maintenance management and selected personnel routinely inspect maintenance areas such as shops, yards, docks, laydown areas, storage areas, and office areas for general conditions and housekeeping. Formal self-assessment and facility programmatic review processes are discussed further in Chapter 17.0.

Performance-based self-assessments have been incorporated into HNF-IP-MIP, *Maintenance Implementation Plan*. These assessments consist of activities ranging from desktop comparisons to field observations and are performed by management personnel. Self-assessments measure the effectiveness of the maintenance program based on all of the elements listed in Chapter II of DOE 4330.4B. The self-assessments also compare previous assessments for trending and repeat findings.

Discrepancies are identified and documented. Corrective actions are tracked through the work request system and through assigned action based on the discrepancy report. Previous inspection reports are compared with current reports by Tank Farm management and personnel to identify trends.

10.4.5 Training of Personnel Performing Surveillance

Training of maintenance personnel is discussed in Section 10.5.2. The guidelines and procedures of HNF-IP-0842, Volume III, Section 10.6, "Maintenance Training," were developed to meet the requirements of DOE 4330.4B. In addition, facility managers, cognizant engineers, and operations personnel are trained in the facility TSR controls and the required SSC surveillances. These training programs are developed according to the processes discussed in Chapter 12.0.

10.5 MAINTENANCE PROGRAM

The TWRS has overall responsibility for the operation and maintenance of the Hanford Site tank farms. The 200 East Area and 200 West Area Tank Farm organizations are responsible for the maintenance of the systems and facilities within their control. Planned shutdowns, interruptions, or changes in utilities and services that interface with the TWRS, such as electrical power, are communicated to TWRS management.

The TWRS maintenance program is conducted according to DOE 4330.4B, which provides general policy and objectives for establishing cost-effective maintenance and repair of DOE property. Major elements of the maintenance program, following the graded approach of the Maintenance Implementation Plan, includes the following:

- Preventive maintenance
- Predictive maintenance
- Spare parts control
- Maintenance history
- Corrective maintenance
- Maintenance training
- M&TE.

Requirements for the maintenance program reflect the relative importance of facility SSCs in protecting the public, workers, and the environment.

DOE 5480.23, *Nuclear Safety Analysis Reports*, requires that "Safety analyses should document a systematic inquiry...This inquiry should explore the safety implications of the possibility that faults and failures may, undetected, occur or accumulate over the service life of the facility." DOE 5480.23 also requires that "...safety analyses should identify the plans, provisions, or compensatory action developed to prevent the limitations of maintenance and repair from degrading safety and should furnish a basis for Departmental review and approval of the adequacy of the provisions for maintenance and repair and for compensatory actions for limitations on maintenance and repair."

The elements of the maintenance program are combined with other key programs such as safety classification of SSCs, Defense-in-Depth, conduct of operations, and quality assurance to facilitate reliable operations through proper maintenance and replacement of SSCs, thereby protecting the public, workers, and the environment. Other systems (e.g., occurrence reporting, maintenance recall, and surveillance tracking) are in place to assure that safety is maintained.

A thorough hazard and accident analysis (Chapter 3.0) was conducted to examine normal, abnormal, and accident conditions. Some of these conditions are those that could be caused by faults and failures of SSCs, whether detected or undetected, and cumulative damage to SSCs. The scenarios examined included hazardous conditions that could be observed and resulted in postulated accidents with potential releases of radiological and toxicological materials. The resulting set of controls focuses on preventing or mitigating those postulated accidents. The controls are implemented primarily through TSRs (Chapter 5.0) and WHC-SD-WM-HSP-002, *Tank Farm Health and Safety Plan*.

Performance of the TSR surveillance requirements, as well as operator daily activities, and worker presence in the Tank Farms would eventually discover faults and failures that occur or accumulate over a facility's lifetime. This is particularly true for those events protected by TSR controls. The problems would be called to the attention of management via TSR violations and occurrence reports. These systems and programs would preclude the decline in SSC performance

and limit the impact on the safety of the public, workers, and the environment. Maintenance and proper functioning of these programs is partially protected by the quality assurance function.

The TWRS maintenance organization analyzes and develops procedures similarly for all SSCs. High-cost, Safety-Class, and Safety-Significant SSCs receive higher priority and normally require more surveillance (Technical Safety Requirement control driven) and periodic maintenance activities than the balance of facility SSCs. Each SSC is analyzed by TWRS engineering. Changes to maintenance requirements are reviewed and approved commensurate with the safety importance of the SSC, as specified in WHC-CM-3-5, *Document Control and Records Management*, Section 12.7, "Approval of Environmental, Safety, and Quality Affecting Documents."

A combination of corrective, preventive, or planned maintenance is used by the TWRS maintenance organization to ensure that facility equipment degradation is identified and corrected, that equipment life is improved, and that the maintenance program is cost-effective.

Corrective maintenance consists of all those actions performed to restore failed or malfunctioning equipment. When failure occurs, the failure is identified, corrected, and documented. A planner reviews the maintenance management system for procedures to correct the failure. If none exist, then written instructions are prepared and approved according to HNF-IP-0842, Volume V, *Maintenance Production Control*. Analysis of corrective maintenance influence the preventive and predictive maintenance programs as well as the maintenance training and qualification programs.

Preventive or planned maintenance consists of planned and scheduled actions necessary to prevent equipment failure. These actions may include surveillance and inspection; servicing (e.g., lubrication, cleaning, or filter replacement); functional testing; and component replacement. Preventive maintenance procedures and their frequencies are included in the maintenance management system. Planned maintenance is typically done during outages or on spare or redundant equipment that is available during facility operation. Maintenance frequencies are developed from many sources, including manufacturer recommendations, plant experience, good engineering practice, predictive maintenance, As Low As Reasonably Achievable considerations, and performance monitoring.

Predictive maintenance, on a graded approach, is used to forecast equipment degradation so that maintenance can be performed before equipment failure. Several techniques are available to the cognizant engineer, including reliability-centered maintenance, periodic maintenance results (e.g., shock pulse monitoring), analysis of the maintenance history, surveillance results, and feedback from the corrective maintenance program.

TWRS equipment is designed and operated to limit impacts on routine maintenance, renewal, or repair of SSCs. Equipment in hazardous and radiological areas is designed to be as maintenance free as possible. Control systems are used to ensure a safe working environment as required by WHC-CM-3-5, Section 12.7, "Approval of Environmental, Safety, and Quality Affecting Documents." Formal work control procedures, the work request system, supervisory

involvement in the work process, and review of work requests are examples of such control systems.

Maintenance or troubleshooting activities on TSR controls Safety-Class and Safety-Significant, SSCs, and Defense-in-Depth SSCs are documented in one or more of the following: work package instructions, maintenance procedures, preventive maintenance and data sheets, and plant operating procedures.

10.5.1 Maintenance Organization

The philosophy, responsibilities, and processes for management of work activities, including the structure of the maintenance organization, are defined in WHC-CM-1-8 and HNF-IP-0842. The responsibilities are applicable to work performed for modifications and construction, as well as for corrective, preventive, and predictive maintenance. The responsibilities can be summarized as follows.

The facility manager provides the overall management of operations and maintenance of a facility and consistent management direction for maintaining an effective work management system. In addition, the facility manager establishes and maintains a knowledgeable work force, ensures compliance with statutory requirements, ensures nonplant personnel (service organization, contractor, and subcontractors) who perform maintenance or modification work within the facility are adequately trained in the facility design and operations, assigns facility resources to the maintenance activities consistent with DOE goals and objectives, establishes a prioritization system that considers the risk associated with each maintenance activity, and establishes a self-assessment program that uses performance measures and assessments to ensure proper and consistent work management implementation. Actual training requirements for maintenance personnel are established by the maintenance manager.

The operations manager is responsible for establishing a safe work environment while maintenance activities are being performed; maintaining consistent prioritization; establishing and adhering to an approved work schedule; maintaining and tracking all variances to current operational and design configuration; maintaining effective coordination among operations, craft management, maintenance management, and support organization management to ensure full support of the work management system; and ensuring system/equipment is acceptable after post-maintenance testing (PMT).

The work control/maintenance manager (or production control manager) is responsible for the effectiveness of the work package preparation, approval, tracking, and post-work review process. The work control manager is also responsible for completing performance indicators to consistently measure work management effectiveness. The maintenance manager is also responsible for training and qualification of maintenance personnel and for developing and maintaining job descriptions.

Managers of support organizations/servicing organizations, including maintenance, are responsible for ensuring that the employees assigned to perform work in a facility use properly approved work documents or work packages, ensuring that prepared and approved work documents or work packages comply with WHC-CM-3-5, ensuring that work is not performed by employees unless released by the facility manager/operations or that work is authorized to start without formal release by the manager, ensuring that employee work is safe and cost effective, and ensuring that employees assigned to work are trained and qualified for the tasks to be performed.

The work management process involves work screening, work package preparation, work scheduling, work completion and retest, and post-work review. Each phase of the work management process considers factors related to health, safety, environment, and maintaining risks at a level As Low As Reasonably Achievable. The process provides priority to work affecting systems or equipment relied on for safety.

HNF-IP-0842, Volume V, "Maintenance/Production Control," assigns overall authority and responsibilities and defines the minimum responsibilities, requirements, and procedures to be used in performing maintenance, modifications, fabrications, and related services including contractor and construction interfaces that impact a facility. The following requirements, responsibilities, and procedures also are addressed in WHC-CM-1-8:

- Use of a work request system, including a description of the process for initiating and processing work requests
- Personnel responsibilities for identifying deficiencies and initiating work requests that adequately describe symptoms or problems
- Supervisory responsibilities for controlling the conduct of maintenance activities and processing the work request
- Definition of the priorities used to schedule work
- Determination of the impact of maintenance activities on facility operations
- Work planning and scheduling
- Requirements for personnel and equipment safety and for radiological protection
- PMT
- Collection of maintenance history.

Work request packages include design documents, lists of materials, necessary permits, and special procedures. Work request packages also communicate As Low As Reasonably Achievable practices and hazardous waste management techniques.

As part of the job planning, a walkdown of the job site may be needed to identify hazardous conditions. The risks identified are then managed to help ensure worker safety.

The TWRS Operations managers ensure a safe work environment exists while maintenance activities are performed. Operating configuration control is achieved through a system of operating procedures (Chapter 12.0), lockout and tagout procedures (Chapter 11.0), communication (Chapter 11.0), work management techniques, and accurate status accounting of variances.

Maintenance procedures are developed, reviewed, and approved in accordance with HNF-IP-0842, Volume 1, Section 2.11, *Technical Procedure Control and Use*. The review and approval process is described in Chapter 17.0.

Maintenance procedures are controlled in accordance with HNF-IP-0842, Volume I, Section 2.11, "Technical Procedure Control and Use," and described in WHC-IP-0731, *Tank Farms Plant Operating Procedures and Alarm Response Format and Preparation Guide*. Maintenance and repair work require authorization through the Job Control System. Activities must be planned and scheduled to comply with health, safety, and environmental criteria and to support the needs of development and production schedules. Maintenance scheduling combines preventive and predictive philosophies with priority on preventive maintenance when higher reliability is required to meet health, safety, or environmental regulations.

Performed maintenance is controlled by use of the work request package. Requests are generated for corrective or preventive maintenance, discovery of an existing deficiency, and plant design changes.

In addition, where necessary, supporting organizations, such as Industrial Hygiene (Chapter 8.0) and Radiation Protection (Chapter 7.0), provide support to limit worker exposure or loss of contamination control.

10.5.2 Training of Maintenance Personnel

The TWRS maintenance training program ensures that maintenance personnel possess the knowledge and skills necessary to perform their assigned duties in a safe, efficient, and cost-effective manner. Training for plant and nonplant personnel provides adequate levels of knowledge of facility administrative, safety, quality control, radiation protection, and configuration management practices and procedures.

The TWRS training program is discussed further in Chapter 12.0. The maintenance training program reflects the requirements of DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, and uses DOE 4330.4B, where appropriate. All training program materials are developed and administered according to HNF-IP-0842, Volume III, "Training."

The maintenance manager is responsible for determining the training and qualification needs of each individual performing maintenance for TWRS. The maintenance manager and supervisors work closely with the training organization to establish and maintain course content, determine and support training schedules, accomplish on-the-job training, and provide feedback to adjust course content and emphasis.

10.5.3 Maintenance Facilities, Equipment, and Tools

TWRS maintenance efficiently supports facility maintenance and maintenance training and responds to the requirements of DOE 4330.4B.

Maintenance shops support the 200 East, Interim Stabilization, Characterization, and 200 West Areas maintenance operations. Each maintenance shop includes a tool crib for tools, consumables, and management of the M&TE inventory.

10.5.4 Post-Maintenance Testing

PMT is conducted to ensure that maintenance is performed properly, that the deficiency is corrected, that the equipment is restored to an operational status, and that no new deficiencies or abnormal conditions are created. The rigor of PMT is based on the extent of preventive or corrective maintenance performed and on the importance of equipment to plant safety and reliability. PMT input is reviewed and approved as part of the work package release process.

PMT is conducted according to procedures or written instructions with clearly defined acceptance criteria (i.e., designated in either qualitative or quantitative terms).

PMT consists of preventive maintenance procedures, calibration procedures, or functional test procedures to ensure the system is restored to system design parameters. Once accepted for operational use, the system or equipment is then restored to service, as directed by operations. The maintenance package is reviewed and approved, including post-maintenance activities, if required, by the cognizant engineering organization and operations, safety, and quality assurance. When a formally documented PMT is not required in a work document, checkout and verification are performed by the craftsperson or operator.

10.5.5 Control and Calibration of Measuring Equipment

TWRS controls M&TE to ensure the accurate performance of facility instrumentation and equipment for testing, calibration, and repairs and to respond to the requirements of DOE 4330.4B. M&TE includes all devices or systems used to inspect, test, calibrate, measure, or troubleshoot an instrument or piece of equipment to verify conformance to specified requirements. Calibration of the M&TE is performed onsite using site physical and electrical

calibration services or offsite at an approved calibration laboratory. The program is implemented in HNF-IP-0842, Volume V, "Maintenance/Production Control."

10.5.6 Maintenance History and Trending

Following maintenance activities, a graded approach post-work review is performed to ensure the work was performed correctly and completely. All completed work documents are reviewed before archiving to identify items important to operations, safety, quality, or environmental protection concerns. Any technical or procedural "lessons learned" are reviewed for future similar work activities.

Equipment maintenance history, using the graded approach of the Maintenance Implementation Plan, provides historical information for maintenance planning and supports maintenance and performance trending analysis. Maintenance history supports maintenance activity planning, upgrade programs, and equipment performance and reliability.

Records generated by facility operations and supporting organizations are maintained by TWRS management according to the requirements in HNF-IP-0842, Volume V, Section 7.1, *Work Control*. Maintenance history can be developed for SSCs through the Job Control System database. Procedures written as work instructions in the Job Control System Work Request are prepared and approved according to WHC-CM-1-8. Document retrieval is accomplished through a combination of manual and automated actions. Corrective and preventive maintenance and calibration information can be accessed through the Job Control System or through the contractor archives of completed work requests.

Engineering and maintenance personnel can use the records for activities such as failure analysis, conducting maintenance assessments, preventive maintenance, predictive maintenance, outage planning, improving the maintenance program, identifying needed equipment modifications and trending of SSC performance.

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CHAPTER 11.0
OPERATIONAL SAFETY

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CHAPTER 11.0
OPERATIONAL SAFETY

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LIST OF TERMS

ALARA	As Low As Reasonably Achievable
DOE	U.S. Department of Energy
FDH	Fluor Daniel Hanford, Inc.
FHA	fire hazards analysis
HFD	Hanford Fire Department
ORR	operational readiness review
POA	Plan of Action
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System

11.0 OPERATIONAL SAFETY

11.1 INTRODUCTION

Features of the Tank Waste Remediation System (TWRS) conduct of operations, fire protection, and readiness review programs are described in the following sections. This chapter provides a description of some of the essential features of the three programs as they relate to facility safety. Other elements of operational safety programs identified in DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1, are discussed in other chapters of this report. Chapter 12.0, "Procedures and Training," addresses training and procedure issues and Chapter 17.0 addresses notification, abnormal event investigation, and reporting practice issues. Chapter 17.0, "Management, Organization, and Institutional Safety Provisions," also addresses fitness for duty. HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, identifies minimum staffing levels and qualifications (Section 17.3.4). The programs discussed in this chapter as well as those programs discussed in Chapter 6.0, "Prevention of Inadvertent Criticality"; Chapter 7.0, "Radiation Protection"; Chapter 8.0, "Hazardous Material Protection"; and Chapter 9.0, "Radioactive and Hazardous Waste Management," ensure safe operations during normal or routine operations, as analyzed in the hazards analysis (Chapter 3.0, "Hazard and Accident Analyses").

Conduct of operations principles for operational safety are applied. Consequently, the level of requirements included in TWRS operational safety, fire protection, and readiness review programs is based on the magnitude of the hazards and complexity of the facility to the degree appropriate for a Hazard Category 2 facility as determined in Chapter 3.0.

11.2 REQUIREMENTS

Adherence to the following design codes, standards, regulations, and U.S. Department of Energy (DOE) orders is required for establishing the TWRS safety basis. This list includes only those requirements specific to this chapter and pertinent to the TWRS safety analysis described in this report.

- 29 CFR 1910.147, "The Control of Hazardous Energy (Lockout/Tagout)"
- 29 CFR 1926 Subpart K, "Electrical Safety"
- 29 CFR 1926 Subpart P, "Excavations"
- 29 CFR 1926 Subpart S, "Electrical Safety Practices"

- DOE O 425.1, *Startup and Restart of Nuclear Facilities*, Change 1, (1995)
- DOE 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, Change 4 (1993)[1]
- DOE 5480.7A, *Fire Protection*, Change 0 (1993)[2]
- DOE 5480.9A, *Construction Project Safety and Health Management*, Change 0 (1994)[3]
- DOE 5480.10, *Contractor Industrial Hygiene Program*, Change 0 (1985)[4]
- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1 (1992)
- DOE 5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities*, Change 0 (1993)[5]
- DOE-STD-3006-95, *Planning and Conduct of Operational Readiness Reviews (ORR)*, Change 0 (1995)
- RLID 5480.7, *Fire Protection*, Change 0 (1994).

11.3 CONDUCT OF OPERATIONS

Conduct of operations is a philosophical approach to performing tasks to achieve given results with minimum opportunity for error. The expectations for conduct of operations, listed

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[1]Attachment 2 Paragraphs 2c, 2d(2)-(3), 2e(1)-(8) cancelled by DOE O 440.1; Attachment 3 Paragraphs 2c, 2d(2)-(3), 2e(1)-(7) cancelled by DOE O 440.1. Compliance with DOE 5480.4 required until the Contracting Officer directs compliance with DOE O 440.1 or provides other direction to terminate compliance with DOE 5480.4.

[2]Cancelled by DOE N 251.4, DOE O 440.1, and DOE O 420.1. Compliance with DOE 5480.7A is required until the Contracting Officer directs compliance with DOE O 440.1 or DOE O 420.1 or provides other direction to terminate compliance with DOE 5480.7A.

[3]Cancelled by DOE N 251.4 and DOE O 440.1. Compliance with DOE 5480.9A is required until the Contracting Officer directs compliance with DOE O 440.1 or provides other direction to terminate compliance with DOE 5480.9A.

[4]Cancelled by DOE N 251.4 and DOE O 440.1. Compliance with DOE 5480.10 is required until the Contracting Officer directs compliance with DOE O 440.1 or provides other direction to terminate compliance with DOE 5480.10.

[5]Chapter II cancelled by DOE 5480.29; Chapter III Paragraphs 2a, 2b, and 2c cancelled by DOE O 231.1; entire order cancelled by DOE N 251.4 and DOE O 440.1. Compliance with DOE 5483.1A is required until directed by the Contracting Officer to comply with DOE O 440.1.

below, and maintenance management for the Site are established by Fluor Daniel Hanford, Inc. (FDH). The expectations include, but are not limited to, the following:

- Procedure use and compliance (adherence)
- Lock and tag compliance
- Work management
- Radiological work practices
- Management oversight.

Lockheed Martin Hanford Corporation is required to develop its own program to achieve FDH expectations and to continuously improve performance. The program will address the following:

- Requirements implementation, including changes
- Monitoring of activities, including management oversight and internal assessments
- Identification of conduct of operations issues
- Training and communications of conduct of operations requirements and procedures
- Corrective action resolution of conduct of operations findings from internal and external assessments
- Establishment of subject matter experts in conduct of operations
- Emergency preparedness planning and response.

The systems or programs developed at TWRS and discussed in Chapters 7.0, 8.0, 9.0, 10.0, 12.0, 13.0, 14.0, 15.0, 17.0; and the following subsections of this chapter, are designed to promote safe and efficient operations. The programs discussed in Chapter 7.0 and 8.0 and, specifically, the inclusion of radiation protection and industrial hygiene and safety procedures and controls in work packages, are designed to maintain exposures to radiological and toxicological hazards As Low As Reasonably Achievable (ALARA). Additionally, the emergency preparedness program, including pre-emergency planning activities and emergency response actions, are designed to minimize exposures to hazardous conditions following an accident.

The maintenance and in-service surveillance and inspection programs described in Chapter 10.0 and the quality assurance programs described in Chapter 14.0 are designed to ensure the availability of safety systems. The availability of safety systems is ensured by performing

required surveillances (as identified in HNF-SD-WM-TSR-006) and preventive or corrective maintenance activities. These activities reduce the potential for unwanted releases of radiological or hazardous materials.

The training program described in Chapter 12.0 is designed to train operations personnel in safe conduct of operations. TWRS operations are procedure driven; therefore, the procedure development program described in Chapter 12.0 incorporates TWRS radiological and industrial safety requirements.

Salient features of the TWRS conduct of operations program are summarized in the following subsections and in other chapters of this safety analysis report. Specific topical areas were selected from DOE 5480.19. TWRS guidelines for implementation of DOE 5480.19 requirements are contained in HNF-IP-0842, *TWRS Administration*, Volume II, "Operations." The shift manager is responsible for the safe operation of structures, systems, and components. All operations are conducted with shift manager approval. Shift operators report to the shift manager, and the shift manager reports to their manager.

Of the 18 conduct of operations chapters in DOE 5480.19, the following subsections address 14 of those chapters. The four chapters not addressed in the following include operations organization and administration, investigation of abnormal events, notifications, and operations procedures. Chapter 17.0 addresses operations organization and administration, investigation of abnormal events, and notifications. Operations procedures are addressed in Section 2.5 and Chapter 12.0.

11.3.1 Shift Routines and Operating Practices

TWRS procedures define standards for professional conduct to ensure operator performance meets DOE and facility management expectations. The following paragraphs summarize the aspects of routine TWRS shift activities and practices for standing watch that are important to safety.

11.3.1.1 Status Practices. The operators and shift manager or delegate are notified promptly (or each will notify the other) of all changes in facility status, operational abnormalities, or of any difficulties operations personnel encounter while performing assigned tasks. When applicable, changes are made to logbook entries and the status boards. Requirements for use and content of logbooks are contained in the tank farms administration manual, HNF-IP-0842.

11.3.1.2 Safety Practices. As part of the conduct of operations program, operators must follow the requirements of the Industrial Safety Program in accordance with WHC-CM-1-11, *Industrial Hygiene Manual*[6]; WHC-CM-4-40, *Industrial Hygiene Manual*; WHC-CM-1-10, *Safety Manual*; and HNF-SD-WM-HSP-002, *Tank Farm Health and Safety Plan*. Appropriate hearing, eye,

[6]Refer to Appendix G, "Site-Wide Controlled Manual Cross Reference Table," for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc. (FDH) procedures (e.g., HNF-PRO-XXX).

head, foot, and respiratory protection is worn in designated areas to reduce the potential for injury as part of compliance with WHC-CM-1-10 and WHC-CM-1-11. Similarly, operators working in the facility exercise appropriate precautions when working with or around potential hazardous objects (e.g., ladders, electrical equipment, other machines) or hazardous materials (e.g., chemicals, toxic materials, waste tank contents) to reduce personal injury. Radiological protection safety practices are covered in Chapter 7.0. Electrical safety practices are governed by 29 CFR 1910, "Occupational Safety and Health Standards," Subpart S. The work practices are implemented through administrative procedures contained in HNF-IP-0842 and the TWRS Health and Safety Plan (HNF-SD-WM-HSP-002).

11.3.1.3 Operator Inspection Tours. Operators conduct periodic inspection tours of their areas of responsibility to ensure that the status of equipment is known. These tours are conducted at designated times. During the tour, equipment is inspected to ensure that it is operating properly or, in the case of standby equipment, that it is properly aligned. The tour activities include, but are not limited to, inspection, troubleshooting, responding to alarms, housekeeping, logkeeping, and reporting deficiencies.

11.3.1.4 Tour Inspection Sheets. Tour inspection sheets are used to uniformly record the status and condition of equipment and areas. Using operator roundsheets and logs is an effective method of providing operators with guidance on the extent to which equipment and areas are inspected and providing a place to record events and status of the areas and equipment inspected. Also, limits on the sheets remind operators of important control parameters for safe operation. The operator uses the narrative section to document major evolutions, causes for abnormal conditions, and corrective actions taken to correct the abnormal condition. Additionally, the narrative section is used to document the notification of shift managers. The roundsheets and logs are monitored periodically by the shift manager/supervisor as part of the normal shift routine to ensure that inspection tours are being conducted as required, and that out-of-limit parameters are promptly corrected.

11.3.1.5 Personnel Protection. Personnel protection practices ensure that radiological, chemical, toxicological material, and other exposure hazards are maintained ALARA (Sections 7.4 and 8.4). Strict adherence to procedures and posted personnel protection requirements ensure (1) appropriate use of monitoring instruments, (2) cognizance of permissible exposure levels, (3) proper use of and adherence to radiation work permits, and (4) effective and accurate deficiency reporting practices.

11.3.1.6 Response to Indications. Instrument readings are considered accurate and responded to accordingly until inaccuracy is proven. Ignoring an unusual reading because an instrument is believed to be faulty can cause unsafe conditions to go undetected. In general, operators are trained to check other indications, if possible, when unexpected readings are observed. Prompt corrective action taken after observing abnormal or unexpected indications will usually reduce the effects of the abnormality.

11.3.1.7 Resetting Protective Devices. When protective devices (e.g., circuit breakers, fuses) trip, an attempt is made to understand the cause of the trip before resetting. Before action is taken, Operations ensures that no unsafe or abnormal conditions exist that would preclude reset.

11.3.1.8 Process Changes. The shift manager or delegate is accountable for ensuring safe operations and should, therefore, approve all process rate changes. An operator may, however, stop a process without manager or supervisor approval to respond to a facility emergency.

11.3.1.9 Authority to Operate Equipment. Operations shift managers ensure that operators of facility equipment possess the necessary procedures, training, and qualifications. Operation of equipment by other than authorized and qualified operators is expressly forbidden. Trainees under the direction of a qualified operator can operate equipment. Operators are trained to follow procedures. Nonroutine operations do not occur without specific approval by the shift manager or delegate. During emergencies, operators are trained to take specific actions to ensure the safety of personnel, the facility, and the environment without obtaining prior approval; however, the appropriate supervisors and managers are informed promptly of these actions. Operators are trained that safety is more important than facility production.

11.3.1.10 Shift Operating Bases. Shift operating bases are areas where operators return when not performing other assigned duties. Each operating base has the appropriate office and communication equipment for the operators.

11.3.1.11 Potentially Distractive Devices and Written Material. Use of entertainment devices (e.g., radios, televisions, tape players, computer games) by on-duty Operations personnel is prohibited to prevent distractions from their responsibilities. Unauthorized reading materials (e.g., newspapers, books) are not allowed, except in approved areas. Inappropriate material is not permitted or allowed to be brought into or posted in the facility.

11.3.2 Control Area Activities

There are no control rooms, in the classic sense, within the Tank Farms. There are operating stations, which during certain activities will resemble a formal control area. The appropriate operating stations will be staffed continually during waste transfers.

11.3.3 Communications

Numerous communication devices are provided for transmission of information within a facility (e.g., telephones, paging equipment, horns, bells, sirens, two-way radios). These devices are controlled to ensure that they do not detract from normal operations and are available in an emergency.

11.3.3.1 Emergency Communication Systems. All areas of a facility are provided with systems (e.g., horns, bells, sirens) for communicating facility emergencies. Areas where emergency

systems cannot be heard have alternate methods for alerting personnel. Emergency communication systems are tested periodically to ensure that they are functional. Telephones and two-way radios are used to pass information.

11.3.3.2 Public Address System. Use of the public address system is administratively controlled to avoid excessive paging and unnecessary announcements.

11.3.3.3 Contacting Operators. Oral instructions through face-to-face communications and use of telephones and radios provide the primary methods for communications among TWRS personnel. The emergency systems provide notification during an emergency by means of horns, bells, and sirens.

11.3.4 Control of On-Shift Training

Facility personnel being trained are carefully supervised and controlled to use the time of the trainee effectively to avoid mistakes during training operations and to ensure that the trainee receives training within the job environment with as much hands-on experience as possible. This training is conducted under the direct supervision and observation of a qualified person and is based on well-defined prejob knowledge requirements and objectives. The operator qualification program is based on instruction on the equipment being operated and on documentation of the training. Training is immediately suspended during unanticipated or abnormal events, accident conditions, or whenever the instructor believes suspension is necessary to ensure safe and reliable facility operation. The TWRS training program is described in more detail in Chapter 12.0.

11.3.5 Control of Equipment and System Status

Equipment and facility configuration is maintained within the design requirements through disciplined operation. Operators know the status of the equipment and operate systems using approved procedures. The shift manager is responsible for maintaining proper configuration and for authorizing status changes to major equipment and systems, which include all of the structures, systems, and components required to maintain the safety envelope as described in Chapter 4.0. Changes in the status of equipment and systems are reported to the supervisor or manager who authorized the change. Before first placing equipment or a system into operation, the individual components are checked for proper alignment and readiness for operation. The status of installed jumpers is communicated via the routing board. Changes to the routing board are controlled in accordance with administrative procedures. Roundsheets, logs, status sheets, turnover instructions, and other appropriate documentation provide administrative controls to ensure that operational limits are maintained.

Equipment deficiency identification and documentation (e.g., tags, logs, and status sheets) provide the necessary communication for removing equipment from active service until it is repaired, tested, and returned to service. The shift manager or delegate authorizes all activities on equipment that is important to safety. This includes Safety-Class and Safety-Significant SSCs

(Chapter 4.0, "Safety Structures, Systems, and Components"), which are required to maintain the safety envelope. The status of control panel and local panel alarms is readily available to operating personnel. Administrative Controls include instructions for operators during installation of temporary equipment and when equipment is revised. These communications ensure that operators have the latest information to enable safe operation of the facility.

11.3.6 Lockouts and Tagouts

As discussed previously, the expectations established by the FDH Conduct of Operations program include lock and tag compliance. Locks and tags are used on components that require special administrative control for safety or other reasons. Locks and tags are used for personnel or equipment protection. Administrative locks or procedures are used to control equipment (i.e., prevent unauthorized use). All personnel follow proper locking and tagging procedures. The lock and tag procedure implemented at TWRS (HNF-IP-0842) is based on the guidance provided in DOE-RL-SOD-INST-L&T.001, *Hanford Site Lockout/Tagout Program,* DOE 5480.19, and 29 CFR 1910.147 and meets all applicable requirements.

The lock and tag program protects workers against the unexpected release of hazardous energy or materials. Locks and tags are installed on isolating devices to ensure that work can be performed safely. That is, a lock and tag ensures that the isolating device and the equipment or system they isolate or control cannot be operated until the locks and tags are removed. Locks and tags can only be removed by authorized workers. Before initiating work, the work package is reviewed to ensure the isolating boundaries have been properly identified (i.e., documented and verified using as-built drawings, specific written procedures, or system and work package walk-downs). The work package is also reviewed to determine the impact of the isolating boundaries with respect to work scope, personnel safety, facility operability, configuration control, public and environmental protection, and compliance with Technical Safety Requirements (TSRs). Before initiating work, personnel shall perform a zero energy check on machines or equipment that has been locked or tagged out.

11.3.7 Independent Verification

Independent verification is the act of checking equipment component position independently of activities related to establishing the component's position. Components may also require independent verification checks (1) when designated equipment is returned to service after maintenance and testing, (2) during recovery from extended shutdowns, and (3) when components that are critical for normal operations are identified. Operators are trained to perform independent verification of component positions and to regularly consult the procedures and other reference materials that provide instructions on independent verification techniques.

11.3.8 Logkeeping

Narrative logbooks are established and maintained to provide an accurate history of facility activities and to provide tools for reconstructing off-normal events. The logbooks provide accessible information and data associated with normal operation, testing, and off-normal activities for review by facility personnel. The logbook permits evaluation of the following activities:

- Equipment and facility condition and status, including transient and problem areas
- Operations, including accountability, shift-to-shift transfer of information, tracking of problem areas, ensuring compliance with reporting requirements
- Deviations from or compliance with safety analysis requirements (i.e., TSR surveillances).

11.3.9 Operations Turnover

TWRS Operations personnel turnover guidelines are established and proceduralized to ensure that information required to adequately perform shift operations is documented by the off-going shift and reviewed by the oncoming shift. Hence, operators will have an accurate picture of overall facility status. Oncoming personnel review documentation such as daily operating roundsheets, logbooks, and checklists before assuming responsibility for their shift position. Off-going shift managers and operators are responsible for documenting equipment status, making entries on the roundsheets and logs, and apprising oncoming personnel of equipment status.

11.3.10 Operations Aspects of Facility Chemistry and Unique Processes

The Tank Farms do not perform any unique processes. There are no processes within the Tank Farms that require operators to monitor the chemistry of a process and make chemical adjustments based on their analysis. The only chemistry adjustments are by batch additions to the process based on engineering direction. The Tank Farms do not process the waste; waste is stored and staged for processing.

11.3.11 Required Reading

The required reading program directs the communication of written items pertaining to the safety of personnel, equipment, and the environment. This written information is distributed to personnel by their managers with a listing of the required reading material, a tracking sheet of the

required reading material, and an acknowledgement sheet for the reader to indicate that the reading has been completed. An auditable file containing this information is maintained.

11.3.12 Timely Orders to Operators

Timely orders allow management to rapidly disseminate essential short-term information and administrative instructions to personnel in a timely manner to support operational activities. The timely orders contain concise information that is dated and segregated into daily and long-term orders. A timely order is not used to change facility operating procedures but can be incorporated into the appropriate procedure when the information is essential to facility operations.

11.3.13 Operator Aid Postings

An operator aid is a posting, diagram, sample schematic, or similar instruction intended to assist operators in performing their duties. Facility managers and supervisors approve all operator aids using an authorization form before entering a copy of the operator aid into the operator aid logbook. These aids may reference procedural steps. Operator aids are posted close to the area of expected use but do not establish the facility operations baseline. The operator aids are periodically reviewed to ensure they are correct and necessary. Outdated operator aids are removed.

11.3.14 Equipment and Piping Labeling

The existing TWRS equipment and piping labels are being upgraded through a standardized labeling program. The TWRS labeling program provides unique identification of components that require labeling (e.g., valves, dampers, instruments, pipes, major equipment, motor control centers, room doors, emergency equipment, and fire protection systems). The labels are designed and oriented to be visible and easily read. They are posted adjacent to the component. The program upgrade will use permanent labels that conform to DOE guidelines and other accepted standards for equipment and piping labels (DOE 6430.1A, *General Design Criteria*; NUREG-0700, *Guidelines for Control Room Design Reviews*; MIL-STD-1472C, *Military Standard Human Engineering Design Criteria for Military Systems, Equipment, and Facilities*).

11.4 EXCAVATION

Excavation program controls are established to prevent the occurrence of spray leaks from ruptured underground waste transfer lines. The following controls are implemented:

- Establish excavation permit procedures
- Coordinate waste transfers with planned and in-progress excavations and with the emergency response process
- Provide surveillance of all transfer lines through which waste is being transferred during the initial stages of an excavation.

Controls are established for routine or normal excavations, emergencies, fire breaks outside of a protected area, and soil sampling or removal of contaminated surface soils. An excavation permit is not required in a radiologically controlled area for routine soil samples taken by Health Physics personnel or hand removal of contaminated surface soil for contamination control, provided the excavation complies with the above requirements.

An excavation permit is not required for excavations less than 30 cm (12 in.) deep. All buried utility and waste transfer lines are buried deeper than this limit (i.e., 30 cm [12 in.]).

An excavation permit is not required for the cutting of firebreaks in an emergency for all areas, except inside protected areas. This authorization is in accordance with a pre-fire plan discussed before each fire season by Pacific Northwest National Laboratory and the Hanford Fire Department.

Excavation permits are not required when the excavation is determined by the responsible person to be emergency in nature and immediately necessary to ensure worker safety or to protect Site systems, services, or structures. Within 4 h of the beginning of an emergency excavation, notifications are required in accordance with the requirements discussed in Chapter 15.0.

Routine or normal excavations can be initiated following issuance of the excavation permit (WHC-CM-1-10). Before starting, all known underground objects need to be properly identified on the excavation permit sketch. Excavation work can be authorized after ensuring requirements for a safe work boundary are established. The facility/system must be in proper configuration to support excavation safety, including lock and tag requirements of WHC-CM-1-10, Sections G-1, "Operations Lock and Tag Program"; G-2, "Construction Lock and Tag Program"; and G-3, "Utilities Lock and Tag Program."

Excavation activities are required to be performed safely and in accordance with approved procedures and applicable statutes. Excavations can be performed (1) using mechanical means to dig below existing grade and beyond 1.52 m (5 ft) from the edge of a known structure, (2) by hand-digging or using air/vacuum to a depth >30 cm (1 ft) and within 1.52 m (5 ft) from the edge of a known structure, and (3) using any excavation (mechanical or hand-digging) belowgrade in

known contamination areas. Any unplanned damages, injuries, or releases are evaluated in accordance with WHC-CM-1-5, *Standard Operating Practices*, Section 7.1, for reporting of occurrences. The following are specific requirements.

- No excavation is permitted within 4.56 m (15 ft) of an ongoing waste transfer.

- Hand digging only is allowed within 1.52 m (5 ft) of known buried items (e.g., waste transfer lines, buried steam, water, sewer, electrical cable, power poles, piping, security systems, telephone, instrument, and alarm and control systems) and any "unknown" utility indications.

- The requirement for hand digging within 1.52 m (5 ft) either side may be waived by the facility/system owner if a marked utility is completely exposed through pot-holing by noninvasive excavation methods such as hand digging or air/vacuum excavation. The responsible engineering organization provides written direction for any exceptions to this requirement.

- When unknown or unidentified field conditions or deviations (deviations include unrecorded and misrecorded utilities as well as specified items that are not found) between the composite map and existing drawings are discovered during excavation, the excavation coordinator and the cognizant/project engineer are notified. Approval by the facility manager or designee is required before proceeding with the excavation.

- When a suspect waste (discovery site) or existing waste site is disturbed during excavation, all excavation activities are stopped. As required in WHC-CM-7-5, *Environmental Compliance*, Environmental Monitoring and Investigation is notified immediately.

11.5 FIRE PROTECTION

This section summarizes the TWRS Fire Protection Program and identifies its features, organization, and safety basis for the tank and other facilities operated and managed by TWRS.

11.5.1 Fire Hazards

A fire hazards analysis (FHA) (WHC-SD-WM-FHA-020, *Tank Farms Fire Hazards Analysis*) has been developed for TWRS facilities according to DOE 5480.7A. The FHA comprehensively assesses the risk from fire at TWRS facilities to evaluate whether (1) the potential for the occurrence of fire is minimized, (2) a potential fire will cause an onsite or offsite release of radiological and other hazardous materials that will threaten the public health and

safety, or the environment, (3) implemented requirements will provide an acceptable degree of safety to workers, (4) the public is not subjected to undue hazards from fire and its effects in DOE facilities, and (5) safety systems will not be damaged by fire. The following discussion summarizes the conclusions from the FHA.

Although the FHA evaluated all TWRS facilities within the scope of the Final Safety Analysis Report, the most significant fire hazards are inside the tanks themselves and in the associated transfer systems. The primary consequences from such incidents are a potential loss of confinement and subsequent dispersion of toxicological/radiological materials. The primary fuels for these internal tank events are gases generated within the wastes that eventually enter the headspace of the tank, solvents that float on the surface of the waste, or organic salts contained within the waste. Hazards associated with aboveground facilities are mainly combustible construction materials and transient combustibles.

The hazards posed by the tank farms are unusual in terms of a fire hazard analysis because of the uniqueness of the equipment and facilities associated with operations (as compared with buildings). The DOE orders governing the FHA presume that ignitions will occur and sufficient fire protection systems should be in place to control the fire and resulting damage. The hazards in these tanks are such that no fire protection system exists that can reasonably be expected to mitigate the event once initiated. Therefore, methods for preventing the formation of flammable gas mixtures in the tank headspaces because of episodic releases should be implemented. Similar accidents are discussed in Chapter 3.0. Controls for such accidents can be found in Chapter 5.0.

Other fire hazards, including those in the outdoor environment, were evaluated by the FHA, but were not included in this discussion, because the hazards had an insignificant impact on the facilities and equipment.

11.5.2 Fire Protection Program Policy and Organization

The fire protection program for TWRS facilities is structured and implemented according to the safety management policies, philosophies, and the criteria identified in WHC-CM-4-41, *Fire Protection Program Manual*.

Fire Protection Program Policy. According to WHC-CM-4-41, contractor responsibilities applicable to safety for fire protection include the following:

- Minimize the potential for the occurrence of a fire or related perils by implementing industry standards and reduced-risk criteria on fire protection and prevention.

- Ensure that fire does not cause an unacceptable onsite or offsite release of hazardous material that will threaten the public health and safety or the environment.

- Establish requirements consistent with NFPA 101-1994, *Life Safety Code*, to provide an acceptable degree of life safety to DOE and contractor personnel and to ensure that the public will not be exposed to undue hazards associated with fire and its effects in DOE facilities.

- Ensure that process controls and safety systems are not damaged by fire or related perils.

This policy applies to all subcontractors and managed facilities, programs, projects, and activities.

Fire Protection Program Organization. According to WHC-CM-4-41, different aspects of the fire protection program are administered or addressed by various organizations as follows:

- **TWRS Environment, Safety and Health and Quality Assurance**—Provide program development and interpretations, independent review, and technical engineering support in the field and to the facilities.

- **Hanford Fire Department (HFD)**—Provides fire suppression, fire system inspection, testing, maintenance, repair, hazardous material response, and medical response for TWRS facilities.

- **Tank Waste Operations**—Implement and maintain the Fire Protection Program at TWRS. This is accomplished by incorporating program requirements into operating procedures, work plans and design documents, and specifications.

11.5.3 Combustible Loading Control

Combustible loading administrative controls and procedures are implemented according to the FHA and contractor procedures (including WHC-CM-4-41). A fire protection program is a required control according to TSR controls. TSR ignition controls also address flame cutting/welding. The fire protection program is established in HNF-IP-0842, Vol. IX, Section 5.1. These controls prevent or minimize the accumulation of flammables, combustibles, and reactives and address all facets of facility operation. The essential requirements include: controlling hot work, flammable/combustible liquids, combustibles, construction sites, oxidizing materials, pyrophoric materials, hazardous material storage, and waste absorbent material.

TWRS procedures designate specific combustible controls and inspections. Adherence to these procedures minimizes the buildup of waste and combustible materials at TWRS facilities.

11.5.4 Firefighting Capabilities

Based on the fire hazards identified in both the FHA and Chapter 3.0, the following discussion summarizes available firefighting equipment, fire response procedures, basic training

and personnel qualifications for firefighters, and special precautions taken for fire fighting in radiological and hazardous chemical environments. HFD emergency actions and system capabilities are discussed in Chapter 15.0.

11.5.4.1 Firefighting Equipment. The HFD supplies, operates, and maintains firefighting equipment used at TWRS. Vehicles contain specially equipped fire/emergency response equipment, including first-line equipment and second-line (reserve or backup) equipment. The initial response (first-line) vehicles in each station are combination aerial device/pumper units, which are commonly referred to as "quints" (vehicles having a pump, water tank, hose, and hydraulic aerial ladder or boom).

The remaining engines in each station are designated as backup (reserve or second line). Pumpers typically equipped with a pump, water tank, and hose—but without a hydraulic aerial ladder or boom—are sometimes referred to as "triple combination pumpers." The HFD reserve pumpers are triple-combination pumpers. The terms "pumper" and "engine" are used interchangeably, the technical difference being that a "pumper" is a vehicle and an "engine" is that same vehicle with a crew.

The quints are used as the first-response units because of their aerial capabilities. The quints can be used to set up a water curtain or provide roof access during the initial response. The triple combination pumpers do not have aerial capabilities and are dispatched only if needed to assist the first-response quint equipment.

The rescue truck is used for specialized rescue operations. It contains various types of equipment. This unit also acts as a support vehicle at hazardous material incidents.

The hazardous material truck is equipped with specialized equipment, clothing, tools, drinking materials, adsorbents, plug and patch kits, sniffers, and a computerized database with specific response information.

The brush trucks are equipped with a portable fire pump and a 760-L (200-gal) water tank. These units provide quick response capabilities for extinguishing small spot fires. Brush tankers/pumps are used for rangeland fire fighting.

A chemical truck, which is equipped with a 227-kg (500-lb) container of the inerting type of dry chemical, is used for extinguishing sodium and lithium fires.

The command/utility vehicles are 4-wheel drive trucks that provide easy access for fire department personnel responding to an alarm from offsite.

The HFD provides prehospital emergency medical services to all individuals on the Hanford Site. These services are provided by cross-training fire suppression personnel to perform these essential life-support tasks.

11.5.4.2 Fire Response Procedures. Currently, when a fire is reported, the protocol is to dispatch a quint and an ambulance from the closest station and a quint from the next closest station. A second alarm response would dispatch remaining ambulances and the quint from the third closest station.

11.5.4.3 Basic Training and Personnel Qualifications for Firefighters. The HFD is responsible for training its employees, including line personnel, test and services firefighters, and system maintenance crafts people. The HFD also provides fire extinguisher use training for Hanford Site workers. Training records that document the levels achieved by individual HFD members using the National Fire Protection Association professional qualification standards are maintained. HFD members are trained to respond to events that occur in radiological and hazardous material environments. The division of fundamental responsibility among HFD Staff is as follows:

- The Hanford Fire Marshal, who functions as "Team Leader," is responsible for managing the HFD training program.

- The station captains are responsible for leading training sessions in their respective stations.

- The battalion chiefs are assigned a monitoring function.

The HFD provides for the continuing medical education of paramedics through attendance of advanced cardiac life support, pediatric advanced life support, and advanced trauma life support classes.

11.5.4.4 Fire Fighting in Radiological and Hazardous Material Environments.

Radiological Environments. A policy regarding requirements and responsibilities for fire fighting and other emergency activities in radiation zones has been established (WHC-IP-0939, *Hanford Fire Department Implementing Procedure*). The policy applies to all members of the HFD and addresses emergency operations and training. The policy identifies personnel responsibilities; precautions for wild land fires involving radiation zones; and requirements for protective equipment, dosimetry, and emergency dose limits.

Hazardous Material Environments. A hazardous materials emergency response plan and a hazardous materials operations plan are maintained by the HFD. The emergency response plan is a general outline for all hazardous material responses designed to meet the requirements of NFPA 472-1992, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*. The operations plan is a step-by-step listing that includes specific actions that need to be taken during an incident.

The HFD preplanning for potential hazardous materials incidents is documented in an HFD hazardous materials response plan. Known hazardous materials and radiological hazards are summarized in the building prefire plans.

Implementing procedures that establish a general operational and tactical approach to hazardous materials incidents have been drafted. The procedures identify specific duties and responsibilities for dispatch and the first arriving unit, as well as provide guidance concerning incident size-up, formulation of an action plan, establishment of hazard control zones, use of non-HFD personnel, and general tactics based on the level of incident severity.

11.5.5 Firefighting Readiness Assurance

11.5.5.1 Fire Prevention. The fire prevention program of the HFD is administered and enforced under the authorities granted by the DOE, Richland Operations Office, to the Hanford Fire Marshal as identified in RLID 5480.7.

Other elements of the fire prevention program include support of building manager responsibilities by performing code-required annual inspection of ignitable/reactive waste sites (WHC-CM-4-41) and inspection (as requested by the facility) of confined spaces for rescue feasibility (WHC-CM-1-11, WKH 5, "Confined Space Program").

Maintenance, tests and inspections, and random record audits are conducted on an annual basis. Witnessing of acceptance test procedures has been delegated to the Manager, Fire Protection Systems Administration and Testing. Explicit inspection of exits according to Chapter 31 of NFPA 101-1994 is not typically conducted because this requirement is covered by other aspects of the sitewide fire protection program such as the building fire protection assessments required by RLID 5480.7 and DOE 5480.7A. The use of a formal permitting process as outlined in NFPA 1, *Fire Prevention Code*, Sections 1-15, is limited.

11.5.5.2 Types and Frequencies of Fire Safety Drills and Exercises. In association with the Hanford Site Emergency Preparedness organization, the HFD may participate in Hanford Site emergency exercises. These exercises are managed by the Hanford Site Emergency Preparedness organization and are scheduled on a monthly basis. Field exercises requiring full HFD participation are typically conducted on a quarterly basis. Desktop exercises requiring HFD participation in the form of representation (typically, by an incident commander) are generally conducted on an annual basis. The HFD may be requested by the building/facility manager to participate in building fire drills.

11.5.5.3 Fire Protection Recordkeeping. The Hanford Fire Marshal maintains records on the following items:

- General examinations and approvals conducted by the Hanford Fire Marshal
- Fire prevention inspections and findings
- "Permitted" areas or operations
- Fire investigations
- Fires
- Hanford Site project reviews in support of the Site Selection Review Board.

Records of all fire protection system acceptance testing are maintained by the HFD Manager, Fire Protection Systems Administration and Testing. Other fire protection records (i.e., fire extinguisher inspections, fire barrier inspections) are maintained by facility management. All records are maintained according to WHC-CM-4-41, Section 2.7, "Fire Protection Records."

11.5.5.4 Prefire Plan Procedures. Written prefire plans are developed by HFD members exclusively for use by fire department members. The plan supplies important information concerning the occupancy of a building, type of building construction, water supply, fire protection features, types of hazards contained within the structure and building layout for access and escape routes. The plan provides knowledge of factors and conditions that enable command officers to make educated fire behavior predictions and reliable estimates of the resources they will need to control the situation (WHC-SD-WM-FHA-020).

11.6 OPERATIONAL READINESS REVIEW

The purpose of the operational readiness review (ORR) process is to provide an independent review of the facility to ensure that the facility can be started and operated within its approved Authorization Basis. The ORR validates that line management responsible for the facility has successfully achieved a state of readiness to commence facility operations within the Authorization Basis.

ORRs are required by DOE 425.1A for startup of new nuclear facilities or restart of a nuclear facility. The DOE and contractor are required to determine if an ORR is required based on the following conditions:

- Initial startups of new Hazard Category 1, 2, and 3 nuclear facilities
- Restart after a nuclear facility unplanned shutdown directed by a DOE management official for safety or other appropriate reasons
- Restart after an extended shutdown for Hazard Category 1 and 2 nuclear facilities. Extended shutdowns for Hazard Category 1 and 2 nuclear facility are 6 and 12 mo, respectively
- Restart of Hazard Category 1 and 2 nuclear facilities after substantial process, system, or facility modifications that require changes in the safety basis previously approved by DOE
- Restart after a nuclear facility shutdown because of operations outside the safety basis
- When deemed appropriate by DOE officials, including restarts of Hazard Category 3 nuclear facilities.

TWRS, with agreement from DOE, can perform readiness assessments for the restart of or startup of selected activities. A readiness assessment is typically performed when all or portions of an operation, process, or facility may be shut down for the routine replacement of equipment, systems, or components (including unanticipated failures); however, before performing a readiness assessment, the line manager receives concurrence from DOE in the form of a Plan of Action (POA). The POA provides a description of the facility or activity in sufficient detail to effectively bound the project, proposed review type and approval authority, and justification for performing a readiness assessment. The justification describes the hazard classification of the facility, the safety basis, and the selection of a readiness method. The following are general conditions that require a readiness assessment:

- Initial startup of all radiological facility program work
- Initial startup of radiological program activities in an existing facility
- Restart of radiological program work following other than a routine shutdown event
- Restart after an extended shutdown for a less than Hazard Category 2 facility; extended shutdown is 12 mo or greater
- When a readiness review is deemed appropriate by DOE or the Lockheed Martin Hanford Corporation Director of Operations.

TWRS implements the readiness review process described in DOE 425.1A and WHC-CM-1-5, Section 1.2, "Startup and Restart of Facilities," whenever a nuclear facility is started or restarted. Guidance on approaches and methods approved as acceptable for implementing the requirements of DOE 425.1A are provided in DOE-STD-3006-95. This guidance is used in TWRS to assure planning and conduct of readiness reviews support safe startup or restart of facilities. Readiness review plans and certification/verification documentation applicable to TWRS startups or restarts are prepared, and review teams are selected, according to the provisions of DOE 425.1A.

11.6.1 General Readiness Review Program Requirements

The objective of a readiness review program is to establish the requirements for startup of new nuclear facilities and for restart of existing nuclear facilities that have been shut down. The DOE programmatic requirements specify a readiness review process that, in all cases, demonstrates it is safe to start or restart a facility. A facility is started or restarted only after documented independent readiness reviews have been conducted and the appropriate contractor and DOE approvals are received. It is incumbent on the facility management to have the facility ready for operation before declaring readiness. The ORR shall not be used as a management technique to achieve this state of readiness.

A minimum set of core requirements is addressed when developing the extent to which each TWRS ORR or readiness assessment will be conducted. The list of core requirements is provided in DOE 425.1A. Additional core requirements may be added to supplement the minimum set. Requirements for readiness review final report content are also identified in DOE 425.1A.

11.6.2 Contractor Roles and Responsibilities

Contractor roles and responsibilities for readiness reviews are identified in DOE 425.1A and WHC-CM-1-5, Section 1.2. TWRS adheres strictly to that guidance. The contractor is responsible for the following:

- Preparation of implementing procedures for use in performing startup and restart activities
- Preparation of planning documents for ORRs and readiness assessments and submittal to DOE for review and comment as applicable for the startup or restart activity
- Preparation of implementing documents for ORRs and readiness assessments and submittal to DOE for review and approval as applicable for the startup or restart activity
- Notification to DOE for all startups or restarts and designation of the contractor startup or restart Approval Authority for each activity
- Conduct of ORRs and readiness assessments
- Notification to DOE of readiness of the facility for startup or restart
- Designation of readiness review or readiness assessment teams.

11.6.3 Contractor Plans

ORR and readiness assessment plans and assessment criteria are prepared to meet the requirements of DOE 425.1A. The plan of action for ORRs or Readiness Assessments describes how the readiness review will be conducted and establishes prerequisites for initiating the review. An implementation plan for ORRs, or Readiness Assessments, contains the readiness review actions and readiness verification criteria.

11.6.4 Contractor Reporting Requirements

TWRS provides documentation and final reports according to DOE 425.1A requirements for all ORRs and readiness assessments to document the results of the ORR or Readiness Assessment. The final reports are prepared and approved by the team leader. The reports contain a listing of all prestart or poststart items and are used by the contractor Approval Authority as a basis to grant approval for startup or restart. The final report contains a "lessons learned" section that may be applied to future readiness reviews or assessments.

11.6.5 U.S. Department of Energy Requirements

For an ORR, DOE reviews and approves the contractor Plan of Action, and reviews and comments on the Contractor's Implementation Plan. After the contractor declares readiness, and the line management has verified the contractor's readiness to commence operation, then DOE conducts an independent ORR. After successful completion of the DOE ORR, the Approval Authority will authorize startup of the facility.

For a readiness assessment, DOE approves the POA, and depending on the requirements of the approved POA, DOE may conduct its own independent readiness assessment. Once the requirements of the POA have been met, the Approval Authority specified in the POA can authorize startup of the facility.

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CHAPTER 12.0
PROCEDURES AND TRAINING

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LIST OF TERMS

DOE	U.S. Department of Energy
OSD	operating specification document
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
USQ	Unreviewed Safety Question

12.0 PROCEDURES AND TRAINING

12.1 INTRODUCTION

Tank Waste Remediation System (TWRS) procedures and training programs are described in this chapter. The procedures and training programs have been implemented to ensure that personnel are well qualified and prepared to safely perform all tasks involved in the tank waste programs. The success of these programs depends on (1) the involvement of TWRS staff and management in the development of procedures and training content and (2) feedback that ensures continuous improvement. TWRS management understands the importance of good procedures and training in achieving the highest level of safety in the operations and maintenance of the facility and actively supports the participation of TWRS staff in the systematic approach used by this organization. The procedures and training program descriptions that define the processes used to meet program requirements are contained in HNF-IP-0842, *TWRS Administration*.

12.2 REQUIREMENTS

TWRS commitment to safe operation of the facility is demonstrated by procedures and training that satisfy the following U.S. Department of Energy (DOE) and federal requirements:

- 10 CFR 830.120, "Quality Assurance"
- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1 (1992)
- DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, Change 0 (1994).

12.3 PROCEDURES PROGRAM

The TWRS procedures organization develops and implements processes that ensure compliance with applicable requirements in DOE 5480.19. Procedure development and control processes are based on HNF-IP-0842, Volume I, Section 2.1, "Procedure Development and Maintenance, Volume I, Section 2.11, "Technical Procedure Control and Use" and Volume 1, Section 2.12, "Management Directives." These standards provide the requirements for identification of need, preparation, verification, review, approval, change, use, and periodic review of Hanford Site Technical and Administrative procedures.

Administrative procedures have been developed to comply with HNF-IP-0842, Volume I, Section 2.1, which defines technical procedure development and use requirements. These

practices ensure safe operations by requiring strict adherence to operating procedures, Technical Safety Requirement (TSR) controls, sound operating practices, configuration management principles, and As Low As Reasonably Achievable principles (Sections 7.4 and 8.4). Company policy and administrative procedures further require compliance with operating, maintenance, emergency, and alarm response procedures.

Procedures are divided into three categories: continuous use, reference, and routine. For nonroutine work with increased risk to the worker or the public, the worker uses the procedure as a step-by-step instruction while performing the task (continuous use). For repetitive tasks, the worker may not need to reference the procedure (routine). For other tasks, the procedure needs to be available for the worker to reference. Further description of these designations is found in HNF-IP-0842, Volume I, Section 2.11, "Technical Procedures Control and Use." TWRS work activities are carried out in accordance with written procedures available at the work site. In all cases the process described in the current procedure must be followed. The extent to which written procedures must be actively used by workers is a function of the frequency with which the work activity is performed, the complexity of the work activity, and the consequences of incorrect performance to the safety of facility personnel, facility equipment, and the environment. All TWRS personnel have the authority to stop work should an unsafe condition arise.

DOE 5480.23, *Nuclear Safety Analysis Reports*, requires a discussion of Safety-Significant administrative controls (Chapter 5.0) and procedures. At TWRS, Safety-Significant administrative controls (in the form of TSRs) are protected by lower-level operating documentation. The first level of documentation immediately below the TSRs are operating specification documents or OSDs. In OSDs, operating limits are set at levels below those specified in the TSRs. The limits specified in the OSDs may be further reduced in the plant operating procedures (second level of documentation, equivalent to the DOE 5480.23 Safety-Significant procedures). This hierarchy of documents has been devised to ensure that the TSR limits are protected to the highest degree possible at the operating level. The function of the procedure organization is to ensure this hierarchy of documents promotes compliance with TSR limits.

The TWRS procedures organization develops, maintains, and controls the procedures addressing normal and abnormal operations, emergency operations, and surveillance and maintenance activities, including testing and calibration of equipment. This organization will (1) provide administrative and technical writing support to ensure that procedures are technically correct and easy to use and (2) provide operators with the most recent version of procedures at all times. Procedures for the calibration of radiation monitoring instruments are discussed in Chapter 7.0, and procedures for calibration for Industrial Hygiene and toxicological monitoring are discussed in Chapter 8.0. Those processes involve TWRS management and staff in development and control of the procedures used to guide administration, operations, and maintenance. Industrial Hygiene and Radiological Control have developed structured processes consistent with the guidance contained in HNF-IP-0842, Volume I, Section 2.11.

12.3.1 Development of Technical Procedures

A structured procedure development process implementing HNF-IP-0842, Volume I, Section 2.11 requirements ensures safe operations by communicating requirements for safe performance of tasks. These processes are applied to the development of all technical procedure types (e.g., operation, maintenance, alarm response, emergency response, fire protection, and surveillance). This development process is documented in HNF-IP-0842, Volume I, Section 2.11, and HNF-PRO-229, *Technical Procedure* Standard, and includes all activities from the identification of the need for a procedure to the distribution of the procedure. Major steps in the procedure development process are discussed in the following subsections.

12.3.1.1 Need Identification. The need for a new or revised procedure may be identified when modifications in the conduct of an operation are implemented or when a procedure is deemed inadequate during task performance. Changes in procedures may also be initiated following new hazards and accident analyses, which result in the implementation of new TSR controls or procedures. Operations, maintenance, engineering, or oversight supporting organizations can initiate procedure changes or new procedure development. The identification of new procedures or changes to existing procedures can be initiated at all levels. However, line management is responsible for initiating the actual procedure writing activities. Before initiating changes or new procedures, an Unreviewed Safety Question (USQ) screening is performed to ensure that the Authorization Basis is not impacted.

12.3.1.2 Develop the Technical Basis. During the technical draft development phase, a subject matter expert gathers the information that will be used as the technical basis for the procedure. Technical basis information includes process and equipment data; safety data, including lessons learned (e.g., Site, DOE, industry); USQs; commitments relative to the Authorization Basis; and data that may affect the ability of facility personnel to respond to abnormal or emergency situations.

Following this initial data gathering, a task analysis is performed on each step in the process. Sources of information for the task analysis include relevant source documents, drawings, TSR controls and other safety documents, interviews with subject matter experts and operators, and inspection of the facility or equipment. This data forms the technical basis for the procedure and provides the necessary information to draft a procedure that will lead to safe and effective task performance.

12.3.1.3 Prepare the Draft. A draft procedure is prepared consistent with the requirements of DOE 5480.19 and HNF-IP-0842, Volume I, Section 2.11. HNF-IP-0731, *TWRS Plant Operations Procedure and Alarm Response Procedure Format and Preparation Guide*, was modeled after DOE-STD-1029-92, *Writer's Guide for Technical Procedures*. HNF-IP-0731 is used to ensure that the format and content of each procedure are consistent, that procedure steps are written to effectively communicate required actions, and that the procedures incorporate human factors principles leading to effective procedure use. The Procedure Writer does not prepare the draft procedure independently but works directly with the end user and the subject matter expert (typically the Cognizant Engineer).

12.3.1.4 Verify the Draft Procedure. The review process is guided by HNF-IP-0815, *TWRS Field Verification and Validation Guidelines*. Verification is the process of objectively analyzing a procedure to determine if it is technically accurate and correctly written. The verification process takes place under the direction of the Cognizant Engineer/shift manager. During verification a person, other than the writer, who is technically qualified evaluates the procedure against the source material to ensure the technical information is accurate, complete, current, and clear. Procedure verifiers use a check sheet to ensure the facility can continue to operate within its design basis and the procedure supports safe operation. In the course of verification, the content of the procedure is compared with the established Technical Basis to include a review of the following:

- Technical codes and standards
- TSR controls
- Accident analyses and other safety data
- Operating limits and acceptance criteria
- Accuracy and sequence of procedure instructions
- Representation of expected operational configuration.

During the validation portion of the review process, the procedure is checked for usability, human factors considerations, correctness, and compatibility with the system equipment by a person technically qualified and under the direction of the shift manager/maintenance manager. The goal of validation is to ensure that the procedure can be effectively performed by operations/maintenance personnel. Validation includes determining if the procedure is user friendly and is compatible with the facility. Level of detail, sequencing of steps, job performance aids, acceptance criteria, and warning and caution statements are reviewed for user friendliness. Validation for plant compatibility includes a review of the equipment nomenclature, equipment location, instrumentation, and of the tools, instruments, materials, and staffing levels needed to perform the procedure.

12.3.1.5 Procedure Review and Approval. New procedures, procedure revisions, and technical changes to procedures are reviewed and approved according to the contractor approval designator requirements (WHC-CM-3-5, *Document Control and Records Management Manual*[1]). The technical authority ensures that USQ screenings and evaluations are performed. The design
ated approvers verify that environmental, safety, radiological control, and quality assurance requirements have been properly addressed. Reviews, in addition to those specified by the technical authority, may be conducted as needed. All comments are resolved before release. Document approval is indicated by a signature from the designated reviewers. At the completion of the review and approval process, final approval is indicated by a signature from the functional area manager. A document approval matrix is used as a grading mechanism for the review of new

[1]Refer to Appendix G,"Site-wide Controlled Manual Cross Reference Table," for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc, (FDH), procedures (e.g., HNF-PRO-XXX).

or revised safety-related procedures. In addition, all procedures affecting safety are reviewed and approved by the cognizant engineer, manager, and independent organizations. All procedures are reviewed for personnel safety by the related discipline experts (e.g., industrial, radiological, fire protection) as directed by the administrative procedure.

The procedure review and approval process ensures that any new procedure or procedure change is coordinated with the training department before release. During the review, training management is notified that a new procedure is being developed. New task requirements imposed by the new procedure or by the procedure change are evaluated and applicable changes in training program content are implemented. Shift management coordinates and schedules any additional training (e.g., on-the-job training) before release of the procedure. Training is completed before use of the new or revised procedure. Workers primarily train for new or revised procedures on the job, on the same equipment they will be using. Depending on the complexity of the new or revised procedure, workers may train in the classroom, walk through the procedures, have increased supervision, or undergo a combination of training types. The procedure will be revised if, during training, the procedure is not usable or compatible with the facility.

12.3.1.6 Procedure Release and Use. Prior to issuance, all procedures are assigned a procedure and revision number and notification is sent to end users. A paper "controlled copy" is placed into the procedure master file, as required by HNF-IP-0842, Volume I, Section 2.11, and an electronic copy is placed into a read-only database that contains current copies of all procedures. All applicable managers, including shift managers, are notified via an electronic mail memo that a new procedure or procedure change has been released for use following approval by the line and oversight organizations. The shift managers are directed to print a copy for their controlled procedure file. When operations personnel need a procedure, a working copy is printed from the electronic file, or the controlled copy is copied and "working copy" is stamped on the procedure.

12.3.2 Maintenance of Technical Procedures

The safety of the facility and the facility personnel is affected by the availability of operating, maintenance, alarm response, and emergency response procedures that correspond to the current plant configuration. To ensure that personnel only use the most current procedures, TWRS has implemented administrative procedures for review, approval, change, revision, and control of procedures consistent with the requirements contained in DOE 5480.19 and HNF-IP-0842, Volume I, Section 2.11.

12.3.2.1 Procedure Change. Procedure changes ensure that current practices, existing equipment configuration, and new requirements are reflected in procedures. This procedure change process is applied to operation, maintenance, alarm response, emergency response, fire protection, and surveillance. The procedure organization has implemented an administrative process consistent with the requirements contained in HNF-IP-0842, Volume I, Section 2.11, and HSRCM-1, *Hanford Site Radiological Control Manual*, to document the review and approval of each procedure change. The procedure change process implements all the requirements for configuration management as defined in DOE-STD-1073-93, *Guide for Operational*

Configuration Management Program. The procedure change process is used (1) to correct procedural errors and ambiguities and implement lessons learned that could prevent operator error or unsafe job performance or (2) to provide for equipment or process changes. The training department is also notified of any expected procedure changes so that staff training may be modified to reflect the most current procedures. The level of review and approval for procedure changes depends on the scope of the recommended change as determined by the functional area manager. Changes that affect the conduct of the work, that result from safety or environmental analyses, or that involve modifications to equipment or facilities follow the development and review process described for new procedures.

This procedure change process is implemented for changes that occur for administrative purposes or changes that occur in the field. Field changes can be caused by system or process changes discovered during implementation or because of implementation problems not identified during procedure verification, review, and approval (Section 12.3.1.4). Field changes are noted on the approved copy and reviewed for approval as discussed previously in Section 12.3.1.5.

12.3.2.2 Periodic Review of Procedures. A periodic review process ensures the technical accuracy and the proper consideration of human factors issues in procedures. Technical procedures (e.g., operations, alarm response, emergency response, surveillance, maintenance, and fire protection) are reviewed periodically or prior to use for infrequently used procedures. This process requires reviews by engineering, operations, and functional personnel. The technical basis and procedure steps are verified formally through the USQ process; the usability of the procedure is validated by operations/maintenance personnel; and the procedure is reviewed by functional disciplines as indicated by the approval designator. As a result of the periodic review, procedures may be revised, placed on an inactive status, or voided. All technical procedures are tracked to determine when periodic reviews are required. The periodic review is documented using standard document control mechanisms.

12.3.2.3 Procedure Control. Procedures are controlled per the requirements in HNF-IP-0842, Volume I, Section 2.11. A document acceptance review form accompanies each new or modified procedure through the review and approval process. Numbers are assigned consistent with a structured numbering system that indicates the facility and the type of procedure. A controlled copy of the procedure is maintained in the procedure master file and in the shift managers' offices, as previously described. Work processes that include selection of the appropriate procedure are controlled through the Job Control System program. This program is described in Chapter 14.0.

12.3.3 Development and Maintenance of Administrative Procedures

A structured procedure development process implementing HNF-IP-0842, Volume I, Section 2.1, requirements ensures accurate administrative procedures that are in compliance with appropriate requirements. This development process is documented in HNF-IP-0842, Volume I, Section 2.1, and HNF-PRO-589, *Processing Project Hanford Procedures*, and includes all activities from the identification of the need for a procedure to the distribution of procedures. Major steps in the procedure development process are discussed in the following subsections.

12.3.3.1 Need Identification. The need for a new or revised procedure may be identified when modifications in the conduct of a process are implemented or when a procedure is deemed inadequate during performance of the process. The identification of new procedures or changes to existing procedures can be initiated at all levels.

12.3.3.2 Prepare the Draft. A draft procedure is prepared in accordance with HNF-IP-0842, Volume I, Section 2.1. The procedure style guide (Attachment A of HNF-IP-0842, Volume I, Section 2.1) is used to ensure that the format and content of each procedure are consistent.

12.3.3.3 Procedure Review and Approval. New procedures and procedure revisions are reviewed and approved according to requirements delineated in HNF-IP-0842, Volume I, Section 2.1. The review includes a verification that the procedure implements the requirements referenced within the procedure and a validation that the procedure can be performed as written. A USQ screening/determination is also completed as part of the review process. All comments are resolved before release. Document approval is indicated by signatures from the designated reviewers. At completion of the review and approval process, final approval is indicated by a signature from the functional area manager. A procedure review matrix is maintained by the manual coordinator and is modified according to input from the functional area managers.

12.3.3.4 Procedure Release and Use. An electronic revision notification, with a summary of changes is sent out once final approval of the procedure is made. Notification is made to LMHC management and designated PHMC individuals. Management makes a determination on the impact to the staff, and provides instructions to staff, as necessary, to ensure proper implementation of the procedure.

12.3.3.5 Periodic Review of Procedures. Periodic review is performed to ensure compliance to requirements and the accuracy of administrative procedures. Periodic review for documents contained in HNF-IP-0842 is required every five years from the last major review. Procedure revisions are initiated if there are changes in references and requirement sources or there are changes in responsibilities or in the conduct of a process.

12.4 TRAINING

The training organization contributes to a high level of safety in facility operations and maintenance by providing well-trained and qualified staff to support TWRS line management. The TWRS training organization has developed classroom, self-study, and on-the-job training programs that are consistent with the requirements contained in DOE 5480.20A as implemented in HNF-IP-0842, Volume III, "Training."

A TWRS Training Manager governs TWRS training activities. This manager is responsible for the following:

- Ensuring that programs meet applicable federal and state laws, DOE orders, and company directives

- Responding to requests from facility management for performance improvement

- Designing and developing the training activities meeting the performance improvement requests in a manner that promotes safe operation in TWRS

- Interfacing with FDH Integrated Training to ensure that sitewide training programs attended by TWRS personnel meet the safety and improvement needs of the TWRS facility

- Maintaining auditable training records.

TWRS managers hold primary responsibility for ensuring that their subordinates are trained. The specific responsibilities regarding training include the following:

- Properly training their subordinates to perform assigned tasks in a manner that minimizes risk to themselves, co-workers, and the public; minimizes negative impacts to the environment; and minimizes risk of damage to plant and equipment

- Ensuring that subordinates receive indoctrination and training for each task performed

- Providing subordinates with all necessary information on personal and public safety and environmental hazards before beginning work

- Ensuring visitors, contracted personnel, and temporary personnel are trained to the extent necessary to safely execute their duties and to meet facility requirements

- Providing timely, constructive feedback to TWRS Training on the courses attended by their subordinates.

TWRS managers work with the TWRS Training organization to meet these responsibilities.

TWRS facility managers own the training programs for personnel working in their facilities. It is the facility manager who is accountable for the overall proficiency of the personnel working in the facility. The facility manager is involved in every step of the training process, and has the following responsibilities:

- Determining the training required for facility access

- Establishing the training requirements for each job at their facility
- Establishing, approving, and implementing project training plans affecting their facilities

- Selecting, training, and qualifying operations personnel assigned to the facility.

Performance of these responsibilities reduces the potential for errors that may negatively impact safety, the environment, or equipment operation.

The TWRS training development process implements training requirements for facility positions indicated in the training implementation matrix (Umek 1998). These processes provide a systematic approach to training and include provisions for initial and continuing training for facility employees, including new training requirements identified in the hazards and accident analysis (e.g., new or additional TSR controls). The training matrix uses course information, training records, and the training requirements for each position to enable management to determine and schedule required training. Training includes programs on general employee orientation, health and safety, environment, and occupational radiation protection. Qualification requirements for managers, supervisors, instructors, operators, maintenance personnel, and radiation control technicians are also included. Training records are maintained by the FDH training organization. Brief summaries of the training programs provided for TWRS follow:

- **General Employee Training**—General employee training provides the mechanism for contractor personnel to meet training requirements as required by applicable DOE orders and federal and state regulations. General employee training is designed to deliver efficient and effective training using appropriate instructional and performance based technologies and an interactive electronic delivery system. This training is required for new employees and annually for all employees. Program content includes facility orientation; Hanford Site policies, practices, and requirements; conduct of operations; and emergency protection procedures. Individual fire protection training is also offered as a part of the training.

- **Qualification Programs**—Qualification programs provide training to individuals to allow them to perform specific tasks related to safe operations of the TWRS facilities. The positions and duties selected for qualifications (1) meet requirements for establishing a qualification program according to DOE Order 5480.20A, or (2) meet facility needs to ensure safety for personnel, the environment, and equipment. A Training Implementation Matrix, required by DOE Order 5480.20A, identifies qualification positions and duties in TWRS. The positions and duties requiring qualification programs may change as required to meet needs as established by DOE Order 5480.20A and facility needs. Program descriptions found in the HNF-IP-0842 describe the elements for each qualification program. These elements may include Qualification Cards, On-the-Job Training Cards, classroom presentations, examinations, performance demonstrations, self-study training, or any other method deemed appropriate for the specific qualification program. Continuing training requirements of each qualification, including requalification requirements, are also described in the program description. Continuing training addresses procedure changes, configuration changes, lessons learned, identified areas of weakness in current operations, and fundamentals topics. The delivery method of continuing training depends on the program needs, but may include self-study, classroom presentation, and

simulations. Most qualification programs also contain a requirement for examination and performance demonstration to show continued mastery.

- **Individual Courses**—Upon demonstration of need, TWRS Training provides additional courses. The needs for additional development include: correction of deficient performance, new policy or procedure dissemination, opportunity to improve safety or other organizational goals, or other similar needs. Attendance requirements for such training will be determined by TWRS management.

Other job-specific training requirements are addressed in other chapters of this report as follows:

- Criticality safety training is addressed in Section 6.5.3
- Radiological protection training is addressed in Section 7.5
- Hazardous material training is addressed in Section 8.5
- Waste management training is addressed in Section 9.3.5
- Surveillance and maintenance training is addressed in Sections 10.4.5 and 10.5.2
- Basic firefighter training is addressed in Section 11.5.4.3
- Quality assurance training is addressed in Section 14.3.4
- Emergency response training is addressed in Section 15.4.6.

12.4.1 Development of Training

The TWRS training organization has implemented a systematic approach to training as indicated in DOE 5480.20A and HNF-IP-0842, Volume III. The systematic approach to training ensures the training program has the following characteristics:

- Uses a systematic analysis
- Uses learning objectives derived from the analysis
- Describes the desired post-training performance
- Requires evaluating trainee mastery of objectives during training
- Bases evaluation and revisions on a number of factors, including the job performance of trainees.

The systematic approach to training, as defined in HNF-IP-0842, Volume III, comprises five phases: analysis, design, development, implementation, and evaluation. This approach is applied to training for normal and abnormal operations, emergency operations, and surveillance and maintenance activities. The major steps in the development process are discussed briefly in the following subsections.

12.4.1.1 Analysis. TWRS Training establishes the need for programs based on the root cause of an event, the potential hazard of an activity, the difficulty of the task, and the frequency of performance of a task. From answers to these questions, TWRS Training establishes the objectives for training and develops how to best meet the objectives. Needs analyses are performed using discussions, observations, and other methods depending on the complexity of the problem being examined.

Job and task analyses clarify the actual tasks requiring training and the skills and knowledge required by each task. In the job analysis, technical experts and training personnel establish the tasks of the job and determine whether or not the task requires training. Some tasks may be classified as over-train, which means that they must be presented and evaluated on a recurring basis. The difficulty, importance, and frequency of performance of the task are reviewed to determine the need to classify the task as over-train.

In the task analysis, the training staff member and technical experts determine the elements, knowledge, and skills required to perform the task. The rigor of each task analysis depends on the complexity and hazard of the task and the current knowledge and ability of the workers.

12.4.1.2 Design. Information generated in the analysis phase is used in the design phase to establish a clear, objective basis for the subsequent development, implementation, and evaluation of the training program. The design phase involves identifying the knowledge, skills, and abilities personnel must acquire to meet job performance standards; defining the learning objectives; determining the appropriate delivery mechanism; selecting an evaluation method; and documenting the training program decisions so training personnel can develop training appropriate to the task.

When properly delivered by the trainer and received by the student, training improves the knowledge, skills, and abilities of the student. Additionally, training enables the individual to perform the task assignment more effectively and safely.

12.4.1.3 Development. Development activities use the analysis and design information as a framework for developing effective training programs. HNF-IP-0842, Volume III lists activities for a complete training package, depending on the complexity and safety significance of the training being developed.

The development process begins with a review of the existing analysis and design information for completeness and technical accuracy. Existing training materials may be reviewed for applicability to current training development.

Student training materials (those items used by the participant to attain the learning objectives) are created during the training development phase. These may include text, lesson plans, Qualification Cards, On-the-Job Training Cards, software, training guides, and checklists. HNF-IP-0842, Volume III requires that the training materials are consistent with the entry-level skills and knowledge of the student, use consistent text style and format, and repeat the learning

objectives throughout. During development, depending on the critical nature of the course, the products may be reviewed by and tested by participants representing the intended audience to evaluate the effectiveness of the course before full implementation.

Written or oral examinations are prepared during the training development phase to objectively assess student mastery of the material. Examination materials created as part of course development are protected in a manner that ensures security and maintains the integrity of the examination.

A pilot course or training tryout may be used to evaluate the lesson for technical accuracy and overall effectiveness. The pilot is conducted for first-time courses and may be conducted for modifications to training programs. Modifications to the training materials or delivery are made where recommended.

12.4.1.4 Implementation. Training implementation procedures provide guidance for conducting the training for TWRS operations, engineering, and maintenance staff. Implementation includes scheduling training sessions and participants, assigning qualified instructors, conducting classroom and on-the-job training, administering examinations, and documenting attendance.

TWRS training uses a training implementation matrix to help determine the required staff training. The training implementation matrix defines and describes the selection, qualification, certification, and training requirements for each TWRS position consistent with the requirements contained in DOE 5480.20A. Staff in assigned positions are then identified for training. TWRS management is responsible for providing the resources necessary for their staff to participate in training required for their job function. Individual and organizational training records are maintained to ensure that training commitments are met.

HNF-IP-082, Volume III, guides the conduct of training. In addition to a general procedure that establishes responsibilities (for TWRS management, the training organization, instructors, and students), specific procedures guide the on-the-job training and performance demonstrations for operations and maintenance personnel. The types of training that can be conducted using these methods, the number of students that can be trained effectively in an operational environment, and the need to ensure the safety of the student and the facility operation in these training activities are specified in these procedures. These administrative procedures establish the processes needed to ensure the security of the test material, administer the examination, evaluate the student's mastery of the material, establish remedial actions, evaluate tests, and disposition records.

12.4.1.5 Evaluation. Assessing the effectiveness of the training offered TWRS staff is an integral component of TWRS systematic approach to training. Several feedback mechanisms ensure that training programs are producing competent employees who can perform their assignments safely and efficiently. Evaluations throughout the life of the training program ensure that the training material reflects current operating conditions and that the material is continuously improved. The training program and course evaluations conducted by TWRS include the following.

- Course evaluations are given for most course presentations, depending on the frequency at which the course is given. These evaluations allow students to state their opinions of the course and provide suggestions for improvement.

- Examinations are given when program needs dictate demonstration of knowledge. This need applies to all qualification courses and some additional courses. When formal examination is not required, a quiz may be given to help the instructor evaluate the effectiveness of the course.

- Oral examinations are required only for Operations Engineers. These examinations allow a more intensive evaluation of knowledge gained by an Operations Engineer. Questions asked ensure that the Operations Engineer will know how to keep the TWRS facilities operating safely.

- Performance demonstrations provide proof that operators have completed their on-the-job training and may effectively and safely perform their duties. Operators follow procedures while demonstrating competence during an operational evaluation.

TWRS Training may decide to periodically evaluate an entire program or further evaluate a course for effectiveness. Such an evaluation will include observation of performance in the field, questionnaires, interviews, and other techniques that show long-term retention and application of the knowledge and skills learned through the program or course.

The process of measuring (1) the student's reaction to the training activity, (2) achievement of training program objectives, and (3) resultant behavior in the field is used to determine the training program changes that are necessary to ensure that TWRS staff are being most effectively trained. The results of these evaluations and any modifications to the training program are documented as part of the Training Materials Maintenance System.

12.4.2 Maintenance of Training Programs

TWRS Training uses the Training Materials Maintenance System to track items that may affect a course or training program. TWRS Training assesses the need for potential training by

receiving notification of all procedural changes, maintaining contact with operations personnel by attending job planning and prejob briefings, participating in committees working on new projects, receiving lessons learned, reviewing assessments, reviewing course evaluations and other methods that may expose the training staff to current events that add to, improve, or change the content of provided training. Training staff inputs problems or requests for training solutions into the Training Materials Maintenance System. Training management determines whether to modify or create training to meet the request.

The TWRS facility has an operations training council and maintenance training council to provide further input into the development and maintenance of training programs. These councils include TWRS facility managers and TWRS Training staff and management. Other personnel attend as invited.

Training records are maintained as prescribed in HNF-IP-0842, Volume III, and HNF-PRO-210, *Records Management Program Standards*.

12.4.3 Modification of Training Materials

When TWRS Training personnel determine a need to modify training materials based on the activities described in Section 12.4.2, the need is identified by creating a Training Materials Maintenance System item. Once in the system, the item is reviewed for action. If modification is necessary, a training staff member will be assigned to make the modifications according to the development process described in Section 12.4.1. Once the item is completed and approved by appropriate management, the item is removed from the system.

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CHAPTER 13.0
HUMAN FACTORS

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LIST OF TERMS

CAM	continuous air monitor
EBA	Evaluation Basis Accident
HEPA	high-efficiency particulate air (filter)
HMI	human–machine interface
HRA	Human Reliability Analysis
N	No
NA	Not applicable
SSC	structure, system, and component
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
Y	Yes

13.0 HUMAN FACTORS

13.1 INTRODUCTION

Human factors is important in assuring the safe operation of Tank Waste Remediation System (TWRS) facilities. Although no formal human factors program exists, the following discusses the organizations responsible for human factors engineering or assessments, human factors analyses performed in support of this safety analysis report, or in support of past TWRS or Tank Farm projects.

Human factors are typically applied to TWRS facility operations where humans are relied on for preventive actions (e.g., surveillance and maintenance activities during normal operations) and mitigative actions (e.g., emergency response activities during abnormal and emergency operations). Human factors analyses at TWRS are typically performed on a case-by-case basis depending on the risk and complexity of the project, the level of operator involvement at the facility, and the life cycle of the facility. For example, the more complex an operation or system is, the more rigorous the human factors assessment may be.

TWRS has developed a comprehensive ergonomics program which is part of human factors. The program conforms to current standards and guidelines. It is nationally recognized that 66% of all occupational injuries are ergonomically related, and TWRS follows this trend. Development of a comprehensive program is expected to decrease worker's compensation costs, injuries, and correct potential sources of ergonomic distress.

13.2 REQUIREMENTS

Applicable regulations do not specifically require a formal human factors program. However, DOE 5480.23, *Nuclear Safety Analysis Reports,* and DOE 6430.1A[1], *General Design Criteria,* Section 1300-12, "Human Factors Engineering," identify specific human factors requirements. In addition, the following regulations and U.S. Department of Energy orders discuss the need for evaluating human performance or actions and systems design with respect to human-machine interface (HMI).

- 10 CFR 830, "Nuclear Safety Management"
- DOE O 232.1, *Occurrence Reporting and Processing of Operations Information,* Change 1 (1995)

[1]Nonsafety-related portions of DOE 6430.1A will be phased out or cancelled when implementation conditions of DOE O 430.1 are met; portions related to nuclear safety for nonreactor nuclear facilities will be cancelled by DOE O 420.1. Compliance with DOE 6430.1A is required until directed by U.S. Department of Energy, Richland Operations Office, to comply with DOE O 430.1 and DOE O 420.1. Contract modification is required when DOE 6430.1A is cancelled.

- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1 (1992)

- DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, Change 0 (1994)

- Americans with Disabilities Act of 1991

- ANSI/HFS-100-1988, *Human Factors Engineering of Visual Display Terminal Work Stations*

- ACGIH (1996), *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)*.

13.3 HUMAN FACTORS PROCESS

No formal program or process guides the application of human factors at TWRS. However, consideration of the operator's ability to reliably operate TWRS systems and equipment and how operator actions may affect facility safety is integrated into the processes that guide engineering, safety, and operations functions at TWRS. The Tank Waste Operations and TWRS Project Design organizations ensure that operator capabilities and limitations are considered in the design, modification, and operation of TWRS facilities and equipment.

The application of human factors at TWRS, as defined in the following sections, depends on the risk and complexity of the project and the level of operator involvement at the facility, as determined by the project or program cognizant engineer. The evaluation of the human factors that may affect operator performance can range from an assessment based on operator experience to a detailed human factors analysis conducted by qualified human factors professionals.

13.3.1 Human Factors in Operations and Maintenance

Operation of the TWRS facility is the responsibility of the TWRS Waste Operations division. As indicated in Section 17.4.3.2, safe operation of the facility is the direct responsibility of line management. Line management, however, is supported by several organizations that provide expertise on topics such as industrial safety, industrial hygiene, hazardous material and radiological control, maintenance, procedures, and training. These groups are an important part of the TWRS Defense-in-Depth program and assist the line management in addressing human factors issues during interactions with operations and engineering and during design, procedure, or training reviews. TWRS waste operations also provides input to line management on a daily basis.

The unique aspects of working in the TWRS outdoor environment are integrated throughout this document which includes specific discussion provided in Chapters 7.0, 11.0, and

16.0. Human factors are included in the planning and completion of work activities. Specifically, the impact of wind, cold and hot temperatures, rain, snow, and other meteorological and environmental factors are routine considerations. Environmental factors also impact the selection of protective clothing (e.g., to minimize heat stress) and are an integral part of the Job Hazard Analysis process described in Chapter 8.0.

13.3.1.1 Operations Personnel. Operations personnel support the development of procedures and training, perform their assigned daily tasks, and participate in emergency drills and exercises at TWRS. Personnel communicate to management any abnormalities or difficulties encountered while performing assigned tasks. The input received from operations is communicated either directly to the operations management or by using a logbook. Operations personnel support development of the training programs and operating procedures. Operators are aware of the work environment, the processes or activities to be performed, and past operating experience. Operations development support involves attending prejob planning and lessons learned reviews. Operations involvement in these activities assures that the activities or processes described can be performed safely and efficiently.

As discussed in Chapter 11.0, "Operational Safety," operators and the operations manager or shift manager are notified promptly (or each will notify the other) of any abnormalities or difficulties encountered while performing assigned tasks. For example, operators are trained to be alert and attentive to facility instrumentation and alarms and to accept that all instrument readings are accurate. The operators are trained to respond accordingly until inaccuracy is proven and to check other indications, if possible, when unexpected readings are observed. Operators are trained to properly respond to alarms or unexpected instrument readings that occur during daily activities. Operator actions to identify the abnormal conditions and report the conditions to management are procedure driven. Management is responsible for communicating the condition (e.g., faulty instrument or alarm) or communicating response required to operations personnel and, if necessary, other support organizations (e.g., emergency response, maintenance).

13.3.1.2 Safety and Quality Support. Staff members in Environment, Safety, and Health and Quality Assurance provide TWRS with expertise and analysis in industrial safety and hygiene, and quality assurance and control. Members of this organization participate in all phases of TWRS operational activities as described in Chapter 17.0 and ensure that the operational environment in which tasks must be performed permits the safe and reliable performance of those tasks. These staff members address factors related to noise, lighting, and other environmental conditions; industrial hazards; and other factors in the workplace that may compromise an operator's ability to safely perform required tasks.

13.3.1.3 As Low As Reasonably Achievable Programs. TWRS concern for work safety is further demonstrated with its As Low As Reasonably Achievable programs for radiological and hazardous materials exposure. Protection of the facility worker from these types of hazards helps ensure that Site work can be safely and effectively performed.

TWRS radiological and hazardous material protection programs are described in Chapter 7.0, "Radiation Protection," and Chapter 8.0, "Hazardous Material Protection." Human

factors considered during the preparation and implementation of the radiological and toxicological protection programs include the following:

- Determine the need for and provide mockup training for complex work performed in high-radiation areas or involving work on highly-contaminated complex structures, systems, and components (SSCs)

- Operations involving radiological or hazardous materials or exposure to those materials are conducted safely and according to applicable procedures

- Workers who perform tasks in which they may be exposed to radiological or hazardous materials are fully trained and qualified to perform those tasks safely.

Examples of work practices that ensure human factors or worker safety issues are considered include prejob planning; lessons learned reviews; and project and task planning, design, and review (Section 13.3.1.1). Other important As Low As Reasonably Achievable practices include the use of personal protective equipment and posting/labeling (Chapters 7.0 and 8.0).

13.3.1.4 Procedures. Procedures are the primary job performance aids used at TWRS. Procedures direct the way in which most human tasks are performed. Consequently, the central focus of procedure preparation is consideration of human performance.

The TWRS procedures organization is tasked with helping line management develop procedures that are technically correct and easy to use. In the procedure organization's structured approach to procedure development (Chapter 12.0, "Procedures and Training"), operations and maintenance personnel serve as discipline experts and are used to ensure humans can perform the tasks identified in the procedures. Writing procedures in accordance with the TWRS writer's guide and validating the procedures ensures that steps are easy to read and follow; steps are presented in logical and correct order; all documentation (e.g., labels, equipment representations, and diagrams) contained in the procedure is accurate; and tasks required by the procedure are within the operator's capabilities.

13.3.1.5 Training. The TWRS training organization's objective is to ensure that all staff have the knowledge, skills, and abilities required to safely operate and maintain TWRS facilities. Knowledge, skills, and abilities are acquired through initial training and maintained through periodic retraining.

The training organization's materials development process is based on a systematic series of steps that include analysis, design, development, implementation, and evaluation. The development of training materials for TWRS staff emphasizes needs analysis and relies heavily on involving operating staff (Section 13.3.1.1). Elements of the training program that ensure consideration of human factors include the following:

- Development of needs analysis, job analysis, or task analysis to determine operational requirements and needed skills

- Determination of skill level required for proficiency in operational tasks

- Assessment of the current skill level of TWRS staff

- Inclusion of operating and maintenance staff in the development of training materials to ensure that these materials reflect operational experience (e.g., lessons learned).

Additionally, the training department and the procedure development staff work together with engineering to identify training requirements for new operations. Interfaces among training, operations and maintenance, and procedures groups are maintained to preserve the quality and accuracy of training and of operating and maintenance procedures, based on lessons learned and operator feedback. The TWRS training program is further described in Chapter 12.0.

13.3.2 Human Factors in Facility, Systems, and Equipment Design

The TWRS Technical Operations and Engineering group, with support from TWRS operations personnel, is responsible for the design, development, and implementation of the systems and equipment used at TWRS. As discussed in Chapter 17.0, the Nuclear Safety and Licensing group is responsible for the development and maintenance of the TWRS Authorization Basis. The Technical Operations and Engineering group ensures that human factors are considered in the modification of TWRS facilities, systems, or equipment that may affect safety.

The role of the Safety Analysis element is to establish and maintain the Authorization Basis Management System. Specifically, Safety Analysis has the lead role for establishing prevention and mitigation functions and determines the appropriate set of SSCs and Administrative Controls. The scope of this work is graded according to the complexity of the facility and the hazards identified.

The TWRS Nuclear Safety and Licensing group conducts safety analyses to ensure that facility configuration and operations are maintained such that the facility is managed within the Authorization Basis. In these safety analyses, the analyst documents the assumptions used in the safety analyses. As part of these analyses, human factors assumptions relating to the operator's awareness of a condition, recognition of a problem, and actions to mitigate a problem must be documented. These human factors considerations are verified and validated by operations personnel during the analysis review process. These considerations are documented in the Authorization Basis document, other safety documents, and the HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*.

13.4 HUMAN FACTORS ANALYSES PERFORMED IN SUPPORT OF THE TANK WASTE REMEDIATION SYSTEM FINAL SAFETY ANALYSIS REPORT

Two human factors activities were performed in support of this safety analysis report: identifying and qualitatively evaluating selected TWRS systems HMIs and accident analysis support. Both of these activities are discussed in the following subsections.

13.4.1 Identification of Human-Machine Interfaces

HMIs necessary for the surveillance and maintenance of TWRS safety SSCs during normal operations are described in this section. Surveillance in this context is defined as the monitoring of an SSC to ensure that it is operating within specified parameters. Maintenance in this context is defined as maintaining SSCs and keeping them in optimum condition. The safety SSCs discussed in this section are the high-efficiency particulate air (HEPA) filters, temperature monitoring systems, and leak detection systems. The function of the instrument building with respect to surveillance and maintenance of safety SSCs is also discussed.

The major systems and structures currently used at TWRS were designed and constructed between 1945 and 1980. This predates the issuance of DOE 6430.1A, which establishes human factors design criteria for nonreactor nuclear facilities. As a result, much of the design of the HMIs at TWRS does not comply with the criteria contained in DOE 6430.1A. There have been no formal TWRS projects or programs to backfit or upgrade the existing systems to meet these criteria. Most of TWRS facility equipment, Safety-Class and Safety-Significant SSC HMIs use standard industrial controls to start and stop equipment, position valves, and perform other required tasks. These controls are not complex nor is the equipment difficult for TWRS operators to operate. Typical equipment controls and indicators include the following:

- Pushbutton controls and switches to start and stop ventilation fans, pumps, and motor-operated valves; incandescent indicators display equipment status

- T-handles and handwheels to manually reposition valves; each has a permanent indication of valve position painted on the cover block

- Alarm panels arranged in a matrix of labeled, illuminated alarms; typically an audio alarm is also sounded.

Hardwired alarm panels of standard design are located in instrument buildings and on local panels (i.e., at the equipment). The alarm panels are equipped with alarm test features. Traditional alarm coding has been implemented for these panels as follows:

- New alarm conditions are indicated by a flashing alarm indicator and a redundant audio alarm

- An acknowledged alarm is indicated by an illuminated alarm status indicator (e.g., alarm, acknowledged alarm)

- The alarm indicator is reset when the alarm condition is cleared.

Routine surveillance of tank farm instrumentation and equipment is primarily conducted in the individual instrument building associated with the tank farm. If an abnormal condition or alarm occurs, the operator will advise the shift manager of the alarm, proceed to the tank farm to verify the cause of the alarm or abnormal condition, and mitigate the condition by performing the appropriate alarm response procedure.

Previously acknowledged alarms, as noted in the logbook at the time of acknowledgment, may require no further action based on the initial alarm response actions. That is, the initial condition is communicated to shift management at the time of the alarm and the appropriate actions are taken, including verifying the alarm through other instrumentation and noting the condition as abnormal or identifying the alarm as failed. Alarm conditions are discussed as part of shift turnover (Chapter 11.0).

Primary alarms important to the safe operation of TWRS are identified in HNF-SD-WM-TSR-006. The alarm setpoints and priorities are established based on the accident analysis. Secondary or redundant alarms monitor the same functions or conditions as the primary alarms and provide additional information regarding system status or condition. Operator training and procedures distinguish between primary alarms and secondary or redundant alarms and provide alarm response priorities.

13.4.1.1 The Instrument Building and Human-Machine Interfaces for Safety SSCs. The instrument building serves as a central monitoring station for the associated tank farm and is normally located outside the tank farm boundary. The location of the instrumentation and alarms necessary for SSC surveillance in the instrument building permits surveillance to be performed consistent with As Low As Reasonably Achievable requirements. A typical instrument building contains tank farm indications, alarms, relays, and breakers for various functions and components of safety SSCs within the tank farms. During normal operations, operators are required to check safety parameters and record their values on daily round sheets. Operators are alerted to abnormal conditions within the tank farms by means of alarm indications and can respond to problems by using the alarm response procedures.

13.4.1.2 Human-Machine Interfaces at Local Stations Related to Surveillance and Maintenance of Safety SSCs. Several HMIs for the surveillance and maintenance of safety SSCs during normal operations are located within the tank farm boundaries. One example, is the surveillance and maintenance of HEPA filters.

HEPA filters are maintained and monitored to mitigate the consequences of potential tank pressurization transients (i.e., mixing of incompatible material) and HEPA filter failures from exposure to high temperatures or overpressure events. Technical Safety Requirements (TSR) Administrative Controls are required for HEPA filters to mitigate the consequences of these

accidents and potential radioactive releases. Aerosol tests are conducted upon installation of a new HEPA filter and annually thereafter. Other HEPA filter Administrative Controls include filter radiation surveillance and filter changeout based on radioactive material accumulation. Operators monitor HEPA filter differential pressure and the corresponding continuous air monitor (CAM) radiation level to ensure that the HEPA is operable. More information about the HEPA filter HMIs associated with the ventilation systems is provided in the following discussion.

13.4.1.3 Human-Machine Interfaces that Ensure Safety Function during Normal, Abnormal, and Emergency Operations. HMIs required for ensuring the safety functions of safety SSCs during normal and abnormal operations are described in the TWRS operating procedures. Expected operator actions that are important to facility safety are also included in the procedures.

Control of active ventilation systems is generally manual and local (i.e., at the equipment). Operator actions are basic and are consistent with the simplicity of the system design. TSR controls call out the Emergency Preparedness Plan and emergency response procedures for a spectrum of accidents that were analyzed and discussed in Chapter 3.0, "Hazard and Accident Analyses" (e.g., high flammable gas concentrations and subsurface and surface leaks from transfer lines).

13.4.1.4 Ventilation System. Exhaust ventilation systems prevent the accumulation of flammable gas and the unfiltered release of radioactive contaminants. These systems prevent the spread of contamination by maintaining a slightly negative pressure in the tank headspace. The operator's role is to start the ventilation system, monitor ventilation system parameters during operation, and respond to ventilation system alarms and abnormal conditions.

All operating controls and most of the indications and alarms for ventilation systems are located next to the ventilation equipment. Alarms associated with the ventilation system, such as those that indicate fan trips or high HEPA filter differential pressures, are located on panels in the instrument building. Locally, within the tank farms, pressure gauges provide analog readouts of the HEPA filter differential pressure, and local thermometers measure ventilation heater temperature. Manual valve handwheels and position indicators on valves, circuit breaker position indicators (open/closed lights and labeled breaker position at the breaker switch), and pushbuttons for ventilation fan startup are also located at the tank farms. Additionally, the HMI includes a two-position switch that identifies the primary fan (normal running fan) and the backup fan (standby fan that will start when the CAM indicates the presence of radiation and the primary fan is tripped) and a ventilation heater ON light. The CAM measures and records radiation level on a dial indicator in counts per minute.

Operator actions on startup are to line up valves and breakers, verify that the CAM is energized, and verify that alarms are cleared in the instrument building. To start the ventilation system, the operator must press the START pushbutton for several seconds to allow the motor-operated butterfly valves to fully open. The operator verifies that the butterfly valves are open by observing local manual indicators on the valve handwheels. To ensure that running conditions are normal, the operator monitors temperature and pressure on the local analog gauges

and radiation levels on the CAM dial readout and strip chart recorder. Periodic monitoring is recorded on daily round sheets. If an abnormal condition occurs, the operator takes actions in accordance with alarm response procedures. For example, if a loss-of-vacuum alarm occurs, the tank farm must be immediately evacuated or all in-farm personnel must don respirators because of the potential for airborne contaminants escaping the tanks through cover blocks and risers.

TWRS design since 1989 has applied the human factors criteria contained in DOE 6430.1A. As a result, design improvements have been made in the HMIs for some of the Safety-Class or Safety-Significant SSCs. The evaluation of the HMI varies from project to project and is dependent on an assessment of the importance of the HMI to the safety of plant operations.

13.4.2 Evaluation of Human-Machine Interfaces

The evaluation of the HMIs involved a systematic inquiry into the ability of facility staff to accomplish their responsibilities during abnormal and normal operations. The inquiry comprised the following activities:

- Development of HMI checklists
- Walkdown of a sample of significant TWRS operations.

13.4.2.1 Development of Human-Machine Interface Checklists. Checklists for TWRS were developed to evaluate whether the HMIs for safety SSCs were designed to accommodate operator capabilities and limitations. A sample page from the checklist for labeling is illustrated in Figure 13-1. The evaluation was performed in conjunction with the walkdown of significant TWRS operations described in the next section. Checklists were developed for the following:

- Visual displays, transilluminated displays, scale indicators, and other displays
- Alarms and annunciator displays
- Hand-operated controls and controls for user–computer interfaces
- Labeling
- Work environments, including physical access, need for protective clothing or breathing apparatus, noise levels, temperature, humidity, distractions, and other factors bearing on physical comfort, alertness, and fitness for duty
- Communications
- Hazards and safety.

13.4.2.2 Walkdown of Significant TWRS Operations. Walkdowns of operations related to safety SSCs with HMIs at 200 West Area tank farms and 200 East Area tank farms were performed. The following facilities, which are considered representative and include many of the Safety-Class and Safety-Significant SSCs, were visited:

- 241-T Tank Farm
- 244-TX double-contained receiver tank
- 242-S Evaporator Control Room (cross-site transfer controls)
- 241-SY Tank Farm
- 271-SY Instrument Building
- 241-S Tank Farm
- 241-AP Tank Farm and Instrument Building
- 241-AW Tank Farm and Instrument Building.

The review concluded that the HMI design for these safety SSCs has not been optimized. Inconsistency exists between location and orientation of control switches, labeling, and status lights for valves, pumps, and fans. Other results from the checklist reviews were as follows:

- Instrumentation and means of communications provided for operators use in performing safety functions on safety SSCs are generally adequate. Operators are given the tools to capably perform their tasks.

- Layout and design of controls and instrumentation generally follows the principles of ergonomics and human engineering. Some controls that were modified as a result of design changes are placed on existing panels without regard to optimizing their locations. Additionally, some inconsistency exists between switch positions from one part of TWRS to another. Controls with this deficiency are not used for critical or complex tasks.

- The labeling program has not been optimized for human factors. Labeling on equipment and components is a confusing alphanumeric combination that requires the operator to interpret the information rather than understand it intuitively. Labeling should be identified more concisely so that the operator can more readily recognize the system and function associated with the labeled component.

- Operator needs are generally accommodated by work environmental factors and are considered during equipment design. Design changes have been considered to reduce noise and improve comfort levels, particularly in the control building areas. Some local instrumentation panels in tank farm boundaries could be better protected from sun glare to allow operators to read and register instrument indications.

None of the conditions noted is considered critical because the operation of the safety SSCs is usually a combination of simple tasks that are within operator capabilities and for which

there is adequate time to complete. Additionally, the design of the operating procedures as described in Chapter 12.0 compensates for discrepancies noted during the review.

13.4.3 Human Factors and Hazard and Accident Analyses and Control Selection Interfaces

The hazards and accident analysis and the selection of controls decisions regarding human interfaces required limited qualitative human factors evaluations. The following sections discuss each of the assessments performed.

13.4.3.1 Hazards and Accident Analysis Interfaces. During the development of the hazard and accident analyses in Chapter 3.0, an interactive process was implemented to ensure that human error data was factored in the accident frequency correctly and to support the selection of controls (i.e., safety SSCs and TSRs) based on required human responses and HMIs. The process that was followed is shown in Figure 13-2 and is described in the following paragraph. The results of the human factors analyses are documented and contained in the safety analysis report project files.

The human factors evaluation process begins with the review of the hazards and accident analyses in Chapter 3.0 of the Final Safety Analysis Report. A human factors analyst performs a preliminary task analysis based on the operator actions identified for safety SSCs and TSR controls for event initiators and accident mitigators. In addition, the analyst reviews data from operations in the form of questionnaires, interviews, and occurrence reports in order to determine the feasibility of current operations and recommendations for improvement. Once the recommended operator actions are determined, the analyst conducts a more thorough human factors safety analysis in three parts. First is the identification of HMIs, which are evaluated with checklists and walkdowns. Simultaneously, the task sequence is generated and a thorough task analysis conducted. The human factors analyst then conducts a human reliability analysis to determine the likelihood that an operator could perform necessary response actions within a specified time interval. The assessment is based on HMIs and human response times or the availability of a person to respond to the accident. If the analyst determines an action is not possible within the specified times, the accident analyst and the human factors analyst select controls to prevent or mitigate the accident accordingly. Procedures are developed and modified based on the results of this process in accordance with Chapter 12.0 (Procedures and Training), and are continuously improved based on further feedback.

Following the accident analysis, if the mitigating controls require human response actions, the likelihood that a human could perform the response within a specified timely manner is assessed. The assessment is based on HMIs and human response times or the availability of a human to respond to the accident. This is an iterative process. Based on the results of the assessment it may be determined that any of those factors (HMIs, response times, or availability) are not adequate to prevent or mitigate the accident. The accident analyst, in concert with the human factors analyst, uses an interactive process to select controls that will provide a timely response, thus preventing the accident from occurring or providing an acceptable level of

mitigation. Therefore, the human factors evaluation ensures the human could perform the required response specified in the control.

13.4.3.2 Controls Selection Interfaces. In support of the TWRS controls selection process, tank farms operating procedures, existing Administrative Controls, and potential Safety-Class and Safety-Significant SSCs were reviewed for HMI issues. Task analysis was used to evaluate the effectiveness of tank farm operating procedures for optimizing the HMIs and minimizing the probability of operator error using a graded approach (i.e., only those SSCs or proceduralized actions identified in Chapters 3.0 and 5.0). Operating procedures as well as surveillance and maintenance procedures are developed and validated as discussed in Chapter 12.0. Classes of significant HMIs were submitted to task analysis reviews to verify that TWRS staff could fulfill the responsibilities demanded of them during normal operating conditions as well as during abnormal and emergency conditions. Task analysis tables developed for the human factors evaluation of the double-shell tank farms in WHC-SD-WM-ES-298, *Double-Shell Tank Farms Human Factors Study*, were verified recently for current TWRS operations.

Task analysis was also used to evaluate the effectiveness of tank farm Administrative Controls. Operator actions associated with the controls are described in approved procedures. These Defense-in-Depth features serve as an additional layer of protection for the safe operation of TWRS and compensate for the deficiencies in the optimization of the HMI hardware design.

The process for selecting safety SSCs and TSR controls served as a systematic inquiry into the ability of facility staff to accomplish responsibilities during normal and abnormal operations. For each analyzed accident scenario, TWRS operators and engineers were involved in the process of selecting Safety-Class and Safety-Significant SSCs and TSR controls for TWRS facilities and operations. The SSC and TSR selection process was based on the best available information from the hazard and accident analyses and from TWRS engineering and operations personnel. The selection process therefore served as a practical verification that action statements and completion times (e.g., shutdown of transfer pumps within 30 min of leak detection alarm) for TSR controls were set to be well within the knowledge, skills, abilities, and limitations of TWRS operators.

13.5 REFERENCES

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*.

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HNF-IP-0842, 1997, *TWRS Administration*, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-SD-WM-ES-298, 1994, *Double-Shell Tank Farms Human Factors Study*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Figure 13-1. Sample Page from a Human–Machine Interface Checklist.

1.

CHECKLIST 6.0 LABELING

System, Version, Description:
241-T Tank Farm (241-T-104 saltwell pumping skid, 242-T Evaporator, 244-TX DCRT), 242-S Evaporator or Control Room

(Cross Site Tansfer Controls), and 241-SY Tank Farm, 271-SY Instrument Building, 241-S Tank Farm, 244-S DCRT

Reviewer: _____ **Date:** _____

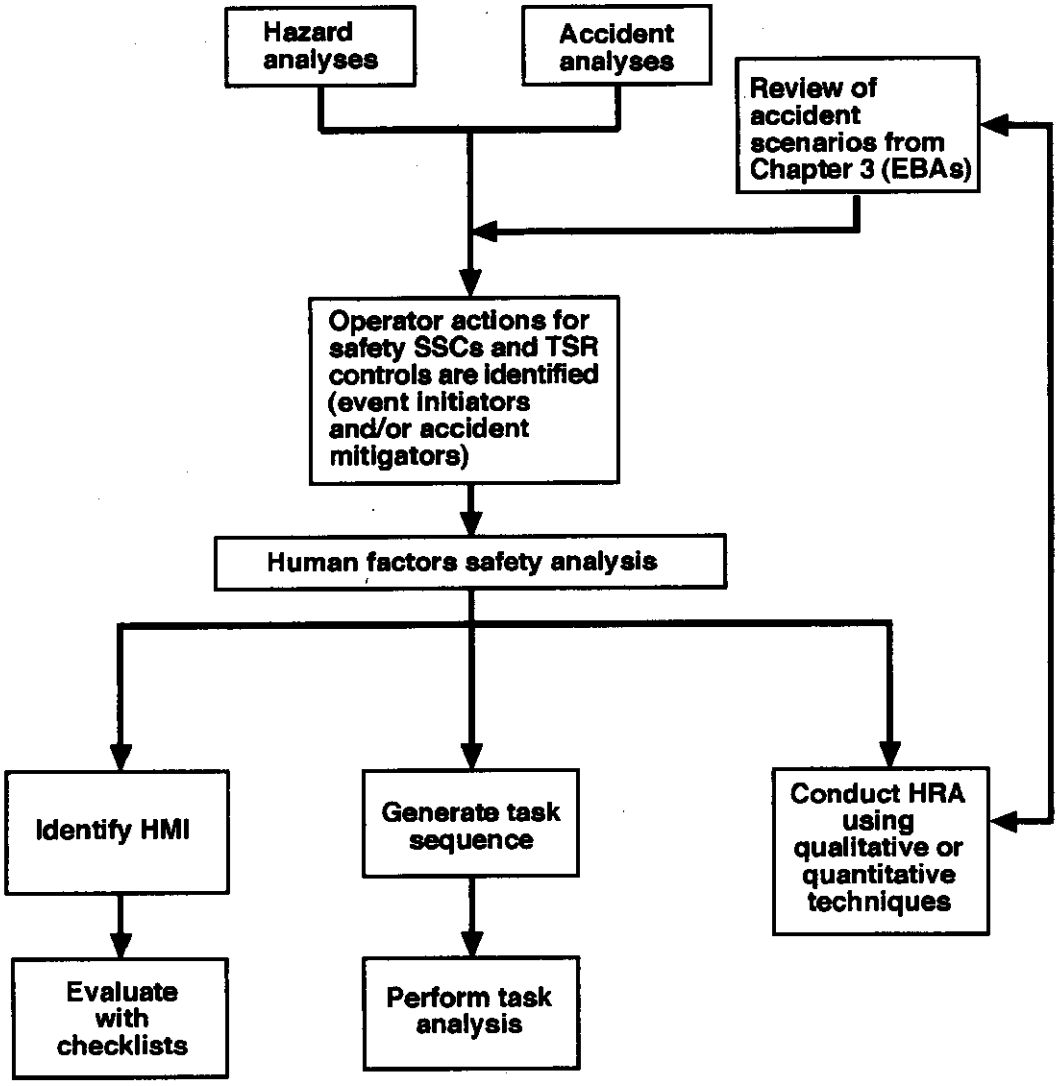
No.	CRITERIA/ITEM	Y/N/NA	Comments
1.	Are labels, legends, placards, signs or markings, or a combination of these provided whenever it is necessary for personnel to locate and identify controls, displays, and equipment items to interpret and follow procedures, or to avoid hazards? (Application: 6.1.1)	Y	
2.	Are label characteristics consistent with accuracy of identification required? (Label Characteristics: 6.1.2a)	Y	For maintenance; operator needs are not considered.
3.	Are label characteristics consistent with time available for recognition of the responses? (Label Characteristics: 6.1.2b)	Maybe No	Labeling does not use standard operator nomenclature
4.	Are label characteristics consistent with distance at which the labels must be read? (Label Characteristics: 6.1.2c)	Y	Black on white high contrast
5.	Are label characteristics consistent with illumination level and color? (Label Characteristics: 6.1.2d)	Y	
6.	Are label characteristics consistent with criticality of the function labeled? (Label Characteristics: 6.1.2e)	Y	
7.	Are label characteristics consistent with label design within and between systems? (Label Characteristics: 6.1.2f)	Y	

Y = Yes N = No NA = Not Applicable

Sample Page

7G96100087.13D
R2 SRP-13

Figure 13-2. Limited Human Factors Evaluation Process.



EBA = Evaluation Basis Accident.
HRA = Human Reliability Analysis.
HMI = human-machine interface.
SSC = structure, system, and component.
TSR = Technical Safety Requirement.

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R2 SRP-13

CHAPTER 14.0
QUALITY ASSURANCE

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CHAPTER 14
QUALITY ASSURANCE

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LIST OF TERMS

ATP	acceptance test procedure
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
ESL	evaluated suppliers list
FDH	Fluor Daniel Hanford, Inc.
QA	quality assurance
QAP	quality assurance program
QAPD	Quality Assurance Program Description
QAPP	Quality Assurance Program Plan
SSC	structure, system, and component
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System

14.0 QUALITY ASSURANCE

14.1 INTRODUCTION

This chapter describes how quality assurance (QA) requirements are incorporated into the Tank Waste Remediation System (TWRS) work processes. The TWRS Quality Assurance program (QAP) is designed to ensure safe operations and working conditions and to ensure the quality of TWRS safety structures, systems, and components (SSCs). All elements of TWRS work processes that have a safety function must comply with the QAP requirements. Application of the graded approach and specific examples of its application are provided throughout this chapter.

14.2 REQUIREMENTS

The TWRS QAP implements the requirements of 10 CFR 830.120, "Quality Assurance Requirements," and DOE 5700.6C[1], *Quality Assurance*, Change 1 (1996). The 10 CFR 830.120 requirements apply to nonreactor nuclear facilities and DOE 5700.6C requirements apply to the balance of the plant.

14.3 QUALITY ASSURANCE PROGRAM AND ORGANIZATION

14.3.1 Quality Assurance Program

Implementation of 10 CFR 830.120 and DOE 5700.6C requirements is detailed in a hierarchy of manuals and procedures shown in Figure 14-1. HNF-MP-599, *Project Hanford Quality Assurance Program Description*,[2] describes the Hanford Site QAP.

Fluor Daniel Hanford, Inc. (FDH) is the managing/integrating contractor for the Hanford Site and is responsible for HNF-MP-599. FDH ensures that subcontractors performing work at the Hanford Site know the requirements and provide implementing procedures to ensure compliance. Compliance with the HNF-MP-599 program is verified by FDH through independent assessments. WHC-CM-4-2, *Quality Assurance Manual*,[3] is the first-level implementing manual

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[1]Although DOE Order 5700.6C has been rescinded, the contractor is obligated by the existing contract to meet the requirements stated in that order.

[2]Implements the provisions of the *Price-Anderson Amendments Act of 1988*.

[3]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc. (FDH) procedures (e.g., HNF-PRO-XXX).

in the hierarchy. WHC-CM-4-2 contains the procedures that implement the QAP committed to in HNF-MP-599. The procedures in WHC-CM-4-2 are applicable across the Hanford Site, and work is required to comply unless waivers are requested of and approved by FDH. Subcontractors are required to document a Quality Assurance Program Plan (QAPP); FDH approves the QAPP and independently assesses compliance.

The QAPP describes the organizational structure, functional responsibilities, levels of authority, and interfaces for managing, performing, and assessing work. Hanford Site work processes are described in a series of procedures (HNF-PRO procedures) that apply to work conducted across the Hanford Site. Procedures that implement the TWRS work are contained in HNF-IP-0842, *TWRS Administration*. See Chapter 17.0 for additional information about how the Hanford Site work has been assigned among the managing/integrating contractor and the subcontractors.

HNF-MP-599 defines the requirements and responsibilities that have been established by FDH to ensure that Hanford Site quality assurance problems are prevented or detected, and to ensure continuous quality improvement in activities and products. The management systems established to prevent or mitigate breakdowns in the quality assurance process include deficiency and nonconformance identification, root cause analysis, control, and tracking; corrective action management; and performance data analysis. Each major subcontractor (such as Lockheed Martin Hanford Corporation) is responsible for implementing the Hanford Site corrective action management, deficiency tracking, and nonconformance control systems for their activities.

Although these programs are sound and are expected to maintain quality, DOE 5480.23, *Nuclear Safety Analysis Reports*, requires a discussion of the breakdown of the quality control program. Such a postulated breakdown would eventually degrade equipment and operating performance. However, the Technical Safety Requirements (TSRs), including surveillances and operator daily activities, would discover any quality issues which would be called to the attention of management via TSR violations and occurrence reports. These avenues would preclude a decline in quality and protect the health and safety of the public, workers, and the environment.

Additional detail on the following items is contained in WHC-CM-4-2: design control; procurement control instructions, procedures, and drawings; document control, control of processes, inspection, surveillance, and testing control; control of measuring and test equipment; handling, storage, and shipping control; control of nonconforming materials, components, and fabrication/construction features; corrective actions for identified conditions adverse to quality; control of personnel training and qualification; quality improvement; quality assurance documents and records; and independent quality audits.

14.3.2 Tank Waste Remediation System Quality Assurance Program

The TWRS QAP was derived from HNF-MP-599 and WHC-CM-4-2, which establish requirements for the TWRS QAP. A TWRS-specific QAPP appears in HNF-IP-0842, Volume XI. The TWRS-specific QAPP identifies the organizational structure, roles, and responsibilities

for meeting the requirements in HNF-MP-599 and WHC-CM-4-2, and the QAPP identifies the implementing procedures that are used by TWRS to achieve quality.

The TWRS QAP implements the higher-level policy that work performers are responsible for in the quality of their work. The QAP is designed to implement the concept of process control (i.e., do-it-right-the-first-time). Therefore, the QAP emphasis is on processes, both operational and administrative, with less emphasis on after-the-fact inspections that inherently emphasize sorting and disposing of nonconforming items.

The TWRS QAP has been developed with the graded approach in mind. SSCs are assigned a safety classification that determines the QAP features commensurate with the safety requirements of the SSC. See Chapter 4.0 for additional details on safety classification.

The primary goal of the TWRS QAP is to ensure that work that affects safety is properly specified and performed. The implementing methods ensure that safety SSCs are properly determined, specified, fabricated, installed, used, and maintained. TWRS QA personnel support the establishment and implementation of processes and systems that implement the requirements specified in 10 CFR 830.120 and DOE 5700.6C. TWRS QA personnel ensure correct interpretation and implementation of QA requirements by participating in the procedure development process and by assessing the work performed within the purview of a procedure. Assessment results are reported to responsible TWRS managers for their use in ensuring safe operations and safe job performance. Quality Control personnel and Quality Engineers perform specific planning and assessment functions, as described below:

- **Quality Control**—Quality Control personnel are members of the team who plan and perform work on SSCs through development and implementation of work packages. Inspection, witness, and hold points are integrated into the work packages. Quality Control personnel perform the designated inspection activities and report the results.

- **Quality Engineers**—Quality Engineers review design and testing requirements to ensure that the proper test standards have been identified and that the parts or systems can be manufactured as designed. Quality Engineers are also responsible for ensuring that designs are documented in accordance with procedures and that the design documents are controlled. The issuing organization is responsible to ensure that drawing modifications and document revisions (configuration control) are performed.

The QAP is integral to the many processes used by TWRS in accomplishing its mission. The QA organization is integral to the development and implementation of the processes used to ensure safe operations and safe working conditions. TWRS personnel are responsible for ensuring that the QA requirements are met.

14.3.3 Tank Waste Remediation System Quality Assurance Organization

Organization of TWRS is described in Chapter 17.0. TWRS QA is a separate and independent support organization. Safe operations and safe working conditions are built into mission implementation programs when the TWRS QA organization is involved from planning through execution.

14.3.4 Personnel Training and Qualification

The contractor Personnel Training and Qualification Program ensures that personnel are trained and qualified to perform assigned tasks. This program provides for the development of personnel proficiency commensurate with the scope, complexity, and nature of assigned activities. Management is responsible for developing generic staff position requirements based on these proficiency requirements.

Facility managers and suppliers who provide personnel to support facility operations are responsible for ensuring that staff members are trained. Specifically, staff must be trained to perform assigned tasks in a manner that minimizes (1) risk to onsite workers and the public, (2) negative environmental impact, and (3) risk of damage to the facility and facility equipment.

Qualification of TWRS operations personnel is described in Chapter 12.0.

14.4 QUALITY IMPROVEMENT

The TWRS QAP provides for quality improvement through control of conditions adverse to quality. Adverse conditions are characterized as nonconformances or noncompliances. Nonconformances relate to items that do not meet established requirements, and noncompliances relate to deviations from procedure requirements. The processes to control and correct nonconformances and noncompliances require that adverse conditions be detected, characterized, documented, dispositioned, and resolved. Data is collected and analyzed for potential quality improvements. The quality improvements are implemented through preventive actions and process control improvements.

There are significant differences in the role of the QAP for activities when the SSCs are operational (i.e., performing active or passive functions) compared with the role of the program when the SSCs are not operational. The program role differences concerning handling nonconformances and noncompliances are particularly significant. For nonoperational situations the emphasis is to prevent inadvertent use of nonconforming items. For operational situations the emphasis is to avoid noncompliances with operating requirements that could impact safety. Operational noncompliances are evaluated for reportability within the occurrence reporting system, which takes precedence over a QAP reporting system. The QAP reporting system becomes a complementary activity when the occurrence reporting system has precedence.

Operating items can become nonconforming to the original design and are typically corrected through maintenance activities performed within the job control system.

14.4.1 Nonconformances

Items that do not conform to established design requirements are documented as nonconforming. Upon detection as nonconforming, the item is controlled to preclude it from being inadvertently installed or used and related work activity is stopped until the nonconformance report is dispositioned.

A nonconformance is documented after the nonconforming item is placed under control. The documentation (1) uniquely identifies the nonconforming item, (2) accurately cites the violated requirement and its source, and (3) identifies the unique tracking number associated with the nonconformance. The nonconformance is then dispositioned. A nonconformance report is complete when TWRS QA personnel verify and signify that the disposition has been implemented.

14.4.2 Noncompliances

A deviation from procedure or performance requirements is documented as a noncompliance. A noncompliance differs from a nonconformance in that items installed in the plant or used in plant operations are not involved. Most elements of the process to document and resolve a noncompliance are the same as for the nonconformance process. Because there is no item involved, the noncompliance process is reduced to (1) initial documentation of the violated requirement and description of the noncomplying event, (2) determination, documentation, and approval of the course of action to resolve the noncompliance, (3) implementation of the action, and (4) verification of the completion of the remedy.

14.4.3 Preventive Actions

Nonconformances and noncompliances are tracked to ensure resolution and to identify trends in the quality of operations and output. When a specific condition adverse to quality requires preventive action, the condition owner performs a root cause analysis to determine the direct cause and the more fundamental cause of the noncompliance. When the root cause is determined, appropriate preventive actions are implemented to prevent recurrence. Information from the nonconformance and noncompliance systems is collected as part of the corrective action program for quality improvement.

TWRS personnel review information to determine the causes and develop preventive actions. Procedure reviews are also used to identify problems and develop preventive actions. The results of these reviews, commonly called "trending," are fed back from the Deficiency Tracking System to TWRS managers for use in prioritizing quality improvement activities.

14.5 DOCUMENTS AND RECORDS

Processes for document control and records management are used at TWRS. Documents requiring control include those that specify requirements, set parameters, or establish safety bases. Quality records are documents that contain documentary evidence of the quality of plant SSCs. Other records are documents that are required by law or company policy.

Documents requiring control are reviewed for adequacy and approved by authorized personnel before release and use. The preparer of a controlled document is responsible for ensuring that the document meets release criteria before approval and release. Personnel authorized to review and approve configuration controlled documents are identified and their approval is documented on the document or on records traceable to the configuration controlled document (e.g., signature sheets). Documents that contain or implement QA requirements must be reviewed by the designated QA representative. Document control practices pertain to the original document as well as to subsequent revisions. Controlled documents are marked to indicate their controlled status. Revisions are reviewed by the same organization that originally reviewed and approved the document and are approved and released for use in the same manner as the original documents. The document control process is designed to ensure current, correct information is available at the work site.

Records that contain documentary evidence of quality are specified, prepared, authenticated, maintained, secured, and stored in a retrievable manner. The system described in WHC-CM-3-5, *Document Control and Records Management Manual*, is used at TWRS to manage records generated as a result of TWRS activities. Records are to be legible, complete, identifiable, accurate, and retrievable. Records are to be classified for ultimate disposition according to the National Archives and Records Administration general records schedules. Documents that define work (e.g., procedures) identify the records generated as a result of performing the work. Records are processed and reviewed for authentication upon generation. The authentication review confirms that the information on the record is complete and accurate. Following authentication, records are secured, maintained against substantive deterioration, and stored in a manner compatible with timely retrieval. Records are maintained as long as the designated disposition schedule requires.

14.6 QUALITY ASSURANCE PERFORMANCE

Processes designed to ensure that performed work meets requirements are described in the following subsections.

14.6.1 Work Processes

Work processes are controlled through the use of procedures. Operations and maintenance work are controlled using the TWRS job control system. The job control system is designed to ensure that operations and maintenance work is comprehensively planned, scheduled,

categorized for importance, and documented in work packages. A work package is a set of documents that administratively defines the manner in which specific work is performed. The work package (1) identifies pertinent technical standards and requirements, and (2) contains written instructions, applicable drawings and specifications, required permits, and in-process tests or inspections. The SSCs affected by the work to be performed dictate the type of work package developed, and the type of work package dictates the rigor and extent of package approval. Package approval is based on the graded approach. Approval requirements vary according to document type, purpose, and content.

When work prerequisites are complete, work is performed according to the approved work package. Designated hold, witness, and verification points are observed and released by qualified personnel. Approval for release of these points is documented in the work package. At the completion of work, records generated as a result of performing the work are collected into the package and a post-work review is held with the team of work performers to identify lessons learned. Lessons learned are used to improve the quality, efficiency, and safety of future work.

14.6.2 Design

Quality is designed into products, processes, and services by establishing and implementing the QAP, training personnel, seeking continual process improvement, and interfacing with the users of the product or service.

Codes, standards, and practices for the assurance of technical quality are identified and incorporated into the design of new or replacement items through system design requirements documentation. Design documentation incorporates the latest revisions of the applicable codes, standards, and practices in effect on the date of design approval. Exceptions to preserve maintainability or interchangeability are handled on a case-by-case basis and documented in the design description.

Whenever possible, new, replacement, and revised designs incorporate materials, components, and processes with proven use in similar applications. Applicable data and documentation are used whenever necessary to (1) identify SSC critical characteristics and design features, (2) validate requested changes, and (3) establish requirements for any design verification necessary for validation.

Some specifications or contracts require suppliers or contractors to design certain components. In these cases, supplier or contractor design is approved for technical adequacy only when sufficient design data has been furnished. This approval process ensures that the design meets requirements according to procurement documentation.

Engineering designs documented in drawings, specification and design analyses, system descriptions, engineering studies, and technical reports are verified according to approved procedures and instructions. Verification of designs, calculations, and functional requirements is discussed in the procedures delineating the design process.

The procedures identify the positions responsible for verification and require the identification and correction of design errors. Designs cannot be released without verification. Verification of designs is accomplished by individual or interdisciplinary design reviews, alternate calculations, or qualification testing. The alternate calculations verify the correctness of the original design calculations; qualification testing demonstrates adequacy of performance during the most adverse of design conditions. The extent of the design verification is based on the complexity, risk, and uniqueness of the design.

Specifications and calculations supporting the designs are also verified. Documentation of the design verification is provided by a design verification report signed by the appropriate individual.

Computer software is also subject to Quality Assurance requirements and procedures. The software QA requirements provide for detailed planning of development, verification and validation, configuration control, and operation and maintenance. Plans identify tasks, deliverables, and baselines for each phase of development, and required reviews, milestones and responsibilities for each task. Document reviewers and test witnesses are independent of (i.e., not responsible for) technical content of the document and product, and are competent in the technical discipline they are reviewing. Tests are performed to confirm that completed software performs its designated function, and plans are made for configuration control of the implemented software. Outputs are traceable to the software and hardware configuration used to produce the outputs, and are fully documented. Input data controls are specified in procedures, operating instructions, user manuals, or special application plans. Documentation is controlled in a centralized data directory. Software other than those produced under this procedure are likewise controlled, with appropriate documentation maintained and verification and validation procedure performed. Personnel involved in the assessment of computer software are subject to qualification requirements.

Design changes, including field changes and software changes, are subject to design control measures commensurate to those applied to the original design. Verification and review of design changes are performed to the same level as that of the original design. As-built changes are documented and verified through field walk-downs before the changes are incorporated into the as-built records.

14.6.3 Procurement

Procurement activities are planned and controlled to ensure an effective procurement process. Procurement methods and organizational responsibilities are documented in site procedures. The procurement process is managed to ensure that (1) accurate and complete procurement documents are prepared, (2) prospective suppliers of material, equipment, and services have the requisite capability to provide the material, equipment, and services, and (3) procured items and services are acceptable for use.

The TWRS QA organization is involved in the procurement process at several points. For procurements affecting safety SSCs, the TWRS QA organization participates in review and approval of procurement documents, including procurement specifications and scope-setting documents for the purpose of ensuring that (1) appropriate QA requirements will be imposed on the successful offeror, and (2) appropriate criteria for accepting the successful offeror's product are included.

Offerors or suppliers are evaluated and, if determined to be acceptable, are placed on an evaluated suppliers list (ESL). This ESL is maintained by FDH with supplier performance input from TWRS. Periodic desktop reviews of the supplier's QAP are conducted to ensure that the supplier's program continues to meet acceptance criteria specified in the purchase order. If the review reveals deficiencies, the supplier is instructed to bring the program into compliance. When deficiencies are found, any ongoing procurement with that supplier is flagged and scrutiny of the procured item or service is performed to ensure that delivered items and services continue to meet requirements.

Procurement of a safety SSC is typically awarded to a supplier that is listed on the ESL. However, there are provisions for procurement of a safety SSC from an offeror who is not on the ESL. When a decision is made to procure and accept an item from a nonlisted offeror, the item is subjected to qualifying inspections and tests. The inspections and tests are designed to determine the acceptability of the item for a safety application. When the results are acceptable, the item is dedicated to the application.

When a procurement specification requires a source inspection, TWRS personnel visit the supplier's facility to inspect the item and to evaluate supplier-generated documentation and processes associated with that item. Any deficiencies noted during the source inspection are communicated to the supplier, and the supplier is afforded an opportunity to bring the item into conformance and its documentation into compliance. When a procurement specification requires that an item be inspected for acceptability upon receipt at the Hanford Site, qualified inspection personnel perform receipt inspection. Delivered items that fail receipt inspection are controlled under the nonconformance system.

14.6.4 Inspection and Acceptance Testing

14.6.4.1 Inspection. TWRS SSCs are inspected or tested to ensure acceptability. This includes verifying that the use, maintenance, and storage of SSCs to prevent damage, loss, or deterioration is within design specifications.

Inspections of TWRS SSCs that are being installed or modified are performed as part of the activities defined in the Job Control System. SSCs that are procured for installation or use may undergo a source inspection or a receipt inspection.

14.6.4.2 Acceptance Testing. Acceptance testing is typically performed on systems comprising two or more interrelated components. An acceptance test of the system is required when it is

important that components function as a safety system with the facility infrastructure in which they are installed. Acceptance test procedures (ATPs) are generated, reviewed, and approved before acceptance tests are performed. The TWRS QA organization participates in the test preparation cycle to provide the quality perspective in the formation of the test plan and subsequent ATP. TWRS QA organization involvement includes (1) identifying hold, witness, or verification points in the ATP and (2) ensuring that appropriate and measurable acceptance criteria have been included. At the point of test performance, the TWRS QA organization provides qualified individuals to release the points identified in the ATP. When the ATP is completed, the work package is processed as a quality record.

ATPs specify the measuring and test equipment devices to be used during the acceptance test and the acceptance criteria for the devices. The actual measuring and test equipment devices used for the test are evaluated for compliance with acceptance criteria before the performance of the ATP. Measuring and test equipment is subjected to calibration evaluations at specified intervals to ensure the measured values are reliable. Post-test compliance, as specified in the ATP, is verified and recorded and becomes part of the quality record.

14.6.5 Assessment

Assessment organizations external to TWRS define their own process for assessments. The assessment processes are described in the following subsections.

14.6.5.1 Management Assessments. Management assessments of TWRS activities are conducted in accordance with requirements appearing in the TWRS-specific management assessment procedure. The TWRS QA Organization complements both independent and management assessments by providing more focused, in-depth evaluations related to compliance with the TWRS quality program. TWRS QA program evaluations are scheduled to ensure adequate coverage of TWRS programs that implement quality requirements. Adjustments to the annual schedule are made as necessary (1) to account for line organization activities that are behind or ahead of schedule, and (2) to address emergent issues.

14.6.5.2 Independent Assessment. TWRS activities are assessed by independent organizations to determine if the TWRS QAP is being satisfactorily implemented. The Facility Evaluation Board and Independent Program Assurance are independent external programs that assess TWRS activities. Other external independent assessment organizations are from or sponsored by the DOE Richland Operations Office or DOE Headquarters. In addition, the TWRS QA organization schedules, plans, performs, reports, and follows up on assessments of TWRS activities.

14.6.5.3 Assessment Results. Assessment results are documented and reported to management for information and action. The report becomes the official basis for triggering any corrective actions to address negative findings. Corrective action implementation is verified depending on the significance of the finding.

14.7 REFERENCES

10 CFR 830.120, "Quality Assurance Requirements," *Code of Federal Regulations*.

DOE 5480.23, 1994, *Nuclear Safety Analysis Reports*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE 5700.6C, 1996, *Quality Assurance*, Change 1, U.S. Department of Energy, Washington, D.C.

HNF-IP-0842, 1997, *TWRS Administration*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-MP-599, 1997, *Project Hanford Quality Assurance Program Description*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

The Price-Anderson Amendments Act of 1988.

WHC-CM-3-5, 1996, *Document Control and Records Management Manual*, Rev. 35, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-2, 1996, *Quality Assurance Manual*, Rev. 89, Westinghouse Hanford Company, Richland, Washington.

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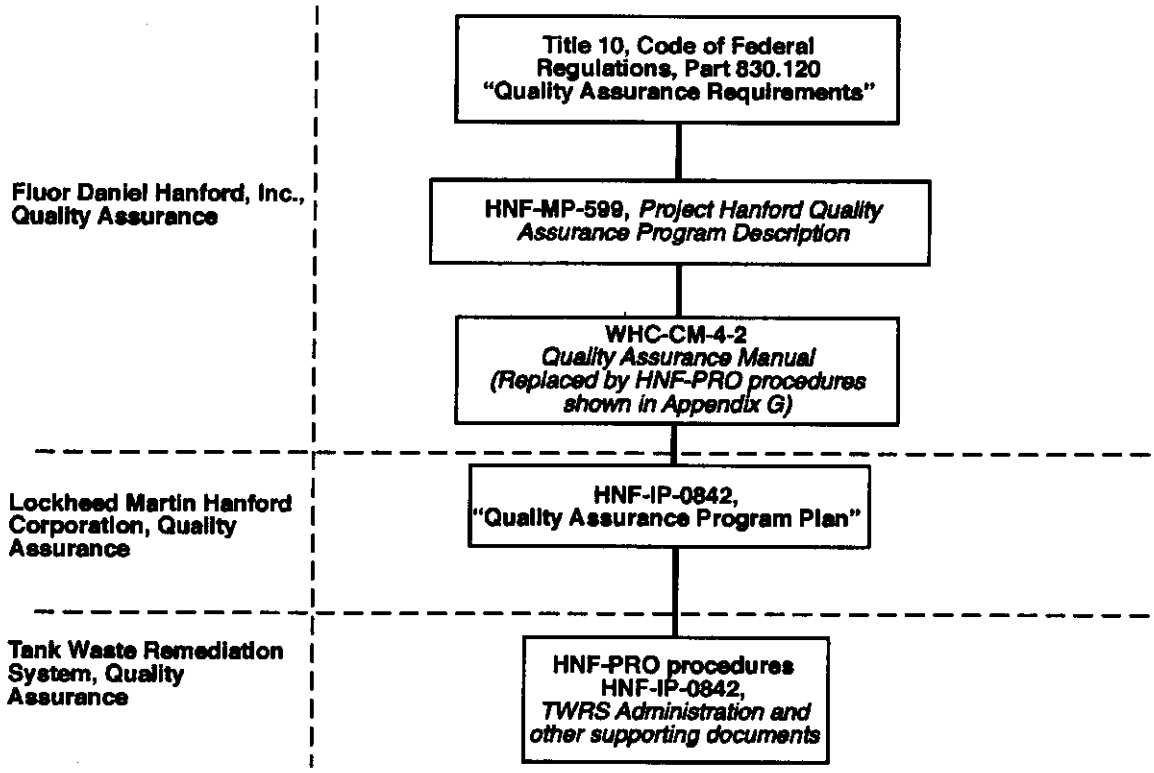
Figure 14-1. Hierarchy of Quality Assurance Implementing Manuals and Procedures.



10 CFR 830.120, "Quality Assurance Requirements," *Code of Federal Regulations*.

HNF-IP-0842, 1997, *TWRS Administration*, Volume XI, "Quality Assurance," Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-MP-599, 1997, *Project Hanford Quality Assurance Program Description*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-CM-4-2, 1996, *Quality Assurance Manual*, Rev. 89, Westinghouse Hanford Company, Richland, Washington. (Note that this manual has been superseded by the HNF-PRO procedures shown in Appendix G.)

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CHAPTER 15.0
EMERGENCY PREPAREDNESS PROGRAM

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CHAPTER 15.0
EMERGENCY PREPAREDNESS PROGRAM

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LIST OF TERMS

AWF	Aging Waste Facility
BED	Building Emergency Director
BWP	B&W Protec, Inc.
DACS	Data Acquisition and Control System
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy, Headquarters
DST	double-shell tank
DYN	DynCorp Tri-Cities Services, Inc.
EAL	Emergency Action Level
ECC	Emergency Control Center
EDO	Emergency Duty Officer
EMT	Emergency Management Team
EOC	Emergency Operations Center
EPP	Emergency Preparedness Program
EPZ	Emergency Planning Zone
ERO	Emergency Response Organization
ERPG	Emergency Response Planning Guideline
FDH	Fluor Daniel Hanford, Inc.
FDNW	Fluor Daniel Northwest, Inc.
HAZMAT	hazardous materials
HFD	Hanford Fire Department
HPT	health physics technician
IC	Incident Command
ICS	Incident Command System
JIC	Joint Information Center
LMHC	Lockheed Martin Hanford Corporation
MOU	Memorandum of Understanding
MSA	Mine Safety Appliance
ONC	Occurrence Notification Center
PAG	Protective Action Guideline
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
POC	Patrol Operations Center
PPE	personal protective equipment
PUREX	Plutonium Uranium Extraction (Facility)
RL	U.S. Department of Energy, Richland Operations Office
SCBA	self-contained breathing apparatus
SED	Site Emergency Director
TWRS	Tank Waste Remediation System
UDAC	Unified Dose Assessment Center
WNP-2	Washington Nuclear Power (Plant 2)

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15.0 EMERGENCY PREPAREDNESS PROGRAM

15.1 INTRODUCTION

This chapter describes the philosophy, objectives, and organization of the Emergency Preparedness Program (EPP) for response to emergencies at the Tank Waste Remediation System (TWRS) facilities. Also discussed are (1) specific building emergency plans detailed in DOE/RL-0223, *Emergency Management Procedures*; (2) relevant features of DOE/RL-94-02, *Hanford Emergency Response Plan*, and DOE/RL-93-75, *Hanford Facility Contingency Plan*; and (3) the TWRS EPP links to state and local offsite EPPs (Figure 15-1).

The TWRS EPP applies to all TWRS facilities described in Chapter 2.0, "Facility Description," and to all TWRS operations and personnel, including subcontractors, vendors, visitors, and noncontractor tenants. The scope of the TWRS EPP ensures that appropriate actions are taken to protect the health and safety of the workers, the public, and the environment. Effective response to the spectrum of hazards, accidents, and consequences addressed in Chapter 3.0, "Hazard and Accident Analyses," and in facility hazard assessments is assured through use of a graded approach.

15.2 REQUIREMENTS

The following U.S. Department of Energy (DOE) orders, regulations, standards, and codes contain specific emergency preparedness requirements that establish the safety basis for the TWRS facilities.

- 10 CFR 835, "Occupational Radiation Protection"
- 29 CFR 1910, "Occupational Safety and Health Standards"
- 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"
- 40 CFR 302, "Designation, Reportable Quantities, and Notification"
- 40 CFR 355, "Emergency Planning and Notification; EPA/Superfund, Emergency Planning, and Community Right-To-Know Programs"
- WAC 173-303, "Dangerous Waste Regulations" (1995)
- WAC 296-62, "Occupational Health Standards - Safety Standards for Carcinogens" (1995)

- DOE O 232.1, *Occurrence Reporting and Processing of Operations Information*, Change 1 (1995)
- DOE 5480.10, *Contractor Industrial Hygiene Program*, Change 0 (1985)
- DOE 5480.11, *Radiation Protection for Occupational Workers*, Change 3 (1992)
- DOE 5482.1B, *Environment, Safety, and Health Appraisal Program*, Change 1 (1991)
- DOE 5500.1B, *Emergency Management System*, Change 1 (1992)[1]
- DOE 5500.2B, *Emergency Categories, Classes, and Notification and Reporting Requirements*, Change 1 (1992)[2]
- HSRCM-1, *Hanford Site Radiological Control Manual* (1994).

15.3 SCOPE OF EMERGENCY PREPAREDNESS PROGRAM

The TWRS hazard analysis in Chapter 3.0 and the facility hazards and vulnerability assessments for each hazardous facility provide the technical basis for the TWRS EPP. The extent of planning and preparedness directly corresponds to the type and scope of the hazards identified for each facility and the potential accidents, fires, explosions, natural phenomena, and extrinsic events. The spectrum of accident categories, accident types, consequences, and protective actions is summarized in Table 15-1. Implementing details of the TWRS EPP are provided in WHC-IP-0971, *Tank Waste Remediation System Emergency Preparedness Program Plan*. The TWRS EPP is consistent with and coordinated by the Hanford Site EPP[3] through emergency plans and implementing procedures.

15.4 EMERGENCY PREPAREDNESS PLANNING

TWRS emergency preparedness planning comprises the Tank Farms Building Emergency Plan, emergency implementing procedures, the TWRS Emergency Response Organization (ERO), emergency facilities and equipment, and training and drills. Planning includes coordination with

[1]Entire order cancelled by DOE O 151.1, Change 2. Compliance with DOE 5500.1B is required until directed by the Contracting Officer to comply with DOE O 151.1.

[2]Entire order cancelled by DOE O 151.1, Change 2. Compliance with DOE 5500.2B is required until directed by the Contracting Officer to comply with DOE O 151.1.

[3]Hanford Site EPP identifies RL responsibilities.

RL, and the Site Contractor[4] EROs through emergency plans and procedures and training and exercises in accordance with DOE/RL-94-02.

The TWRS ERO is responsible for event recognition, initial consequence assessment, initial classification, and implementation of corrective and protective actions necessary to mitigate emergency conditions (Sections 15.4.2 through 15.4.5); for protection of the workers, the public, and to the environment; and for returning the facility to a safe condition. The TWRS ERO is responsible for responding to all emergencies involving TWRS facilities and activities in and around the 200 East and 200 West Areas. The TWRS EPP elements and facilities and the capabilities of the ERO (e.g., training, drills, assessments, notifications, recovery, and response structure) are described in WHC-IP-0971.

Interfaces among the TWRS ERO and other contractor emergency organizations are described in DOE/RL-94-02. Interface activities include coordination of personnel protective actions, emergency notifications, activation of emergency centers, communications, consequence assessments, mitigation, and event termination and recovery. Under this plan, the RL ERO, and the Site Contractor ERO provide support to the TWRS ERO at the event scene and consequence assessments and protective action recommendations for downwind areas (onsite and offsite). The TWRS ERO, supported by onsite or offsite EROs at the event scene, is responsible for all response activities with the exception of recovery operation. Recovery operations are overseen by RL with support by TWRS. RL interfaces with other onsite EROs and offsite agencies, including the DOE Headquarters Emergency Management Team (EMT).

15.4.1 Emergency Response Organization

Responsibilities of key individuals (primary and alternates) in the integrated TWRS and Site Contractor ERO are described in this section. The chain-of-command for notifying, alerting, and mobilizing the necessary response personnel is also described.

The Site Contractor ERO encompasses the TWRS ERO, the Patrol Operations Center Staff, and the RL ERO (Figure 15-2). When an emergency is declared, the Site Contractor ERO is activated to implement protective actions for Site personnel; to recommend protective action for offsite public; and to implement consequence assessment, event mitigation, and recovery actions. Responsibilities include technical, analytical, and emergency response support to contractor EROs that are conducting facility-level response actions. The Hanford Site emergency communication chain is shown in Figure 15-3.

The TWRS ERO (24-h coverage) is responsible for emergency response at the event scene. Each facility has a staff of trained and experienced individuals that assists in the protection of personnel, property, and the environment during an emergency.

[4]The term "Site Contractor" refers to the Fluor Daniel Hanford, Inc. (FDH), entity. The two terms are used interchangeably in the text. The term "contractors" is a general term for Project Hanford Management Contract team companies.

Emergency response actions are divided into hazardous and nonhazardous facility criteria. Emergency response actions implemented at nonhazardous facilities are designed to protect the facility personnel, visitors, and property. These actions are conducted by the personnel accountability aides. Staging area managers assist the personnel accountability aides by ensuring that personnel and visitors are properly evacuated from designated staging areas to a safe location from designated staging areas. Because the potential consequence for an emergency at hazardous facilities is much greater, the chain-of-command is more complex.

15.4.1.1 Tank Waste Remediation System Facility Emergency Response Organization. The TWRS ERO is responsible for emergency response at the event scene. Event response information is conveyed to and from the RL Emergency Operations Center (EOC). RL maintains responsibility for communication with offsite agencies as shown in Figure 15-3. Each hazardous facility (e.g., each tank farm) has an emergency staff of individuals who assist in the protection of personnel, property, and the environment. During an event, this staff is directed by the facility Building Emergency Director (BED). The key TWRS ERO positions and responsibilities are discussed in the following sections.

15.4.1.1.1 Building Emergency Director. The BED is the emergency coordinator for hazardous /facility-related events (WAC 173-303) and has the authority to commit all necessary facility resources (both equipment and personnel) in response to any emergency and to request supporting resources. Other responsibilities include (1) implementing a hazardous facility emergency plan; (2) ensuring that the TWRS ERO is fully staffed and trained; (3) initially assessing, categorizing, and classifying events; (4) notifying the Patrol Operations Center (POC) and applicable contractor and DOE management; (5) implementing protective actions; (6) establishing a TWRS Command Post; (7) controlling the event scene; (8) initiating mitigating activities; and (9) initiating recovery actions when directed. At tank farm facilities, the BED is a certified operations shift manager.

15.4.1.1.2 Command Post Staff. The Command Post staff is a group of TWRS emergency response personnel assigned to a Command Post established for an event. The BED, Hanford Fire Department Incident Commander, and Hanford Patrol Shift Commander direct all emergency response efforts at the event scene. Emergency response efforts for the Hanford Site are conducted in accordance with DOE/RL-0223, RLEP 1.1.

15.4.1.1.3 Event Scene Staff. The event scene staff comprises the TWRS Facility Operations Specialist, a Radiological Hazard Assessor, trained support staff (including Industrial Hygiene staff), and (as required) Hanford Fire Department medical responders and Hanford Patrol. The event scene staff, as directed by the TWRS Command Post, supports actions requested by the BED.

15.4.1.2 Site Contractor Emergency Staff. The Site Contractor emergency staff activate and operate the RL EOC. The RL EOC is staffed with RL, FDH, DynCorp Tri-Cities Services, Inc. (DYN), B&W Protec, Inc. (BWP), Pacific Northwest National Laboratory (PNNL) and Bechtel Hanford, Inc., personnel. The Site Emergency Director (SED) (Lockheed Martin Hanford Corporation [LMHC]) is a part of the RL Emergency Management Team staff and is responsible

for coordinating all site management team activities. The SED is responsible for the activities of the Event Support Coordinator (appointed by the EOC Operations Manager), EOC Operations Manager (RL or Site Contractor), and the Unified Dose Assessment Center (UDAC) Manager (RL or Site Contractor). The SED, in conjunction with the Safety Oversight Director (RL), is responsible for periodically providing status information to the RL Emergency Manager. The contractor representatives and Site Contractor Management Team Emergency Preparedness Advisor provide support to the SED.

15.4.1.3 U.S. Department of Energy, Richland Operations Office Emergency Operations Center Staff. The RL EOC staff comprises the RL EMT and staff in the UDAC, Occurrence Notification Center (ONC), and the Joint Information Center (JIC). The staff and responsibilities of these organizations are discussed in the following sections.

15.4.1.3.1 U.S. Department of Energy, Richland Operations Office Emergency Management Team. The RL EMT is staffed by RL and the Site Contractor emergency staff. The RL EMT is the decision-making body that manages all offsite interfaces and provides support of the Hanford Site emergency response effort. The RL manager directs operation of the RL EOC and serves as the EMT manager. In the absence of the RL manager, the RL deputy manager is the RL EMT manager. The RL EMT manager approves reclassification of events, approves recommendations for offsite protective actions, serves notifications, and determines event termination.

15.4.1.3.2 Representatives to the U.S. Department of Energy, Richland Operations Office Emergency Operations Center. Senior Site Contractor staff and managers provide liaison among the RL EOC and the Site Contractor emergency staff. These representatives can call on Site Contractor resources to aid RL during an emergency.

15.4.1.3.3 Unified Dose Assessment Center. The UDAC is staffed and operated by Site Contractor personnel for RL. The center is responsible for providing assessment, communications, and protective action recommendations in the areas of industrial hygiene, radiological assessment, environmental monitoring, and meteorology.

15.4.1.3.4 Occurrence Notification Center. The ONC is staffed and operated by Site Contractor personnel. The center is a 24-h/day operational facility equipped to support notification and communications regarding event information and occurrences affecting the Hanford Site to DOE Headquarters, RL, and state agencies. Additionally, the ONC will assist with offsite communication when the RL EOC is operational.

15.4.1.3.5 Joint Information Center. The JIC operates under the direction of the RL EMT and is managed and staffed by RL communications staff. The JIC is responsible for preparing and releasing public statements pertaining to an event. Provisions are made at the JIC for representatives from federal agencies, including tribal organizations, the states of Washington and Oregon, and the affected emergency planning zone (EPZ) counties that may be involved in the emergency response.

15.4.1.4 Outside Agencies. RL and the contractors have established arrangements to integrate emergency response resources. The coordination agreements for the emergency responses of both onsite and offsite organizations are described in this section.

15.4.1.4.1 Other Onsite Emergency Support Resources. Other Hanford Site emergency resources include the Hanford Fire Department (DYN), Emergency Duty Officer (FDH/DYN), and the Hanford Patrol (BWP). The Hanford Patrol serves as the security agency for the Hanford Site. In the event of an emergency, the Hanford Patrol provides services such as activating the crash alarm systems or area sirens, coordinating the movement of emergency responders through security gates, assisting evacuation, establishing barricades, and making initial emergency notifications.

The Site Contractor EDO is an on-call individual from the Site Contractor Emergency Preparedness staff. The EDO serves as the liaison between the TWRS Command Post and the EOC and assists the Command Post personnel with emergency preparedness requirements.

The Hanford Fire Department is the emergency response element responsible for confining and controlling potential fire emergencies (e.g., radiological, structural, range) within the Hanford Site. The Hanford Fire Department is also the designated hazardous material incident command agency responsible for control of all hazardous materials incidents on the Hanford Site, including fire control, hazardous materials, and personnel rescue response activities associated with an emergency.

15.4.1.4.2 Offsite Emergency Support Resources. RL (not the TWRS emergency staff) interfaces with federal, state, tribal, and local organizations for offsite emergency response and for protection of the environment and the public. These organizations assist RL in developing integrated programs and response plans for emergencies at the Hanford Site. Typical interfaces are with state and local EROs, the Hanford Environmental Health Foundation, local hospitals, police departments, sheriff departments, ambulance services, fire departments, and the American Red Cross. On the basis of the recommendation of RL, offsite agency support may include Hanford Site access control (e.g., because RL does not control State Highway 240, barricading State Highway 24 or 240) and evacuation assistance (e.g., traffic control, "clearing" public areas adjacent to the Hanford Site boundary). Additionally, the Washington Nuclear Power Plant 2, Benton and Franklin Counties, and the Thirteenth Coast Guard District may be requested to alert personnel on the Columbia River.

RL Safeguards and Security, the Hanford Fire Department, and the RL Quality, Safety, and Health Program Division execute and maintain Memoranda of Understanding (MOUs) with various offsite entities related to emergency preparedness assistance. Copies of MOUs are provided in DOE/RL-94-02, Appendix B.

15.4.2 Assessment Actions

To determine the extent of emergency response, assessments are performed to support emergency classification. These assessments can be subdivided into two types (i.e., preliminary and real-time). The real-time assessment is performed during the occurrence of an event. A preliminary assessment, or hazards assessment (HNF-SD-PRP-HA-013, *Tank Farm Hazards Assessment*), is performed prior to facility operations or when modifications to an existing facility or process have occurred. The preliminary assessment typically relies on accident analyses for the identification of potential emergencies and the associated consequences. These assessments are the basis for emergency classification.

The hazard assessment models for dose projection and radiological releases are different than the models used in the accident analyses in Chapter 3.0. The primary reasons for these differences are time and simplicity. While models used in accident analyses determine the design basis for controls, the models in hazard assessment provide the basis for emergency response procedures. To simplify verification of response procedures in the event of an accident, the computer programs calculate effects in about 5 min, providing the RL EOC verification data quickly to minimize their response time to an accident. The real-time assessment data is easily comparable with the data computed for the preliminary assessment. The calculations for the accident analyses are significantly more complex and time consuming. The results of the two techniques are not significantly different, and the use of real-time assessment is justified when rapid feedback is essential. The lengthy computations for the hazards assessment are justified by the need to have a pedigreed basis to support the accident analyses in Chapter 3.0.

For both real-time and preliminary assessments, dose projection and meteorological models are used to assess the potential consequences and impacts associated with each accident or event. The models used for the preliminary and the real-time assessment are the Hanford Unified Dose Utility Computer Program (Scherpelz 1991) and the Emergency Prediction Information Code Computer Program (Homann 1988). The Hanford Unified Dose Utility Computer Program calculates radiological releases by using a straight-line Gaussian distribution and Pasquill-Gifford stability classes. The Emergency Prediction Information Code Computer Program calculates hazardous chemical releases by using both plume and puff Gaussian dispersion modeling, depending on the projected release duration. Other Hanford Site–approved models (as described in WHC-IP-1201, *Guidance for Conducting Emergency Preparedness Hazards Assessment*) may also be used to calculate consequence assessment values.

Meteorological data for models is obtained from PNNL weather stations and local indicators. This data allows the characterization of atmospheric transport and diffusion conditions (e.g., wind speed, wind direction, stability) near TWRS facilities, which is essential for consequence assessment of airborne releases of hazardous materials during emergencies.

Releases to aquatic and ground pathways may not have the same time urgency as airborne releases; however, considerations of these pathways are part of the consequence assessment activities. The water and groundwater monitoring and environmental surveillance programs

required by DOE 5400.1, *General Environmental Protection Program*, are used to characterize transport and diffusion of accidental releases of hazardous materials to aquatic pathways in the vicinity of a TWRS facility.

15.4.2.1 Preliminary Assessment. A preliminary hazards assessment (HNF-SD-PRP-HA-013) evaluated the consequences of the accident scenarios in Chapter 3.0. In accordance with standard emergency preparedness practices, the assessment used the Emergency Prediction Information and Hanford Unified Dose Utility codes to calculate toxicological concentrations and radiological consequences. Consequences to hypothetical receptors, using default meteorological data, at 100 m (328 ft), State Highway 240, and at the site boundary were determined. The consequences are compared with the TWRS Emergency Action Levels (EALs) identified in DOE/RL-0223. The EALs identify specific, predetermined, observable criteria used to evaluate an event and determine the appropriate emergency classification level.

Emergencies are grouped into one of three classes according to magnitude of event severity (Tables 15-2 and 15-3): alert, site area emergency, and general emergency. The level of emergency classification triggers specified, preplanned, graded responses such as activation of the ERO and initiation of protective actions and appropriate notifications. TWRS emergency response actions and corresponding levels of emergency are described in WHC-IP-0263-TF, *Tank Farms Building Emergency Plan*.

15.4.2.2 Real-Time Assessment. The TWRS BED uses the EAL procedure, located in DOE/RL-0223, Appendix 1.2A, to recognize and determine an initial emergency classification. The EAL procedure is based on the accidents identified in Chapter 3.0. Real-time assessments involve event indicators (e.g., alarms, visual observations, local monitoring analysis, damage assessments) that are reported by event scene personnel. From this information the BED reviews the EAL procedure and determines if the event meets emergency classification criteria. The actions taken by the TWRS BED are shown in Figure 15-4.

If an event is classified as an emergency, the BED initiates a specific, preplanned, graded response that includes personnel protective actions, emergency notifications, and activation of Hanford Site and TWRS emergency centers and TWRS and Site EROs. Brief descriptions of response actions are stated in WHC-IP-0263-TF and in applicable emergency implementing procedures.

Preplanned response actions are based on the results of the preliminary hazards assessment (HNF-SD-PRP-HA-013). For example, assuming an accident occurred with the potential to impact State Highway 240, the BED determines if State Highway 240 will be affected based on the accident and the existing meteorological conditions. If State Highway 240 will be impacted, the BED promptly notifies the POC. The POC notifies the EDO of the accident and the potential to impact State Highway 240. The EDO notifies the SED who in turn notifies the RL EOC Emergency Management manager. It is the responsibility of the RL EOC Emergency Management manager to notify onsite and offsite agencies. Further discussion of closure of State Highway 240 is included in Section 15.4.5.1.11.

Individuals from tribal organizations, universities, or other federal, state, or local government agencies who have received approval from RL to access areas within the Hanford Site (e.g., Fitzner-Eberhardt Arid Lands Ecology Reserve) are also notified in an emergency. These individuals are required to receive emergency preparedness training and to be aware of the proper emergency response actions.

Following initial emergency classification and response, reiterative consequence assessments are performed by TWRS, event scene responders, and UDAC. UDAC has the primary responsibility for overall onsite (outside the event scene area) and offsite consequence assessments during an emergency. The UDAC assessments consider the event prognosis, actual accident conditions, real-time meteorological modeling, and airborne and ground concentration levels along with completed and projected mitigative actions. The results of these assessments are used to validate or revise the emergency classification, protective actions, and mitigative response actions.

15.4.3 Notification

If a TWRS-related emergency event were to occur, prompt and accurate emergency notifications would be performed to mitigate consequences and to protect the health and safety of workers, the public, and the environment. Emergency procedures identify initial and followup notifications of onsite and offsite organizations (e.g., federal, state, tribal, and local organizations). These procedures have been validated through drills, exercises, and actual events. The RL EOC is responsible for notification of affected areas and other contractors onsite. The spectrum of operational emergencies and the classification levels of those emergencies are summarized in Table 15-4.

15.4.3.1 Prompt Initial Notifications. The person who witnesses or discovers an abnormal or emergency condition promptly notifies the applicable TWRS BED and facility-assigned operator, and the POC (BWP) by telephone on 911.

All subcontractors (non-TWRS personnel) receive a pre-job briefing advising them of whom to contact in the event of an emergency (i.e., the BED). Visitors contact the POC by calling 911 in accordance with Hanford General Employee training or Visitor Vendor Orientation.

15.4.3.2 Onsite Notifications. Prompt onsite notifications are required as soon as an event is determined to threaten personnel safety. The BED ensures activation of appropriate system facility take-cover sirens and direction to the POC to make crash-alarm telephone system notifications. Once the event is classified, the BED directs the POC to initiate emergency notifications for onsite and offsite EROs.

15.4.3.3 Offsite Notifications. After being notified of the classification of an emergency event, the POC duty officer and available staff make offsite notifications to DOE Headquarters and other potentially affected federal, state, tribal, or local organizations. The RL EMT oversees the offsite contractor notifications.

The release of public information, which is integrated through the RL JIC, is an integral part of the emergency management programs. Offsite agency interfaces and mutual assistance agreements are documented in the MOU. Information is provided to the public and to employees during the course of an emergency. The RL, state, and local governments share in this responsibility. Each response organization speaks to the individual area of responsibility.

15.4.3.4 Followup Notifications. When operational, the RL EOC is responsible for followup notifications when emergencies are reclassified or terminated. If the RL EOC is not operational, the followup notifications are made by the TWRS BED through the POC.

15.4.4 Emergency Facilities and Equipment

Emergency facilities provide a location for coordinating emergency response activities. Emergency equipment includes the materials and tools that may be required to measure, control, or mitigate the consequences of an emergency.

15.4.4.1 Emergency Facilities.

15.4.4.1.1 Tank Waste Remediation System Emergency Facilities. TWRS emergency facilities include a Command Post and a Decontamination Center. The designated locations for the TWRS Command Posts are in the 272-AW Building (200 East Area Tank Farms) and the 278-WA Building (200 West Area Tank Farms) with alternate locations selected by the TWRS BED when conditions become unsafe at the designated locations. The Command Post provides a central location for controlling all response activities and interactions with the RL EOC, the POC, and the Hanford Fire Department. To assist the Command Post, the BED establishes an event scene response location.

As required, the 272-AW Decontamination Center can be activated for contaminated personnel. If the 272-AW Decontamination Center cannot be used, other decontamination centers at other 200 Area facilities can be used (e.g., 222-S Laboratory, T Plant, Plutonium Finishing Plant, B Plant). The decontamination centers provide a location for decontaminating personnel who are not injured or severely contaminated. Injured or severely contaminated personnel are transported to the offsite Emergency Decontamination Facility.

15.4.4.1.2 U.S. Department of Energy, Richland Operations Office Emergency Facilities Supporting Tank Waste Remediation System. The RL EOC is located in the Federal Building, 825 Jadwin Avenue, Richland, Washington. The RL EOC, UDAC, and ONC are dedicated facilities in the basement of the Federal Building. The JIC is a dedicated facility on the main floor of the Federal Building. Telecommunications, word processing, and duplicating services are provided to support JIC participating agencies and the media. The center may also dedicate the use of the auditorium, portions of the lobby, and other areas in the Federal Building, as needed. The emergency centers and area of responsibility are shown in Table 15-5.

The POC is located at the 2721-E Building in the 200 East Area and acts as a single point of contact for RL and onsite contractors.

The Emergency Decontamination Facility (adjacent to the Kadlec Medical Center in Richland) contains unique equipment for performing minor medical procedures and decontamination on severely contaminated persons with injuries that are not life threatening. The locations of emergency facilities are shown in Figure 15-5.

15.4.4.2 Emergency Equipment. The TWRS has fixed and portable emergency equipment located throughout the facilities. The majority of emergency equipment is staged in designated areas to provide response capabilities throughout all facilities. Emergency equipment locations are discussed in WHC-IP-0263-TF. All emergency equipment is inventoried and inspected to ensure availability, assessibility, and operational status. A listing of TWRS emergency equipment is located in Table 15-6.

15.4.4.2.1 Tank Waste Remediation System Nonradiological Hazardous Emergency Response Equipment. Hazardous material spill kits are used to clean up nonradiological hazardous material spills and are located in chemical areas next to diesel-operated equipment and battery stations. Acid gear is available in areas where acids are stored and used during process operations (e.g., 204-AR Waste Unloading Facility). The Hanford Fire Department maintains spill response equipment for minor and major releases of nonradiological hazardous materials listed in DOE/RL-93-75.

15.4.4.2.2 Tank Waste Remediation System Radiological Emergency Response Equipment. The radiological emergency response equipment is stored in designated radiological emergency response vehicles, change trailers, change rooms, and designated storage areas. The equipment includes personal protective clothing, radiological monitoring instrumentation (e.g., meters, air samplers respirators, self-contained breathing apparatus, radiation rope, caution rope, and boundary flags). The equipment is used during radiological emergency events. The equipment is described in HNF-IP-0718, *Health Physics Technical Practices and Procedures*.

15.4.4.2.3 Tank Waste Remediation System Operations Response Emergency Equipment. The inventory and storage of the operations response emergency equipment is in accordance with HNF-IP-0263, *Tank Farm Building Emergency Plan*.

15.4.4.2.4 Tank Waste Remediation System Communications Equipment. The commercial telephone system is the primary means of communication for the TWRS facilities. Cellular telephones and radios (i.e., mobile, hand-held, and base stations) back up the commercial telephone system. Commercial and cellular phones can be used to contact all emergency personnel and organizations for the Hanford Site. If the telephones fail, radio communications can be relayed through the POC.

15.4.4.2.5 Tank Waste Remediation System Firefighting Equipment. TWRS facilities use fixed fire alarm systems and, in the majority of hazardous facilities, a sprinkler system. The Data Acquisition and Conditioning System trailer in 200 West Area uses a Halon fire

suppression system. TWRS also has portable fire extinguishers (ABC type) located throughout all buildings that can be used to extinguish small fires. The fire alarm system is used to notify personnel and the fire department of a potential or actual fire situation. The fire sprinkler systems are used for fire suppression. Other firefighting equipment is under the control of the Hanford Fire Department.

15.4.4.2.6 Tank Waste Remediation System Emergency Lighting. Where required, emergency lighting is provided for evacuation of TWRS buildings. The lighting is not intended for reentry into a facility for response activities.

15.4.4.2.7 Tank Waste Remediation System Operational Alarms. TWRS hazardous facilities are equipped with operational alarms for abnormal and emergency conditions, such as the waste tank pressurization alarm (located in double-shell tank farms only), radiation alarms (located in and near radiation areas), and other alarms that provide event indications of a potential or actual emergency (e.g., an exhaust stack continuous air monitor and high-efficiency particulate air filter low differential pressure alarms). All alarms are tested monthly.

15.4.4.2.8 Tank Waste Remediation System Facilities and Site Area Sirens. TWRS buildings (272-AW and 272-WA) are equipped with internal take-cover and evacuation sirens, which are activated by Operations. The 200 Area take-cover and evacuation sirens are located throughout the 200 Areas and are operated by the POC, Site Contractor SED, or Site Contractor EDO. When activated for an emergency, the sirens are turned on for 3 min. The sirens are tested monthly. Personnel inside trailers have difficulty hearing the sirens. Backup notification for personnel inside the trailers and throughout the Site is by telephone.

15.4.4.2.9 Hanford Site Communications Equipment. The Hanford Site communication system comprises a commercial telephone system, cellular telephones, two-way radios, computerized notification systems (i.e., emergency notification system and a priority message system), a secured communication system, and emergency signals (i.e., sirens, bells, alarms). The primary emergency communication device is the commercial telephone system. If the commercial telephones cannot be used, backup devices are cellular telephones and radios.

15.4.5 Protective Actions

Protective actions are those actions taken to prevent or minimize the exposure of individuals to hazards or unsafe conditions during an emergency at a TWRS facility. Protective action recommendations for the TWRS facilities reflect the use of chemical emergency response planning guidelines (AIHA 1988) and radiological protective action guidelines (EPA 400-R-92-001, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*) and are consistent with DOE direction. The AIHA (1988) emergency response planning guidelines are used during a TWRS emergency response to determine protective actions for unique exposures to chemical releases (Table 15-7). The protective action guidelines included in DOE/RL-0223 are used during a TWRS emergency response to determine protective actions for unique exposures to radiological releases (Table 15-2). RL directs use of the protective action

guidelines (adopted by the states of Washington and Oregon) on the basis of the criteria published in EPA 400-R-92-001 and DOE/RL-94-02.

The Hanford Site emergency management program uses the EPZ concept to focus emergency planning activities. EPZs are designated areas where protective actions may be required. The size of an EPZ is determined primarily by the expected dispersion distance of a particular concentration of substance. The two exposure pathways for radiological and nonradiological hazardous materials are (1) the plume exposure pathway and (2) the ingestion exposure pathway. Figure 15-6 illustrates the Hanford Site default EPZs.

The plume exposure pathway EPZ is the probable area of exposure to a passing cloud, or plume, that could result in direct contact with the substance through the exterior of the body or through inhalation. To ensure that prompt and effective actions are taken in an emergency and to protect onsite personnel and public health and safety, the plume exposure pathway EPZ includes the area where emergency planning is conducted. The plume exposure EPZ for the 200 East and 200 West Areas is 16 km (10 mi) (DOE/RL-94-02).

The ingestion exposure pathway EPZ is the probable area of exposure to contaminated foods or water that may result in deposition of hazardous material in various internal organs following ingestion. The ingestion exposure pathway EPZ for radiological and nonradiological incidents for all Hanford Site facilities corresponds to the 80-km (50-mi) EPZ for Washington Nuclear Power Plant 2 (DOE/RL-94-02).

The protective actions required to minimize the exposure of workers and the public are summarized in the following subsections. Examples of protective actions as a function of accident category and consequence are illustrated in Table 15-1.

15.4.5.1 Initial Protective Action Responses at the Facility. The TWRS BED is responsible for initial protective actions at the event scene, TWRS facilities, and impacted 200 Area (East and West) (Figure 15-4). These preplanned actions include the following:

- Immediately evacuating the impacted area (event scene)
- Obtaining emergency medical assistance for any injured personnel through the POC
- Implementing a take-cover (sheltering) through the POC
- Immediately evacuating downwind facilities (if time allows and if evacuation can be performed safely)
- Shutting down plant operations
- Conducting event scene personnel accountability

- Establishing traffic controls to secure the event scene
- Monitoring event scene personnel
- Directing use of personnel protective equipment

The specific event determines the initial protective actions at the facility (e.g., waste tank fire/explosion requires a 300-m [1,000-ft] evacuation area and subsurface leaks creating surface pools [Section 3.4.2.8] require evacuation of onsite receptors within 30 min after detection of the waste leak). Other actions may include emergency rescue decontamination of personnel. If downwind facilities cannot be evacuated safely, hazardous material monitoring is established for the facility and an action plan is developed to move facility personnel to a safe location, where personnel monitoring is conducted.

15.4.5.1.1 Emergency Evacuation. Planning for emergency evacuations includes determining safe evacuation routes, estimating evacuation time, assessing transportation needs, and planning for possible relocation of emergency facilities. TWRS preparations include training personnel in what protective actions are required when the evacuation sirens are activated.

Emergency evacuation procedures are described in the building emergency plan. Evacuation procedures include siren activation criteria, evacuation route communication, personnel transportation, and protective actions for personnel immediately adjacent to the event. In conjunction with annual drills, building management and employees review evacuation training through either formal training or informal notification. The activation of the standard Hanford Site evacuation siren, which has a steady tone, alerts personnel that an evacuation is in progress. Some of the facilities also are equipped with interior evacuation sirens and crash-alarm telephones. Facility evacuation routes are designated by the TWRS BED. Evacuation routes for 200 East or 200 West Area events are determined by the area RL EOC in response to existing event location and meteorological conditions. Once determined, the evacuation routes are communicated to all 200 Area facilities.

15.4.5.1.2 Sheltering (Take Cover). Sheltering is the preferred initial protective action for an airborne release of hazardous materials, except at the event scene where an immediate evacuation is performed. Sheltering is implemented to reduce exposure and contamination impact on area personnel. Once the projected release path is identified, actions are taken to safely move personnel out of the impacted area.

15.4.5.1.3 Relocation of Emergency Facilities. Unsafe onsite conditions (e.g., degraded building integrity, plume meander, and projected radiological dose levels) may cause relocation of emergency facilities to alternate locations selected by the TWRS BED.

15.4.5.1.4 Plant Shutdown. TWRS emergency plant shutdown procedures detail immediate emergency response actions to prevent or reduce impacts to the public, workers, and the environment. Plant shutdown entails putting the plant into a safe configuration upon discovery of an event and ceasing all non-essential operations.

15.4.5.1.5 Access and Traffic Control. A single point of entry and egress is established to control access to the event scene and the TWRS Command Post. Roadblocks established in safe locations prevent entry into the event scene and downwind locations.

15.4.5.1.6 Use of Protective Equipment. Protective clothing and respiratory equipment may be used to provide a protective barrier to minimize exposure to radiological and hazardous material contamination during response to emergencies.

15.4.5.1.7 Food Control. Intervention levels for offsite foods are based on Food and Drug Administration guidelines and are described in the Washington State procedure, *Derived Intervention Levels* (WASH 1991). The RL EMT provides recommendations to the offsite agencies when applicable.

15.4.5.1.8 Personnel Monitoring. Personnel will be monitored for radiological contamination at the scene to determine appropriate actions, (i.e., segregate from noncontaminated personnel, secure areas where contamination has been spread, transport contaminated personnel to decontamination facility).

15.4.5.1.9 Exposure and Contamination Controls. These controls are to prevent overexposure of response personnel during the initial response phases and thereafter and to reduce or prevent the spread of contamination by responders or vehicles.

15.4.5.1.10 Event Scene Controls. Event scene controls and response actions are implemented in accordance with the Incident Command System described in DOE/RL-0223.

15.4.5.1.11 State Highway 240 Closure. If the event may impact State Highway 240, the TWRS BED identifies and classifies the event and notifies the POC. The POC coordinates with these agencies directly to ensure rapid closure of the highway. POC and Hanford Patrol are developing MOUs with the Washington State Patrol and Benton County Sheriff Department to allow Hanford Patrol to implement closure and evacuation of the State Highway.

15.4.5.1.12 Columbia River Closure. DOE/RL-0223 covers emergency response procedures on alerting community members and personnel on the Columbia River.

When the BED declares a Site or General Emergency in a 200 Area facility, the BED contacts the POC as required by procedures. The POC contacts the PNNL Duty Officer and notifies him/her to alert the community members and personnel on the Columbia River from Vernita to Leslie Groves Park, and requests the River Alerting Staff from PNNL to respond to their designated boat launch areas. The PNNL Duty Officer relays information on hazardous materials to the boat crews. The POC then advises the RL EOC Patrol Liaison of the circumstances. The POC advises the RL EOC when the boat crews arrive at their pickets. If the event involves a potential or actual radiological release, the ONC contacts K-Basins Radiological Control and tells them to report to monitoring stations at the Vernita Boat Launch. ONC notifies the Supply System Security Communications Center to send a river monitoring team and Benton County to send a boat to Leslie Groves Boat Launch. Radiological survey teams will consist of

two radiological control technicians and a manager, who will establish an area from which to conduct monitoring and surveys of personnel and a decontamination section. If decontamination is required, the team requests dispatch of the Hazardous Materials Team from the Hanford Fire Department. PNNL boat crews at the Vernita launch prevent boats from entering the contaminated area and continue monitoring activities. If radiation is detected at more than twice background levels, they contact the Field Team Coordinator for more information on releases, moving to best suit the actual conditions reported by the Field Team Coordinator.

15.4.5.1.13 Airspace Closure. Once it has been determined during a Site or General Emergency that hazards may affect airspace over the Hanford Site, the ONC notifies the Federal Aviation Administration Seattle Center. The ONC requests that the Federal Aviation Administration impose flight restrictions over the Hanford Site, in accordance with MOUs in DOE/RL-94-02.

15.4.5.2 Follow-on Actions. Follow-on actions to initial emergency responses may include rescue, medical support, or decontamination.

15.4.5.2.1 Emergency Rescue. The Hanford Fire Department is qualified to provide emergency rescue services and assist injured or severely ill personnel from work locations in the TWRS facilities.

15.4.5.2.2 Medical Support. The Hanford Environmental Health Foundation is the primary provider for professional medical assistance for the Hanford Site. Medical staff are available for emergency assistance 24 h a day and have been trained in contaminated- or exposed-victim medical techniques. Secondary medical services are available at Kadlec Medical Center in Richland with backup services at Kennewick General Hospital and at Our Lady of Lourdes Health Center in Pasco.

15.4.5.2.3 Decontamination. Noninjured, contaminated personnel are decontaminated in designated Site decontamination facilities (e.g., 272-AW, 222-S Laboratory, Plutonium Finishing Plant, B Plant).

Patients with nonlife-threatening injuries who are severely contaminated are cared for in the Emergency Decontamination Facility which provides for patient decontamination, treatment of internal contamination, and minor medical treatment for persons who are radiologically contaminated and have minor injuries. The Emergency Decontamination Facility is staffed by Kadlec Medical Center and Hanford Environmental Health Foundation personnel.

Patients with life-threatening injuries who are contaminated are cared for in the local hospital emergency rooms. The hospital prepares to receive a contaminated/injured person by establishing radiological controls outside and inside emergency rooms. Hospital staff is supported by Site Radiological Control personnel (FDH, PNNL) for the patient care and, when necessary, additional hospital staff. Site Radiological Control personnel also perform hospital area surveys and decontamination. Hospital care includes accepting patients transported by Hanford Fire Department, assuming responsibility for patient care once a patient arrives at the hospital, and

coordinating with Mid-Columbia emergency medical services, Tri-City trauma services, and other agencies for support and air transport as needed.

15.4.6 Training and Exercises

The TWRS Emergency Response Training Program ensures the readiness of the TWRS Emergency Preparedness organization as well as general employee awareness of hazards and response actions. This program is part of the overall Site Contractor training program and may involve classroom instruction, tabletop exercises, facility walk-throughs, on-the-job training, and drills. The effectiveness of the training program is evaluated by the Site Contractor-written examinations, qualification cards (knowledge-performance objectives), and emergency drills and exercises. Emergency drills and exercises of sufficient scope and detail are conducted annually to evaluate demonstration of adequate response capability in appropriate areas.

Training is provided annually to workers who have to take protective actions in an emergency (Table 15-8). This training may be provided through general employee training and participation in drill and exercise programs depending on individual responsibilities.

All visitors, vendors, contractors, and consultants receive a safety and emergency preparedness orientation to the Hanford Site. This orientation is required once every 12 mo and is offered on a drop-in basis. As appropriate, RL offers training programs to offsite organizations that may perform emergency tasks. Training may involve facility-specific orientations, hazard information, and emergency response procedures commensurate with the level of response required. Training is provided at the request of and in conjunction with the states, tribes, and counties (DOE/RL-94-02).

15.4.6.1 Tank Waste Remediation System Emergency Response Training. The TWRS Emergency Response Training Program is based on TWRS building emergency plans and implementing procedures. TWRS managers are responsible for ensuring that all of their personnel receive TWRS Emergency Response Training within 30 days of hiring or reassignment and annually thereafter.

15.4.6.1.1 Building Emergency Directors Training. Training for BEDs includes the TWRS shift manager/operational engineer certification program, TWRS Emergency Response Training, and emergency response training provided by the Site Contractor emergency preparedness organization.

15.4.6.1.2 Command Personnel Training. Command-post personnel receive training in accordance with DOE/RL-94-02.

15.4.6.1.3 Staging Area Managers and Personnel Accountability Aides Training. TWRS staging area managers and personnel accountability aides for nonhazardous support facilities receive TWRS nonhazardous ERO training before ERO assignment and annually thereafter.

15.4.6.2 Tank Waste Remediation System Facility Emergency Drill Program. Emergency drills are conducted to provide training for the emergency staff in the use of emergency facilities, equipment, procedures, and communication channels. These drills are developed and conducted by TWRS Emergency Preparedness personnel.

Facility operations drills are performed by the appropriate TWRS operations organization. These drills are performed on-shift by Operations personnel for training, evaluation, and improvement of response skills. Systems are in place to track corrective actions as a result of drills.

15.4.6.3 Hanford Emergency Exercise. The Site Contractor emergency exercise program organization is responsible for administering the Site Contractor emergency exercise program in accordance with DOE/RL-94-02. The organization develops and maintains a 5-yr schedule to ensure that each reactor and hazardous facility participates in one exercise with the RL EOC and the TWRS Command Post. Offsite agencies, including DOE Headquarters and appropriate federal, state, tribal, and local organizations, are invited to participate in the annual RL field exercises and preparatory tabletop exercises. Systems are in place to track corrective actions as a result of emergency exercises.

15.4.7 Reentry and Recovery

Provisions for emergency event termination, facility reentry, transition from an emergency organization to a recovery organization, and recovery provisions are summarized in this section.

15.4.7.1 Emergency Event Termination. An emergency is officially terminated when the event is stabilized (i.e., under control); protective actions are implemented; all applicable emergency closeout checklist criteria are met; and the event Contractor and the TWRS BED, Hanford Fire Department Incident Commander, Site Contractor SED, and RL EMT Manager agree that termination can be declared. The RL EMT Manager makes the official emergency termination declaration and directs that the notifications be made to the federal, state, and local authorities.

15.4.7.2 Facility Reentry Provisions. Authorization by the RL EMT manager is required for reentry at any time during the emergency except in cases where immediate action is required for saving a life, minimizing injury, or minimizing damage. In these urgent cases, the BED and Hanford Fire Department Incident Commander authorize reentry. The Site contractor responsible for the facility, in coordination with the RL EMT, determines the accessibility of the areas during and after the emergency and evaluates the advisability of reentry operations.

15.4.7.3 Transition from Emergency Organization to Recovery Organization. Hanford Site (RL) and offsite emergency organizations develop recovery staffing plans necessary to return the affected facility and surrounding areas to normal after termination of the event.

15.4.7.4 Recovery Provisions. The RL EMT directs recovery planning for Hanford Site facilities and supports the offsite recovery efforts of federal, state, and local agencies. The

recovery support teams comprise sufficient staff, including facility staff, to perform all functions applicable to the situation.

15.5 REFERENCES

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29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*.

40 CFR 302, "Designation, Reportable Quantities, and Notification," *Code of Federal Regulations*.

40 CFR 355, "Emergency Planning and Notification; EPA/Superfund, Emergency Planning, and Community Right-To-Know Programs," *Code of Federal Regulations*.

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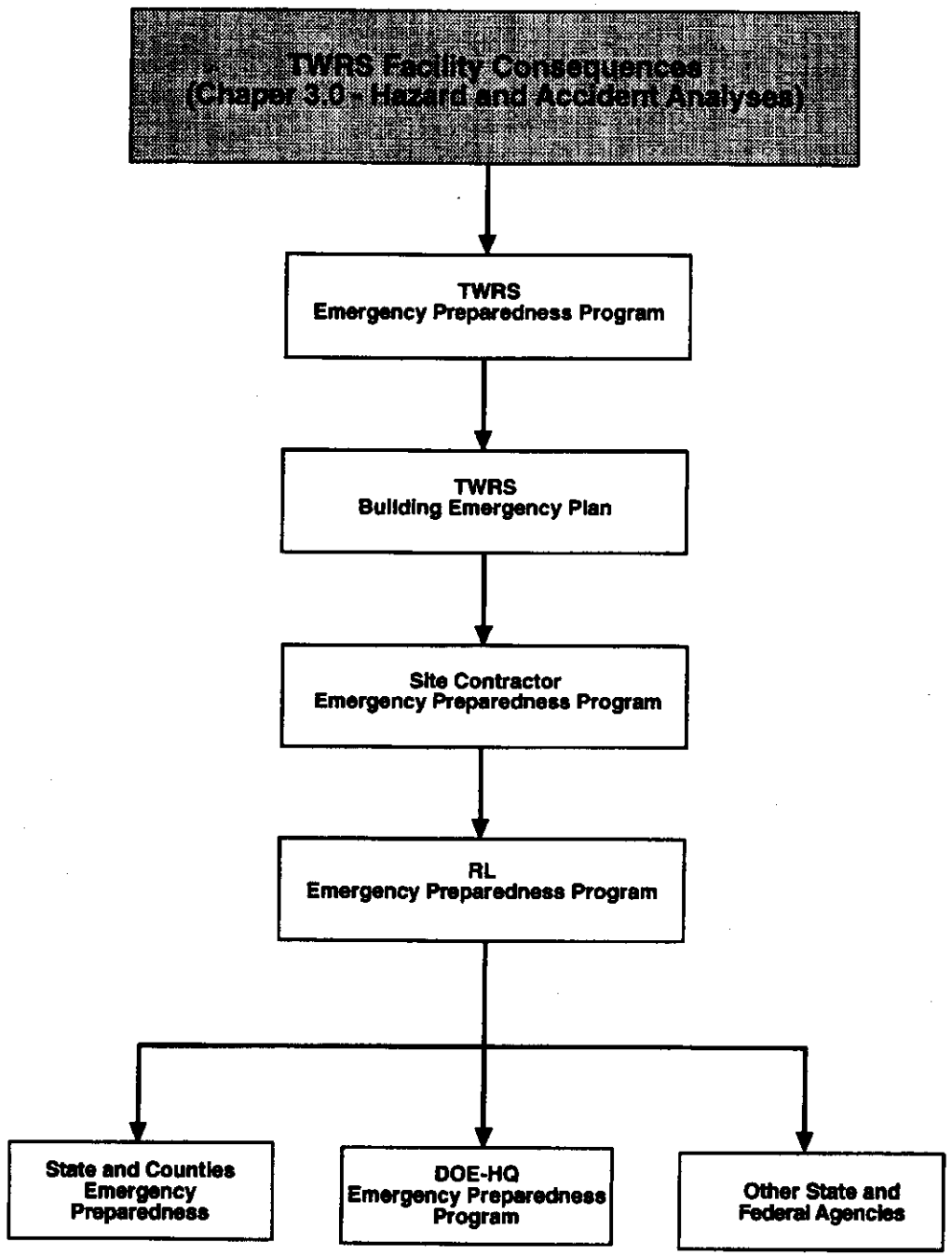
Figure 15-1. Links Between the Tank Waste Remediation System Emergency Preparedness Program and Other Emergency Preparedness Programs.



DOE-HQ = U. S. Department of Energy, Headquarters.
RL = U. S. Department of Energy, Richland Operations Office.
TWRS = Tank Waste Remediation System.

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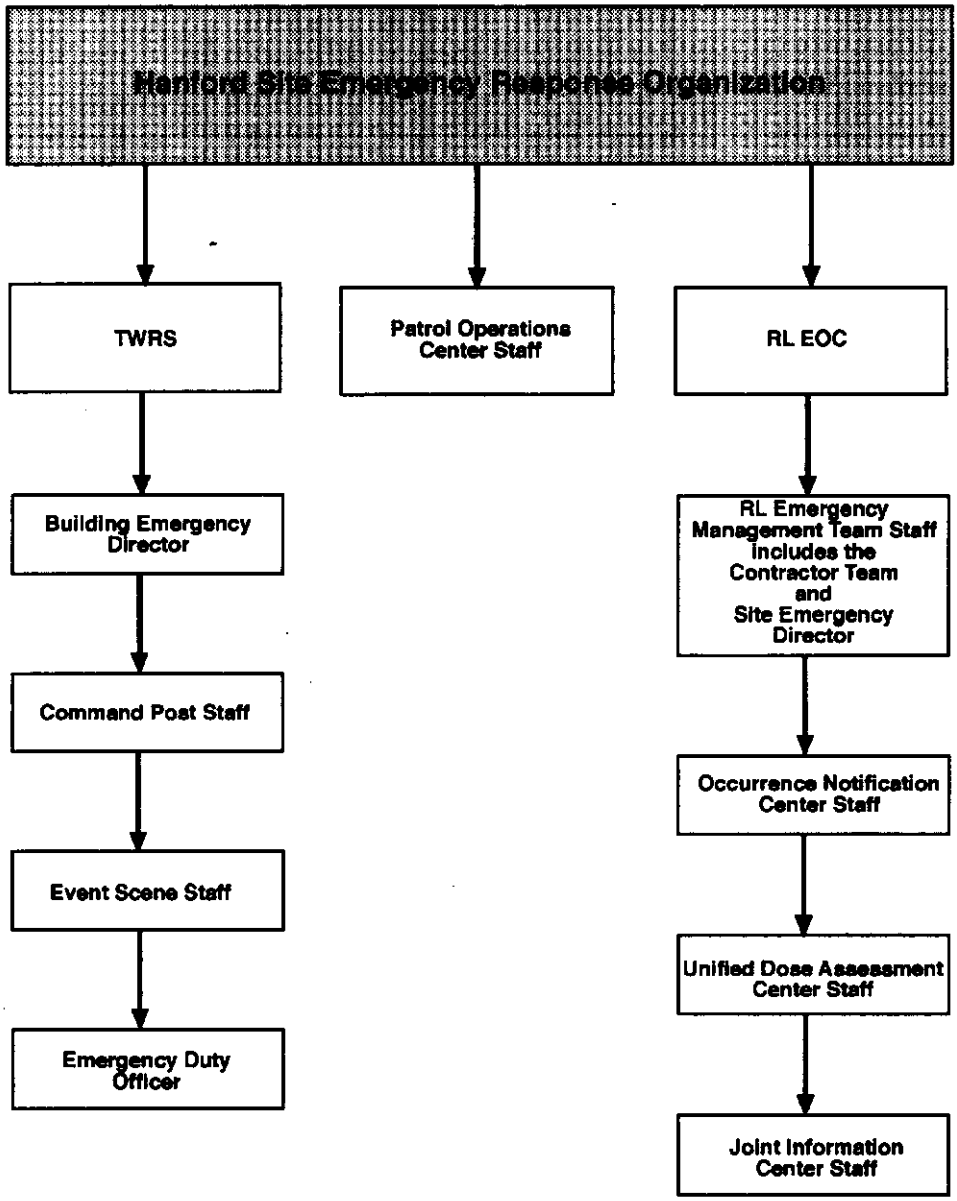
Figure 15-2. Hanford Site Emergency Response Organization.



EOC = Emergency Operations Center.
RL = U. S. Department of Energy, Richland Operations Office.
TWRS = Tank Waste Remediation System.

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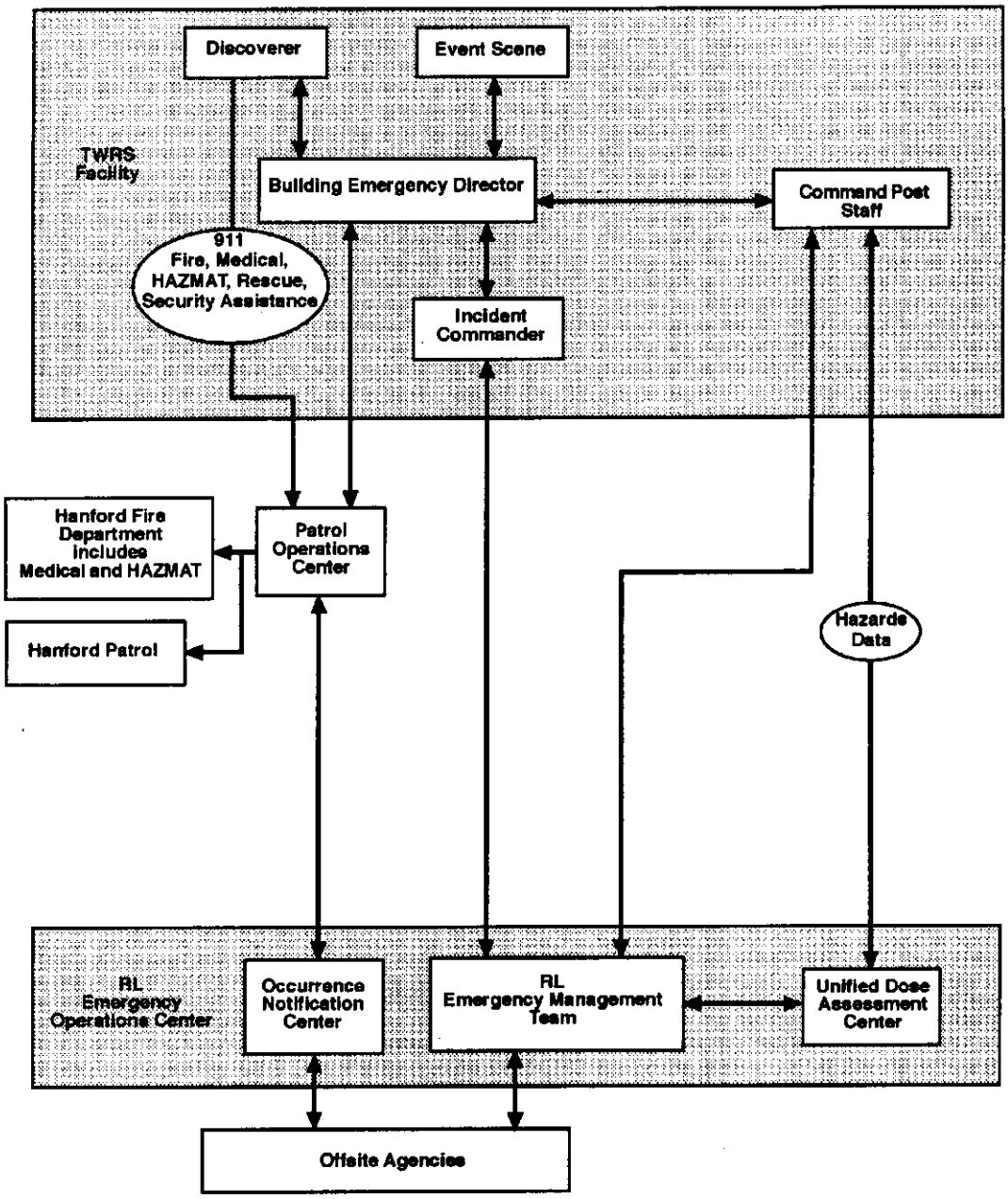
Figure 15-3. Hanford Site Emergency Communication Chain.



HAZMAT = hazardous materials.
RL = U. S. Department of Energy, Richland Operations Office.
TWRS = Tank Waste Remediation System.

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Figure 15-4. Flow Diagram for Assessment Actions. (3 sheets)

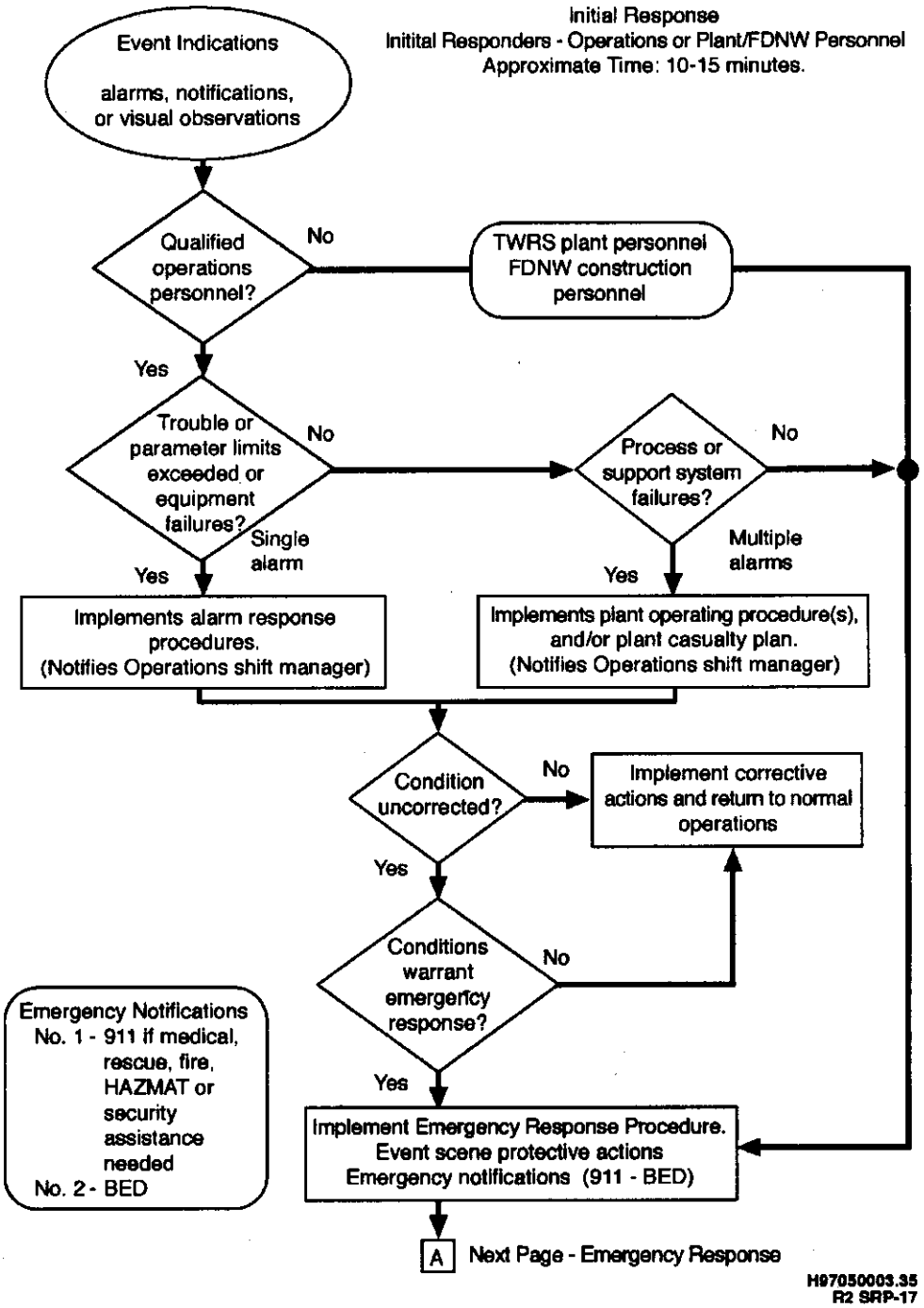


Figure 15-4. Flow Diagram for Assessment Actions. (3 sheets)

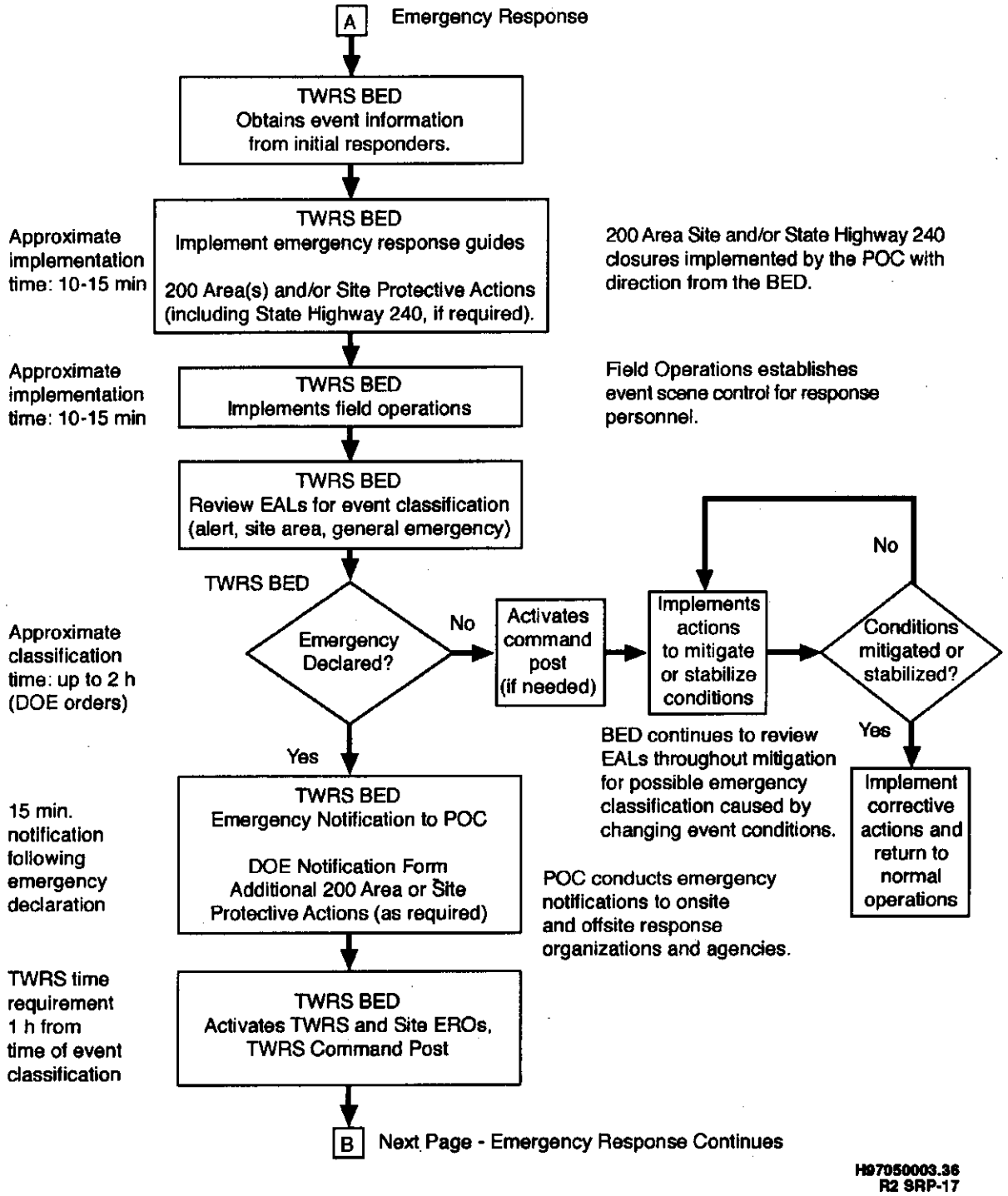
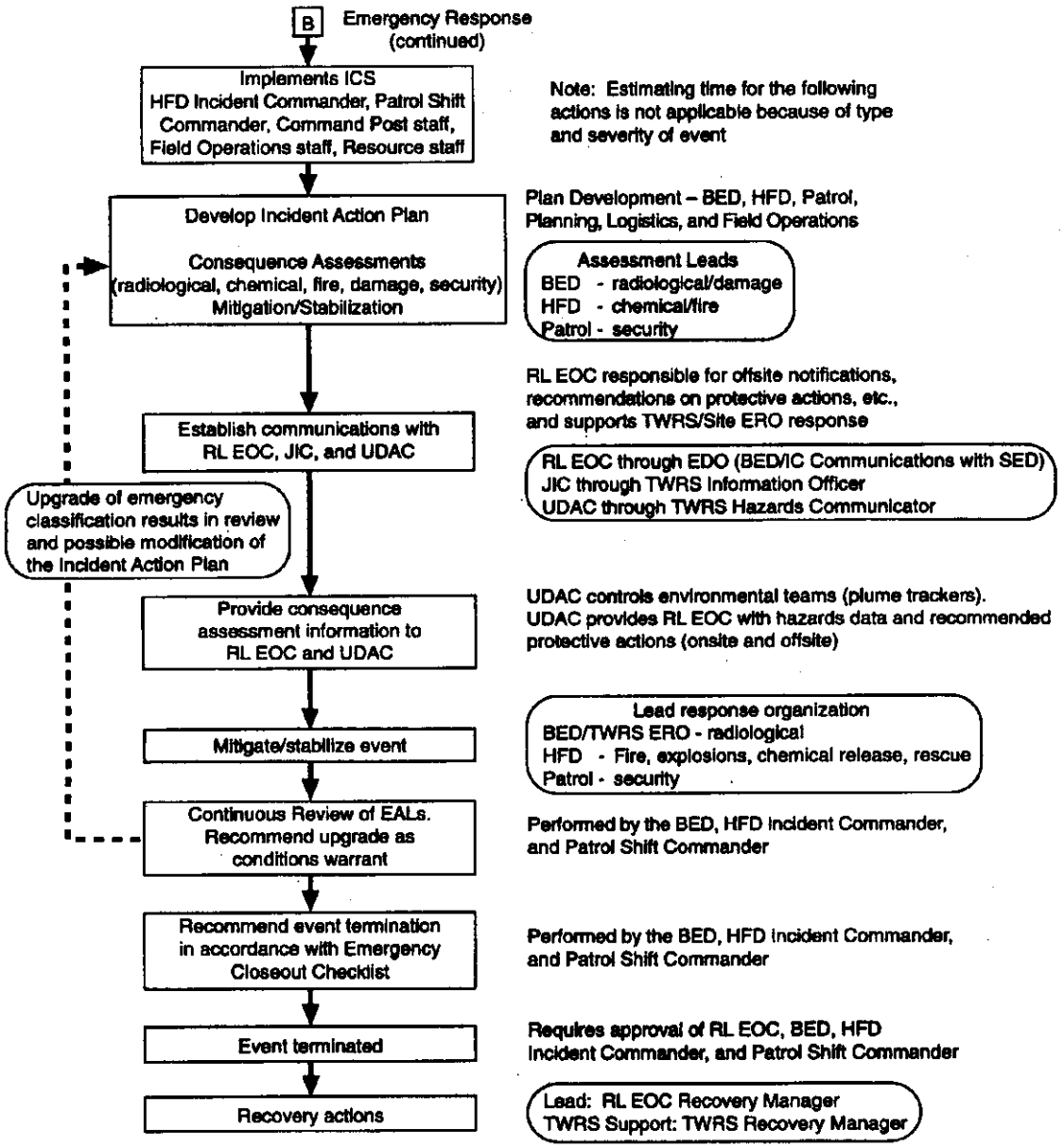


Figure 15-4. Flow Diagram for Assessment Actions. (3 sheets)



BED = Building Emergency Director.
DOE = U.S. Department of Energy.
EALs = Emergency Action Levels.
EDO = Emergency Duty Officer.
EOC = Emergency Operating Center.
ERO = Emergency Response Organizations.
FDNW = Fluor Daniel Northwest, Inc.
HAZMAT = Hazardous Materials.
HFD = Hanford Fire Department.
IC = Incident Command.
ICS = Incident Command System.
JIC = Joint Information Center.
POC = Patrol Operations Center.
RL = DOE, Richland Operations Office.
SED = Site Emergency Director.
TWRS = Tank Waste Remediation System.
UDAC = Unified Dose Assessment Center.

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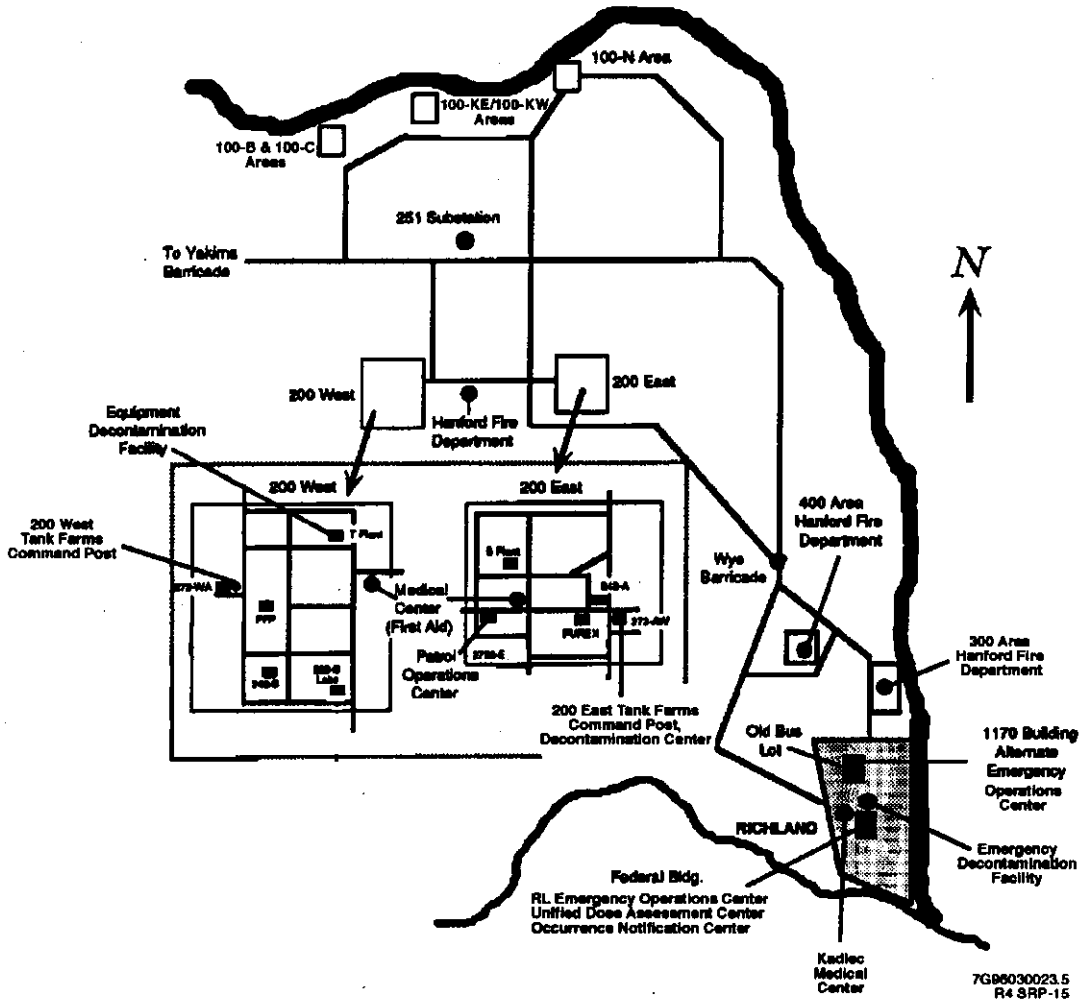
Figure 15-5. Tank Waste Remediation System and Hanford Emergency Centers.



PFP = Plutonium Finishing Plant.
PUREX = Plutonium-Uranium Extraction (Facility).
RL = U.S. Department of Energy, Richland Operations Office.

Figure 15-6. Hanford Site Emergency Planning Zones.

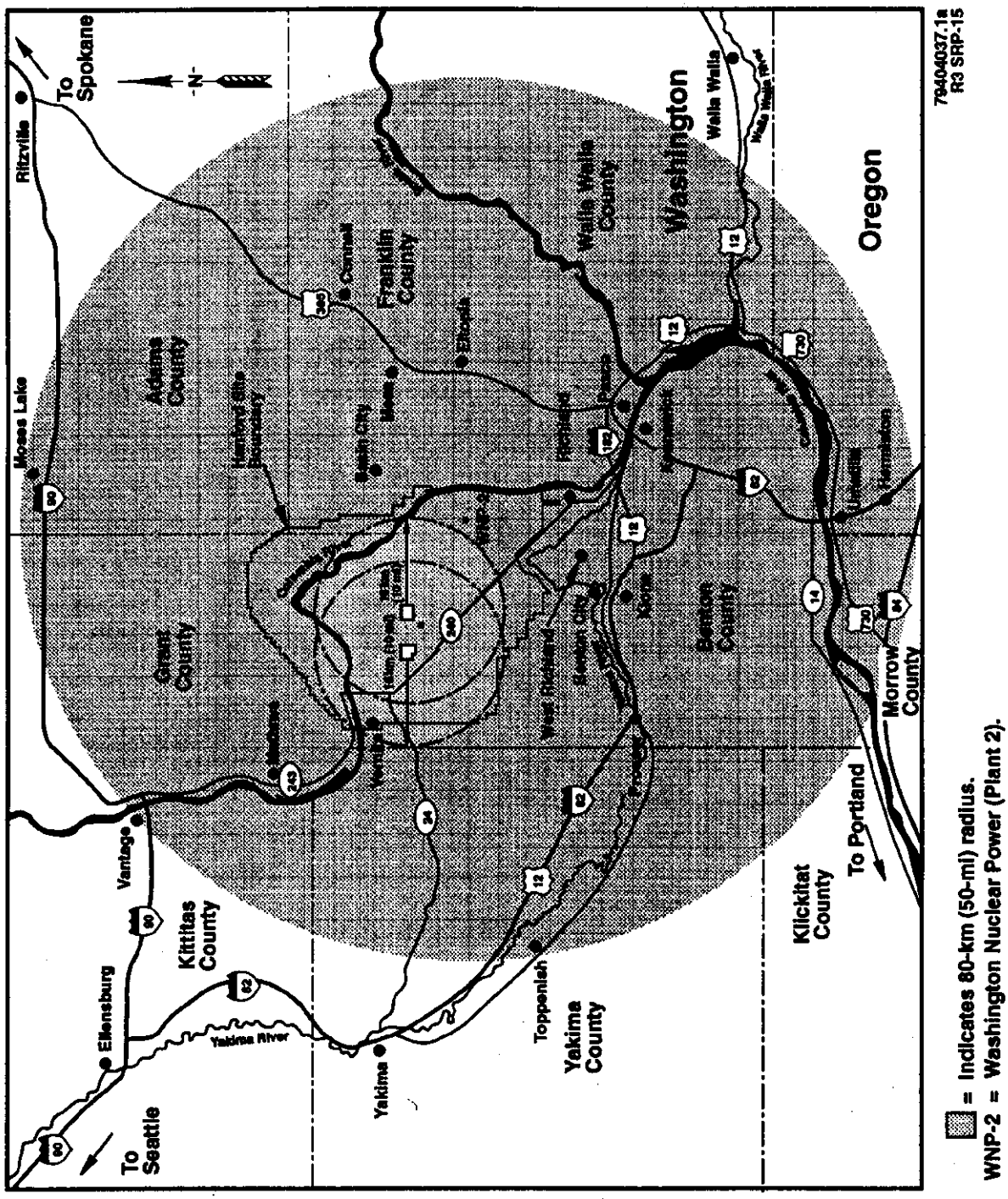


Table 15-1. Matrix of Accidents, Accident Types, Consequences, and Protective Actions.

Accident categories	Accident type	Consequence	Protective actions
Radioactive material release	Loss of containment, criticality	Exposure of public, workers, or environment	Evacuation, sheltering, decontamination, relocation, access control, food control, personal protective equipment
Chemical release	Loss of confinement	Exposure of public, workers, and environment	Evacuation, sheltering, decontamination, relocation, access control, food control, personal protective equipment
Natural disasters	Earthquake	Damage to tank safety systems	Evacuation, sheltering, decontamination, relocation, access control, food control, personal protective equipment
Fires or explosions	Exothermic reactions	Personnel exposure to hazardous materials, injuries	Evacuation, decontamination, relocation, access control, personal protective equipment
Extrinsic hazards	Airplane crash	Personnel exposure, injuries	Evacuation, sheltering, access control, personal protective equipment (depending on event)
Waste disposal	Handling of waste materials	Direct exposure to ionizing radiation	Evacuation, decontamination, relocation, access control, personal protective equipment
Waste disposal	Movement of hazardous materials	Direct exposure to hazardous materials	Evacuation, decontamination, relocation, access control, personal protective equipment

"EXAMPLE ONLY"

Table 15-2. Release Consequence Criteria for Emergency Classification Levels.

Emergency classification level	Projected dose	Boundary[a,b]
Alert-level emergency	• 1 mSv (100 mrem) committed effective dose equivalent, or • 5 mSv (500 mrem) committed thyroid dose, or • 50 mSv (5 rem) committed dose to the skin. • ≥ERPG[c]-1 and <ERPG-2 at facility boundary[d].	At TWRS facility boundary
Site area emergency	• 10 mSv (1 rem) committed effective dose equivalent, or • 50 mSv (5 rem) committed thyroid dose, or • 500 mSv (50 rem) committed dose to the skin. • ≥ERPG-2 at facility boundary.	At TWRS facility boundary
General emergency	• 10 mSv (1 rem) committed effective dose equivalent, or • 50 mSv (5 rem) committed thyroid dose, or • 500 mSv (50 rem) committed dose to the skin. • ≥ERPG-2 at Hanford Site boundary.	At the Hanford Site boundary

[a]The TWRS facility boundaries are defined as 100 m (328 ft) from any potential hazardous materials release location. This distance encompasses personnel within potentially affected areas.

[b]The Hanford Site boundary is depicted in Figure 15-6.

[c]Appropriate ERPG values or equivalent as stated in the DOE-RL-94-02, *Hanford Emergency Response Plan*, Rev. 1, Chapter 4.0 "Assessment and Classification," U.S. Department of Energy, Richland Operations Office, Richland, Washington. Solubility class "D" uranium compounds are limited by chemical toxicity.

[d]Facility boundary is defined as the property-protected area perimeter fence within present procedures or a distance of 100 m (328 ft) from the release location unless otherwise specified in the hazards assessment documentation.

ERPG = Emergency Response Planning Guideline.

TWRS = Tank Waste Remediation System.

Table 15-3. Summary of Emergency Classes.

Emergency class	Facility consequence	Transportation event exposure
Alert level emergency	Substantial actual/potential degradation of level of safety. Releases not expected to exceed PAG/ERPG levels at facility boundary.	Exposures in excess of PAG/ERPG levels expected only for personnel engaged in cleanup, recovery, and investigation (onsite or offsite accident).
Site area emergency	Actual/potential major failures of functions needed for protection of workers and public. Releases could exceed PAG/ERPG levels onsite but not offsite.	Onsite release may exceed PAG/ERPG levels beyond "exclusion zone"[a] onsite but not at nearest Site boundary. Offsite release not to exceed PAG/ERPG levels outside "exclusion zone."
General emergency	Actual/imminent catastrophic reduction of safety systems with potential or actual loss of hazardous material. Releases reasonably expected to exceed PAG or ERPG levels offsite.	Actual/potential catastrophic reduction in safety of a shipment. Onsite releases expected to exceed PAG/ERPG levels offsite. Offsite releases likely to exceed PAG/ERPG levels outside "exclusion zone."

[a]Exclusion zone is the immediate vicinity of the accident.
ERPG = Emergency Response Planning Guideline.
PAG = Protective Action Guideline.

Table 15-4. Spectrum of Operational Emergencies.

Event type[a]	Accident[b]	Emergency class
Radiological release	Ventilation failures	Alert or Site Area (depends on duration of release)
	Waste transfer failures (not spray)	Alert
	Waste transfer failures (no cover blocks)	Site area
	Waste transfer failures (surface pool)	Alert or Site area (depends on amount released)
	Waste transfer failures (spray leak)	Site area or general (depends on duration of release and tank involved)[c]
	Waste transfer failures (AWF tanks)	Site area
	Organic salt-nitrate reaction	General[c]
	Hydrogen deflagration	Site area
	Tank dome collapse	Site area
	Railcar spill	Alert or site area (depends on amount released)
	Steam intrusion (30 min)	Site area
	Waste tank bump	Site area
	Penetration of waste tank	Site area
Fires or explosions	Waste tank fire or explosion	Site area
	Waste tank fire/explosion (dome collapse)	General[c]
	Fire in 209-E or 2718-E Facilities	Alert
	Fire in 204-AR or 244-AR Facilities	Alert
	Fire in 242-S or 242-T Evaporators	Alert
Natural event	Seismic events at tank area	Alert
	High wind/tornado	Alert
	Volcanic ashfall/snowfall	Alert
	Range fire (impacts TWRS facilities)	Alert declared for surrounding area
Security events	Bomb threat/explosive device	Alert
	Hostage situation	Alert
	Armed intruder	Alert
Extrinsic events	Aircraft crash	Alert

[a]Event information in this table is generalized for the Final Safety Analysis Report and should not be used during emergency situations.

[b]Hazard analysis information comes from HNF-SD-PRP-HA-013, 1997, *Tank Farm Hazard Assessment*, Rev. 3, Fluor Daniel Hanford, Inc., Richland, Washington, and WHC-IP-1201, 1995, *Guidance for Conducting Emergency Preparedness Hazards Assessment*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[c]If the magnitude of flammable gas, organic-salt nitrate reaction, spray leak, and seismic event are correct, then TWRS would clearly be a Hazard Category 1 Facility. However, each of these accidents has considerable conservatism. In view of these conservatisms, the accidents are overstated because of model simplification and source term overestimates. Moreover, once these conservatisms are removed, the Hazard Category would be 2. Until the conservatism is removed, it is not appropriate to elevate TWRS to a Category 1 status.

AWF = Aging Waste Facility.

TWRS = Tank Waste Remediation System.

Table 15-5. U.S. Department of Energy, Richland Operations Office Emergency Centers.

Emergency Centers	Area of Responsibility
North Richland Emergency Control Center: Pacific Northwest National Laboratory Materials Reliability Center Building	Pacific Northwest National Laboratory-operated facilities located in the Richland North area
RL Emergency Operations Center: Federal Building, Richland Alternate Location: 1170 Building	Remaining 600 Area not covered by the area emergency centers. Also (1) assists area emergency centers, (2) coordinates the facility-wide response to emergencies, (3) serves as the focal point for other Hanford Site Contractors and RL during emergencies and for providing overall direction for all Hanford Site facility emergency situations involving the RL and/or contractor personnel, and (4) ensures direct interface with all offsite agencies for protection of offsite populations, facilities, and the environment

RL = U.S. Department of Energy, Richland Operations Office.

Table 15-6. Emergency Equipment, Fixed and Portable. (5 sheets)

Type	Technical capabilities	Response capabilities
Fire alarms and automatic sprinkler systems	Fire alarms are located in all TWRS hazardous facilities. The alarms produce a gong sound that can be heard throughout facilities. The alarms also provide a radio signal that identifies the facility to the Hanford Fire Department. Automatic sprinkler systems are located within TWRS hazardous facilities and have the capability of extinguishing structural fires with exception of chemical, oil, gas, or electrical type fires. The system, when activated, also activates the fire alarms system.	Fire alarms provide emergency notification to personnel to evacuate the area to a safe upwind location. In addition, the alarms summon the Hanford Fire Department to the scene. Sprinklers are activated automatically in high temperature conditions. They also activate the fire alarms, which direct personnel to evacuate the area.
Safety showers and eyewash stations	Safety showers and eyewash stations use tempered water for removal of chemical contamination. Areas with hazardous materials have safety showers or eyewash stations (e.g., 204-AR Waste Unloading Facility, 242-S Evaporator). The safety showers and eyewash stations provide a sufficient flow of water to properly remove chemical contamination from clothing, bodies, and eyes.	Safety showers and eyewash stations are designed for easy operation by any TWRS personnel for decontamination of personal clothing, bodies, and eyes of chemical contaminants.
Waste tank pressure alarms (DSTs only)	Waste tank pressure alarms are activated when DST vapor space pressure reaches a predetermine setpoint (below atmospheric pressure). The alarms serve as a warning of abnormal DST vapor space pressures that could lead to a release from the tank. The alarm produces a high-pitched intermittent tone.	The alarm provides emergency notification of abnormal condition to tank farm personnel and directs them to evacuate to a safe location (normally a change trailer). The alarms also notifies Operations of abnormal conditions and initiates operations response actions to the scene.
Evacuation and take-cover sirens	Evacuation sirens produce a loud, steady tone. The take-cover sirens produce a loud wavering tone. Sirens are activated for 3 min for an emergency. The evacuation/take-cover sirens in the 272-AW and 272-WA Buildings are for internal (building) use only. External evacuation and take-cover sirens are located sitewide in the 200 Areas and are controlled by the Patrol Operations Center. The external sirens can be heard throughout the 200 Areas.	Evacuation siren directs 200 Area personnel to evacuate facilities to designated staging areas, followed by area evacuation to a secondary staging area (normally off the Hanford Site). Take-cover sirens direct 200 Area personnel to shelter (take cover) inside facilities and to secure the facility from the outside environment.
DACS trailer Halon system	Halon has the capability of extinguishing structural (wood products) and electrical fires by greatly reducing the oxygen supply within the DACS trailer. Halon enters the trailer at approximately 13.8 mPa (2000 lb/in.^{2}). The Halon storage cylinder provides sufficient supply for the trailer. The system also produces a fire alarm (local and remote at the HFD dispatcher). The Halon system cannot be aborted once activated.	Halon is a fire suppression system to extinguish any type of fire that can occur within the DACS trailer (structural and/or electrical). Fire alarms will sound prior to activation, directing personnel to evacuate the DACS trailer.

Table 15-6. Emergency Equipment, Fixed and Portable. (5 sheets)

Type	Technical capabilities	Response capabilities
Emergency lighting	Emergency lighting is located throughout hazardous facilities and provides sufficient illumination within buildings for personnel to safely evacuate. The lighting is not designed for reentry or response actions. The lighting is normally powered by the building electrical system, but has battery backup. The lighting automatically turns on when a loss of power is indicated.	Emergency lighting provides adequate lighting for personnel to safely evacuate the building during a loss of building electrical power.
Radiation alarms	Radiation alarms are used for detection of beta/gamma or alpha radiation. The detectors are either for dose rate or elevated contamination level (setpoints determined by Radiological Control). These alarms are used inside process facilities and ventilation exhaust stacks. The alarms produce a steady ringing bell and a flashing red light when activated. The alarms provide both local and remote alarm indications.	Radiation alarms inform personnel of potential or actual abnormal radiation levels and direct them to immediately evacuate the area, notify HPTs/Shift Managers, and remain away from others until surveys by HPTs. In addition the alarms provide indication of a potential or actual emergency conditions in which radiological material may be released from the facility/tank, etc.
Communication equipment (telephones, base station radios, crash telephones and public address systems)	Commercial telephones serve as a secondary method of notifying personnel of emergency conditions and as the primary means of communicating with onsite/offsite emergency centers. Commercial telephones are located throughout TWRS facilities and the Site. The crash telephone system is the primary means of sitewide emergency notifications and providing response instructions. Crash telephones are located in all TWRS facilities with exception of the tank farm buildings. Tank farm buildings receive emergency notifications by radio from the BED who receives the crash alarm call. Public Address System is the primary means of notifying personnel and providing response instructions within the 272-AW and 272-WA Buildings. This system is activated by building personnel or the BED.	Commercial telephones are a secondary source of providing emergency notifications and are the main method of communication between emergency centers. The crash telephone system, activated by the Patrol Operations Center under direction of a BED, SED, or EDO, produces a steady ringing bell. The phone provides emergency notification and instructions to building personnel. The Public Address System informs building personnel of event conditions and provides response instructions.
Hazardous materials spill kits at facility	Hazardous materials kits contain the appropriate material for the type of chemical involved: sodium hydroxide, diesel fuel oil, gasoline, antifreeze, oils, and battery acid. Fixed spill kits are located near the associated chemicals, equipment, etc.	Hazardous materials spill kits provide a means for TWRS personnel to stabilize and clean up minor chemical spills. Major spills are handled by the HFD HAZMAT Team, which is properly equipped for this type of spill.

Table 15-6. Emergency Equipment, Fixed and Portable. (5 sheets)

Type	Technical capabilities	Response capabilities
Fire extinguishers	Fire extinguishers are ABC type for use on all types of fire, with exception of a metal fire. They are located throughout all buildings and identified by a red/white striped wallboard or cabinet. Extinguishers are for handling small fires.	Fire extinguishers provide suppression for small fires, with exception of metal fires.
Self-contained breathing apparatus	SCBAs are located throughout TWRS facilities (wallmounted in emergency cabinets) and in designated SCBA inspection stations in 272-AW and 272-WA Buildings. SCBAs can provide ½ or 1 h of air for response personnel. SCBAs are positive pressure to prevent internal contamination. SCBAs bottles are pressurized to 31.0 MPa (4500 lb/in.^{2} gauge).	SCBAs provide a means of responding into airborne contamination areas (radiation or chemical) and reduce the possibility of inhalation through the positive-pressure face mask.
Portable hazardous materials spill kits	Portable hazardous materials kits contain the appropriate material for the type of chemical involved: sodium hydroxide, diesel fuel oil, gasoline, antifreeze, oils, and battery acid. These spill kits are located in the designated operations response vehicles and 272-AW and 272-WA Building storage rooms.	Portable hazardous materials spill kits provide a means for TWRS personnel to stabilize and clean up minor chemical spills. Major spills are handled by the HFD HAZMAT Team, who are properly equipped for this type of spill.
Command Post Equipment	The Command Post equipment is located in the 272-AW and 278-WA Buildings, inside designated cabinets. The equipment is used to identify ERO members (vests), provide response instructions (procedures), identify Command Post (sign), and control access into the facility (rope). Other equipment available outside the cabinet is the event-status board for documenting and displaying event activities and emergency procedures.	Command Post equipment is used by TWRS Command Post staff members for identifying ERO positions (vests), identifying the location of the command post (sign), documenting/displaying event activities (event status board), controlling access (rope), and providing response instructions (procedures).
Operations response vehicle equipment	The operations response vehicles (200 East and 200 West) are for use by the event scene staff. The equipment includes clean PPE (radiological response and contamination control), SCBAs (airborne and unknown conditions response actions), first-aid kits (e.g., minor injury assistance for bleeding, shock, blood-borne pathogen protection), event scene staff identification vests, radiation rope (radiation boundaries), caution tape (event scene control area boundary), boltcutters (for removal of locks or cutting through fences), emergency procedures (response instructions).	The operations response vehicle is equipped for any type of emergency (e.g., radiological, nonradiological, fire). This equipment is for use by the event scene responders assigned by the BED and Operations Officer.
Radiological monitoring instruments	Radiological monitoring instruments are as shown in Table 7-4.	Used by HPTs for dose rate and contamination assessments, analysis, etc.

Table 15-6. Emergency Equipment, Fixed and Portable. (5 sheets)

Type	Technical capabilities	Response capabilities
Radiological response vehicle equipment	Contains radiological instruments stated above, and the following: emergency procedures, self-reading pencils (0 to 500 mR and 0 to 50 R), radiation boundary marker flags, area grid maps, radiation signs, and other miscellaneous equipment.	Equipment in this vehicle is used by the TWRS radiological response personnel at the event scene for dose and contamination assessments, monitoring, boundary identification, posting, and personal protection devices (PPE, SCBA, self-reading pencils).
Cellular phones	Cellular phones are used by selected TWRS personnel, when two-way radios or commercial telephones are not readily available. Cellular phones provide communications capabilities throughout the Site.	Used as the primary means of communications between the command post and the event scene responders. Used a backup communications to commercial telephones and two-way radios.
Personal protective clothing	PPE is anticontamination clothing, surgeon gloves, rubber shoe covers, etc. PPE is available in all change trailers, change rooms, and storage conexs near the 272-AW and 272-WA Buildings.	PPE is worn by response personnel to reduce skin contamination and the spread of contamination outside the impacted area (undressing assistance at boundaries).
Acid gear	Acid gear is coveralls, hoods, gloves, and rubber boots. Acid gear at TWRS is designed for use with acids and is located in the mechanical equipment room in the 204-AR Facility.	Donned by chemical workers or response personnel at a chemical release to prevent skin, face, etc., contamination.
Miscellaneous respiratory equipment	Miscellaneous respirators are MSA, Scott, etc., which can be equipped with particulate filters for radiation/dust and vapors (chemical cartridge). Located in the 272-AW and 272-WA Buildings (controlled distribution).	Used by response personnel for known hazardous conditions. For unknown conditions, SCBA is required.

Table 15-6. Emergency Equipment, Fixed and Portable. (5 sheets)

Type	Technical capabilities	Response capabilities
Two-way radios	Two-way radios for TWRS have limited range within the 200 East/West areas and adjacent Site areas. TWRS has two radio channel capabilities. Radios comprise base stations, mobile and portable (hand-held). TWRS frequencies are RL and Site frequencies, but can be monitored by offsite people through the use of scanners.	Primary communications devices for response teams. Backup communications devices between command post and event scene (cellular phone failure).

BED = Building Emergency Director.
DACS = Data Acquisition and Control System.
DST = double-shell tank.
EDO = Emergency Duty Officer.
ERO = Emergency Response Organization.
HAZMAT = hazardous material.
HFD = Hanford Fire Department.
HPT = health physics technician.
MSA = Mine Safety Appliance.
PPE = personal protective equipment.
RL = U.S. Department of Energy, Richland Operations Office.
SCBA = self-contained breathing apparatus.
SED = Site Emergency Director.
TWRS = Tank Waste Remediation System.

Table 15-7. Emergency Response Planning Guidelines.

Emergency classification level	Emergency response planning guideline[a]	Exposure information
Alert level	ERPG-1	The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 h without experiencing other than mild transient adverse health affects or perceiving a clearly defined objectionable odor.
Site area emergency	ERPG-2 at the facility boundary, but less than ERPG-2 at the Site boundary	The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 h without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
General emergency	ERPG-2 at the Site boundary	The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 h without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

[a]For the purposes of applying DOE 5500.2B, 1992, *Emergency Categories, Classes, and Notification and Reporting Requirements*, Change 1, U.S. Department of Energy, Washington, D.C., the term "ERPG" and "appropriate ERPG exposure levels" shall mean a peak concentration of the substance in air that equals or exceeds the published ERPG-2 value for that substance.

ERPG = Emergency Response Planning Guideline.

Table 15-8. Emergency Preparedness Training Frequencies.

Training course	Frequency	Course summary
Emergency center training	Within 30 days of assignment; annually thereafter	Training provides an overview of the emergency response organization and specific emergency center operation for staff assigned to the RL EOC and area ECCs
Building emergency response organization training	Within 30 days of assignment; annually thereafter	Training addresses emergency procedures, responsibilities, and command and control for members of the building emergency response organization (i.e., BED and support staff)
General employee training	Annually	Training covers basic emergency preparedness response procedures for all DOE and Site Contractor employees.
Visitor/vendor and subcontractor training	Before badging; annually thereafter	Training provides safety, security, and emergency preparedness information to visitors/vendors and subcontractor personnel

BED = Building Emergency Director.
DOE = U.S. Department of Energy.
RL = U.S. Department of Energy, Richland Operations Office.
ECC = Emergency Control Center.
EOC = Emergency Operations Center.

CHAPTER 16.0
PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

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CHAPTER 16.0
PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

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LIST OF TERMS

ALARA	As Low As Reasonably Achievable
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOE-EM	U.S. Department of Energy, Office of Environmental Management
DST	double-shell tank
HEPA	high-efficiency particulate air (filter)
SST	single-shell tank
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TWRS	Tank Waste Remediation System

16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

16.1 INTRODUCTION

Tank Waste Remediation System (TWRS) facilities will undergo the U.S. Department of Energy (DOE) decontamination and decommissioning (D&D) process when those facilities are no longer needed for fulfillment of the TWRS mission. Although the actual D&D activities are not performed by TWRS, TWRS is responsible for "transitioning" (i.e., preparing a facility for transfer to a D&D contractor) facilities. D&D is considered during the design of new or during modifications to existing systems or programs that support waste minimization (i.e., pollution prevention) and personnel health and safety. TWRS will also integrate lessons learned from D&D activities at other DOE facilities (e.g., Pit No. 9 at the Idaho National Engineering Laboratory and the Plutonium Uranium Extraction Facility at the Hanford Site) into operating procedures.

This chapter discusses current requirements for D&D considerations, TWRS responsibilities for transferring facilities to a D&D contractor, existing design and operational features that facilitate D&D, and planning for D&D.

16.2 REQUIREMENTS

At present, numerous documents offer considerations for D&D, although none regulate D&D. The current regulatory basis for D&D activities is being developed. DOE plans to address D&D requirements for existing facilities in greater technical detail in the future. The following documents comprise the basis for D&D considerations in TWRS:

- DOE 5400.5, *Radiation Protection of the Public and the Environment*, Change 2 (1993)
- DOE 5480.7A, *Fire Protection*, Change 0 (1993)[1]
- DOE 5820.2A, *Radioactive Waste Management*, Change 0 (1988)
- DOE 6430.1A, *General Design Criteria*, Change 0 (1989)
- EM-43, *Decommissioning Resource Manual*
- *National Environmental Policy Act of 1969*

[1]Cancelled by DOE N 251.4, DOE O 440.1, and DOE O 420.1. Compliance with DOE 5480.7A is required until the Contracting Officer directs compliance with DOE O 440.1 or DOE O 420.1 or provides other direction to terminate compliance with DOE 5480.7A.

- *Resource Conservation and Recovery Act of 1976*

- WAC 173-303, "Dangerous Waste Regulations" (1995)

- *Regulations for Implementing Procedural Provisions of the National Environmental Policy Act*, Permit WA7890009067, Rev. 2, Ecology (1995).

16.3 TANK WASTE REMEDIATION SYSTEM FACILITY TRANSITION RESPONSIBILITIES

TWRS is not responsible for D&D activities on the Hanford Site. However, TWRS is responsible for transitioning or transferring TWRS facilities to the U.S. Department of Energy, Office of Environmental Management (DOE-EM). That is, TWRS, in agreement with the DOE-EM, is responsible for the removal of hazardous material (radiological and toxicological) and equipment to an agreed upon level and for characterizing the hazards present in the facility. In addition, TWRS is responsible for updating the Facility Fire Hazards Analysis, as necessary, prior to decommissioning any fire protection features. Operations will be performed to minimize the exposure to workers following the As Low As Reasonably Achievable principles discussed in Chapter 7.0, "Radiation Protection," and exposure minimization principles discussed in Chapter 8.0, "Hazardous Material Protection."

The initial step in the transition process, after identifying a facility for D&D and a proposed transfer date, is the preparation of a Facilities Transfer Agreement. This agreement is negotiated between TWRS and DOE-EM. In addition to including a detailed facility description, the transfer agreement addresses the following items:

- **Facility characterization**—Provides DOE-EM an understanding of the nature, level, and probable extent of contamination, including a list of special and other nuclear materials and a hazardous and radiological material/waste inventory.

- **Safe shutdown implementation plan**—Addresses the following issues: safety envelope, surveillance and maintenance requirements, safeguards and security, preservation of equipment and facilities, and compliance with applicable regulations and requirements.

- **Human resources plan**—Addresses federal and contractor personnel critical skills and necessary funding.

- **Material and equipment disposition plan**—Addresses the removal of personal property and equipment or structures installed or attached to the facility.

As an example, TWRS will incorporate lessons learned from the development of acceptance criteria for the 242-T Evaporator's transition to surveillance and maintenance operations. After an agreement is reached based on the information contained in the transfer agreement, TWRS is

responsible for meeting the agreement requirements. Following or during the transition process, D&D planning is initiated with the stakeholders, DOE, and the contractor. The planning process follows the guidelines established in the *National Environmental Policy Act of 1969* and implemented in 40 CFR 1500-1508, "Council on Environmental Quality Regulations."

16.4 DECONTAMINATION AND DECOMMISSIONING ALTERNATIVES AND PLANNING REQUIREMENTS

Careful planning is essential to efficient D&D. The planning process includes the identification and evaluation of alternatives as required by the *National Environmental Policy Act of 1969* and implemented in 40 CFR 1500-1508. A separate environmental impact statement may be prepared at a later date for TWRS facilities D&D to satisfy those requirements. The alternatives developed for evaluation in that environmental impact statement will be consistent with the selected alternative for tank waste disposition. Closure plans for the TWRS facilities that were included in *Regulations for Implementing Procedural Provisions of the National Environmental Policy Act* (Ecology 1995) will be updated during the life of the facility as new decommissioning technologies are developed.

In order to minimize risk, careful planning is necessary to address the number of D&D activities required and to protect against exposure during D&D activities. Assessments for future D&D activities will be based on the type and magnitude of hazards and the complexity of the processes involved in performing the activity. Hazards during D&D activities fall into one of two groups:

- **Nonradiological and nontoxicological hazards**—Nonradiological and nontoxicological hazards involve equipment for construction, operation, or transportation activities. TWRS must consider hazards such as falling debris, work performed on and around scaffolding, electrical equipment and power sources, and heavy machinery moving in limited space. Potential accidents arising from such hazards include cuts, falls, electrical shock, operator-machine impacts, and crushing incidents.

- **Radiological and toxicological hazards**—Waste within the tanks is the most obvious hazard associated with D&D, although chemicals and fuels associated with equipment and vehicles used in D&D activities are included in this category. Potential effects of these hazards are directly related to exposure to these substances.

  TWRS will determine the controls to address the hazards identified during detailed planning for transferring the facility to the D&D contractor. The D&D contractor will implement controls to minimize risk during the actual D&D evolution.

Cleanup methods will be selected for TWRS facilities based on the disposition method deemed appropriate for the waste in those facilities. Facilities that are identified as treatment, storage, and disposal units will be closed in accordance with the requirements of Ecology (1995).

The permit defines requirements for three cleanup options: clean closure, modified closure, and landfill closure. Clean closure involves the removal of contaminants from the tanks and associated equipment, soil, and groundwater, until the site meets natural background levels or health-based standards. Modified closure combines several closure methods and requires periodic assessments to determine if the facility meets the modified closure requirements or requires further remediation. Landfill closure involves leaving some waste in place with corrective action for contaminated soil and groundwater performed under post-closure requirements. This type of closure includes measures to reduce water infiltration and inadvertent human intrusion.

The *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996), commonly known as the Tri-Party Agreement, establishes several milestones that represent conceptual plans necessary to ensure acceptable progress toward Hanford Site D&D. Tri-Party Agreement goals applicable to TWRS facilities include reduction of risks currently associated with the single-shell tanks and implementation of activities that support disposal of all tank wastes as part of the facility D&D process. The following steps comprise a conceptual plan which complies with the milestones in the Tri-Party Agreement:

- Continuing characterization of tank waste, to be completed in 1999
- Characterization of deactivated facilities
- Initial tank retrieval (removing liquid waste from 10 double-shell tanks) by 2000
- Resolution of tank safety issues by 2001
- Turnover to privatization for stabilization, closure of single-shell tanks by 2024, and complete remediation of high-level waste by 2028
- Further D&D assessment
- Completion of D&D.

Tank waste disposal options are discussed in DOE/EIS-0189, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington*. Five of the nine options identified in DOE/EIS-0189 entail leaving some or all of the waste in the tanks. The tank waste treatment options are included in Table 16-1.

16.5 EXISTING FEATURES THAT FACILITATE DECONTAMINATION AND DECOMMISSIONING

Prior to the issuance of DOE 6430.1A, *General Design Criteria*, there were no design requirements addressing ease of D&D for nonreactor nuclear facilities. There also were no requirements addressing worker or public health and safety. However, in an effort to prevent releases to the environment, the TWRS facilities were designed with preventive barriers that will

facilitate D&D of the facilities. The existing radiological and hazardous protection programs discussed in Chapter 9.0, "Radioactive and Hazardous Waste Management," are relied upon to protect worker and public health and safety during the transition process or during D&D activities.

16.5.1 Existing Design Features that Facilitate Decontamination and Decommissioning

Designs of the original TWRS facilities contained no specific criteria to facilitate D&D. The TWRS facilities were and are currently designed with engineered features (e.g., nonporous tank walls and coatings in pits and buildings that can be decontaminated) to contain leaked waste products and minimize the spread of contamination. These design features are required as part of the waste minimization program at TWRS.

TWRS radioactive and hazardous waste facilities designed since the early 1980s have features to facilitate D&D activities. The design of such facilities is based on DOE 6430.1A, Division 13, "Special Facilities," and includes the following:

- Localized liquid transfer systems that avoid long runs of buried contaminated piping (e.g., overground transfer lines from tanker to double-shell tank)

- Exhaust filtration components of the ventilation systems located at or near individual enclosures so as to minimize long runs of internally contaminated ductwork (e.g., single-shell tank passive ventilation systems)

- The 200 West to 200 East Area transfers through one common pipe system

- Equipment (e.g., effluent decontamination equipment) that precludes the accumulation of radioactive or other hazardous materials in relatively inaccessible areas (e.g., curves and turns in piping and ductwork); accessible, removable inspection covers that allow for visual inspection (e.g., gravity drains, cover blocks)

- Materials that (1) reduce the amount of radioactive and other hazardous materials requiring disposal, and (2) are easily decontaminated (e.g., steel liners in boxes and pits)

- Designs that ease dismantlement, removal, and packaging of contaminated equipment (e.g., gloveboxes, air filtration equipment, large tanks, vessels, ductwork) from the facility (e.g., access ways to high-efficiency particulate air filters)

- Modular radiation shielding in lieu of or in addition to monolithic shielding walls (e.g., temporary shielding on overground transfer lines)

- Lifting lugs on large tanks and equipment (e.g., lifting bails on pumps and hooks on cover blocks)

- Fully drainable piping systems that carry contaminated or potentially contaminated liquids (e.g., ventilation system condensate return lines, pit drain lines)

- A list of current design features and their advantages related to D&D operations is included in Table 16-2.

16.5.2 Operational Considerations that Facilitate Decontamination and Decommissioning

Operational considerations necessary for compliance with HSRCM-1, *Hanford Site Radiological Control Manual*, and WHC-CM-7-5, *Environmental Compliance*[2], help maintain the spread of contamination to As Low As Reasonably Achievable. Specific requirements in these documents include the following.

- **HSRCM-1**—Technical work documents are to include provisions to control contamination at the source to minimize the amount of decontamination needed. Decontamination activities are to be controlled to prevent the spread of contamination. Decontamination methods are to be used to reduce the number of contaminated areas. Efforts are to be made to reduce the level of contamination and the number and size of contaminated areas that cannot be eliminated.

- **WHC-CM-7-5**—Radioactively contaminated facilities for which the TWRS operations contractor is responsible are to be managed in a safe, cost-effective manner to assure that release of and exposure to radiological and hazardous and dangerous materials are to be prevented or minimized and are in compliance with federal and state standards.

TWRS operations and facilities are directly exposed to the environment. Future operations by the D&D contractor must include considerations of the same natural phenomena and external man-made threats discussed in Sections 1.5 and 1.6 of the FSAR.

The pollution prevention program discussed in WHC-CM-7-5 replaces the previous requirement for facility waste minimization plans (Chapter 9.0). The requirements for the pollution prevention program are developed so that the planning and implementation requirements identified in WAC 173-307, "Pollution Prevention Plans"; DOE 5400.1, *General Environmental Protection Program*, Chapter III.4.b; and 58 FR 31114-31120, *Hazardous Waste Generators;*

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[2]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc. (FDH) procedures (e.g., HNF-PRO-XXX).

Waste Minimization Program Elements Guidance Availability, are met. The program requires source reduction, recycling, and treatment opportunities for all waste streams, including sanitary, dangerous, radioactive, and mixed waste streams. Considering source reduction during the design of new or during modifications to existing facilities, systems, or operations will minimize the quantity of hazardous waste and reduce the hazards present during D&D activities.

Control and minimization of contamination will facilitate D&D. Operations will be performed to minimize the exposure to workers following the As Low As Reasonably Achievable principles discussed in Chapter 7.0 and exposure minimization principles discussed in Chapter 8.0. In addition, waste concentration (e.g., in-tank or mechanical) is used to reduce the liquid waste volume. Specific operational features that facilitate D&D are listed in Table 16-3.

16.6 REFERENCES

40 CFR 1500-1508, "Council on Environmental Quality Regulations," *Code of Federal Regulations*.

58 FR 31114-31120, *Hazardous Waste Generators; Waste Minimization Program Elements Guidance Availability*, Federal Register, Vol. 58, No. 103.

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DOE 5480.7A, 1993, *Fire Protection*, Change 0, U.S. Department of Energy, Washington, D.C.

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EM-43, 1995, *U.S. Department of Energy Office of Environmental Management Decommissioning Resource Manual*, U.S. Department of Energy, Washington, D.C.

HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

National Environmental Policy Act of 1969, 42 U.S.C. 4321, et seq.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901, et seq.

WAC 173-303, 1995, "Dangerous Waste Regulations," *Washington Administrative Code*.

WAC 173-307, 1995, "Pollution Prevention Plans," *Washington Administrative Code*.

WHC-CM-7-5, 1997, *Environmental Compliance*, Rev. 88, Fluor Daniel Hanford, Inc., Richland, Washington.

Table 16-1. Summary of Tank Waste Alternatives.

Alternative (time frame)	Key features
No action (1997 to 2097)	• Continue existing operations and maintenance (such as continued removal of salt well liquid from SSTs). • No new waste retrieval, treatment, or disposal actions.
Long-term management (1997 to 2097)	• Continue existing operations and maintenance (such as continued removal of salt well liquid from SSTs). • Upgrade tank farm inter- and intra-waste transfer system. • Replace all DSTs starting in 2035 and again in 2085. • Transfer the DST waste to new tanks.
In situ fill and cap (1997 to 2029)	• Evaporate liquid from DST waste. • Fill SST and DST with gravel, and place a thick earthen cover over the tanks. • Dispose of waste onsite in the tanks.
In situ vitrification (1997 to 2033)	• Evaporate liquid from DST waste. • Vitrify waste in SSTs and DSTs in place, and place a thick earthen cover over the tanks. • Dispose of waste onsite.
Ex situ/in situ combination (1997 to 2040)	• Retrieve approximately 50 percent of the waste from SSTs and DSTs (based on the degree of risk posed to human health and the environment). • Dispose of waste remaining in tanks in place as under the In Situ Fill and Cap alternative. • Separate retrieved waste into high-level and low-activity waste streams (use sludge washing, caustic leaching, and ion exchange). • Vitrify waste streams in separate facilities. • Dispose of low-activity waste onsite in near-surface vaults. • Store high-level waste onsite for up to 50 years pending availability of a geologic repository. • Dispose of high-level waste offsite at a geologic repository.

Source: DOE/EIS-0189, 1996, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington*, U.S. Department of Energy, Washington, D.C.

SST = single-shell tank.
DST = double-shell tank.

Table 16-2. Design Features that Facilitate Decontamination and Decommissioning.

Feature	D&D benefit
Localized liquid transfer systems	Avoids long runs of buried contaminated piping
Exhaust filtration components of ventilation systems are close to individual enclosures	Shorter runs of internally contaminated ductwork minimize risk of spread of contamination
200W to 200E transfers through one pipe system	Fewer systems to monitor
Piping and ductwork have fewer turns and curves, and has easily accessible inspection covers	Less accumulation of contaminated material in relatively inaccessible areas, and easier inspections
Material substitution	Reduced amount of radiological or hazardous materials, and easier decontamination
Improved designs of equipment and accessways	Allow for easier dismantlement, removal, and packaging of contaminated equipment from the facility
Modular radiation shielding	Improved radiological protection for personnel
Lifting lugs on large tanks and equipment	Easier removal of equipment for decommissioning
Fully drainable piping systems	Easier removal of contaminated or potentially contaminated liquids
Double-shell tanks	Contains leaks from failing tanks
Encased piping	Contains spread of contamination from leaking pipes
Valve pits	Capture spilled contaminants under valves
Mixer pumps to stir tanks	Reduce risk of occurrences such as tank bumps
Gas monitors, temperature monitors	Earlier detection of changes in tank composition or chemical reactions

D&D = decontamination and decommissioning.

Table 16-3. Operational Features that Facilitate Decontamination and Decommissioning.

Feature	D&D benefit
Interim stabilization	Reduce/eliminate leaks to soil
Engineering design review process	Incorporate D&D provision into all facility upgrades and new projects
Leakage monitoring	Reduce contamination spread
HEPA filtration	Reduce contamination spread
Contamination surveys	Detect contamination
ALARA principle application	Reduce quantity of contaminated material
Waste minimization	Reduce quantity of hazardous material
Technical Safety Requirements	Reduce accidental contamination spread

ALARA = As Low As Reasonably Achievable.
D&D = decontamination and decommissioning.
HEPA = high-efficiency particulate air (filter).

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CHAPTER 17.0
MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

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CHAPTER 17.0
MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

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LIST OF TERMS

A/E	architect/engineer
ALARA	As Low As Reasonably Achievable
BWHC	B&W Hanford Company
CADD	computer aided design and drawing
CEO	Chief Executive Officer
CM	configuration management
COO	Chief Operations Officer
CPI	characterization project implementation
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy, Headquarters
DST	double-shell tank
ES&H	Environment, Safety and Health
ESH&QA	Environment, Safety and Health and Quality Assurance
FDH	Fluor Daniel Hanford, Inc.
FFTF	Fast Flux Test Facility
FSAR	Final Safety Analysis Report
HAMMER	Hazardous Materials Management and Emergency Response
HASP	health and safety plan
HEHF	Hanford Environmental Health Foundation
HLAN	Hanford Local Area Network
HLW	high-level waste
HTI	Hanford Tank Initiative
IS&H	Industrial Safety and Health
ISB	integrated site baseline
LLW	low-level waste
LMHC	Lockheed Martin Hanford Corporation
NHC	Numatec Hanford Corporation
M&I	Management and Integration
PHMC	Project Hanford Management Contract
PNNL	Pacific Northwest National Laboratory
PTH	Protection Technology Hanford
QA	quality assurance
RAD	radiological
RAD/CON	radiological control
RL	U.S. Department of Energy, Richland Operations Office
S/RID	Standards/Requirements Identification Document
SSC	structure, system, and component
SST	single-shell tank
T&P	technology & planning
TF	tank farms
TSR	Technical Safety Requirement

LIST OF TERMS (Cont'd)

TWRS	Tank Waste Remediation System
USQ	Unreviewed Safety Question
VP	Vice President
WMH	Waste Management Federal Services of Hanford, Inc.
WRAP 1	Waste Receiving and Processing (Module 1)
WSCF	Waste Sampling and Characterization Facility

17.0 MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

17.1 INTRODUCTION

This chapter presents an overview of the organization structures, policies, and programs that ensure safety is the fundamental principle guiding all Tank Waste Remediation System (TWRS) operations. This overview comprises a list of Authorization Basis requirements documents and a basic outline of the organization structures, responsibilities, and interfaces of the contractors responsible for management of the TWRS Authorization Basis. Safety management policies and programs in place for (1) assessing and controlling safety performance, (2) integrating safety consciousness, and (3) identifying and reporting deviations from policies and programs are also summarized.

17.2 REQUIREMENTS

The following federal regulations and U.S. Department of Energy (DOE) orders contain requirements for establishing the management, organization, and institutional aspects of the TWRS Authorization Basis:

- 10 CFR 830, "Nuclear Safety Management"
- DOE O 232.1, *Occurrence Reporting and Processing of Operations Information* Change 0 (1995)
- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1 (1992)
- DOE 5480.20A, *Personnel Selection, Qualification and Training Requirements for DOE Nuclear Facilities*, Change 0 (1994)
- DOE 5480.21, *Unreviewed Safety Questions*, Change 0 (1991)
- DOE 5480.22, *Technical Safety Requirements*, Change 2 (1996)
- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)
- DOE 5480.26, *Trending and Analysis of Operations Information Using Performance Indicators*, Change 0 (1993)
- RLP 5480.23, *Review and Approval of Nuclear Safety Documents*, Change 1 (1996).

17.3 ORGANIZATIONAL STRUCTURE, RESPONSIBILITIES, AND INTERFACES

Fluor Daniel Hanford, Inc. (FDH), is responsible to the DOE, Richland Operations Office (RL) for planning, integrating, and managing TWRS activities, including programs, projects, and operations. FDH is supported by subcontractors, collectively referred to as the Project Hanford Management Contract (PHMC) Team, and other companies referred to as enterprise companies. In addition, other onsite contractors (e.g., Pacific Northwest National Laboratory [PNNL] and Hanford Environmental Health Foundation [HEHF]) provide support and have existing contracts with RL for certain site services. The PHMC Team and project activities are directed by FDH project directors. Figure 17-1 depicts the PHMC Team organization.

17.3.1 Organizational Structure

FDH is the management contractor for Project Hanford. The FDH organization includes a Project Director responsible for integrating the TWRS Project into the overall Hanford Site organization. The FDH office-level Environment, Safety and Health (ES&H) organization and Quality Assurance (QA) organization report directly to the President of FDH and provide oversight to ensure institutional safety provisions are implemented.

As shown in Figure 17-2, the PHMC Team management and integration (M&I) roles are divided between FDH, major subcontractors, and the enterprise companies. RL is also considered a role player in the PHMC Team management structure. The following subsections discuss the roles of FDH as the M&I contractor, the major subcontractors as operations organizations, and the enterprise companies as support organizations to FDH and the major subcontractors.

17.3.2 Organizational Responsibilities

The following subsections summarize the organizational responsibilities of the PHMC team that supports TWRS activities. Figure 17-3 identifies the organizations within FDH that interface with TWRS activities and their responsibilities.

17.3.2.1 Fluor Daniel Hanford, Inc. As M&I contractor, FDH is ultimately responsible for (1) contract performance, which includes protecting the public, workers, and environment from anticipated hazards associated with Hanford Site operations; and (2) providing a focal point for interaction with DOE and the stakeholders.

17.3.2.1.1 Environment, Safety and Health Organization. To ensure an integrated approach to safety, FDH has created an ES&H organization that is responsible for the development, incorporation, and implementation of environmental safety and health requirements into sitewide programs. The environmental safety and health requirements are incorporated, as

appropriate, into major subcontractor programs and specific safety and health programs associated with specific projects and activities.

17.3.2.1.2 Project Direction. FDH Project Direction provides leadership, oversight, direction, and control in the execution of projects. The Office of Project Direction monitors and is accountable for the FDH subcontractor's performance to ensure technical, cost, and schedule baseline conformance; integrating interfaces; evaluating, forecasting, and reporting performance for all performance factors including safety, QA, and project progress; and facilitating PHMC Team support to the projects.

The TWRS Project Director is the point of contact for FDH subcontractors and is the designated FDH Contracting Officer's Representative. The Project Director is responsible for the conduct of all aspects of a project, including safety, health, and environmental issues. FDH ES&H consults and advises the Project Director and develops guidance for the subcontractors.

17.3.2.1.3 Quality Assurance Organization. The FDH QA organization is in place to develop sitewide QA programs and policies and to communicate those programs and policies to the major subcontractors. The purpose of FDH QA programs is to establish an integrated approach to quality that ensures performance of all Hanford Site activities meets contract expectations.

17.3.2.1.4 Training Organization. The FDH Training Director establishes the standards for all PHMC Team training to ensure that all training programs meet RL training requirements and to prepare the workforce to perform work safely and effectively. These standards, in conjunction with implementing procedures and supporting documents that govern training under the PHMC, establish a graded, systematic approach to training that is designed to ensure that the qualification and training program meets DOE and federal requirements.

17.3.2.2 Lockheed Martin Hanford Corporation. Lockheed Martin Hanford Corporation (LMHC) is responsible for the day-to-day operation of TWRS. LMHC responsibilities for TWRS include, but are not limited to, the following activities:

- Ensure that TWRS facility operations meet applicable federal, state, and local laws and regulations and comply with sitewide standards, policies, and procedures

- Provide implementation and compliance guidance and direction to all TWRS operating facilities for applicable environmental laws, regulations, permits, and consent orders/agreements

- Establish a self-assessment strategy to determine the effectiveness of each organization and to ensure that senior management is involved in the assessment process

- Manage the operation of facilities associated with the receipt, containment, storage, and handling of Hanford Site liquid waste

- Develop and execute a program for tank waste characterization.

LMHC responsibilities for TWRS also extend to retrieval, pretreatment, treatment for disposal, and disposal of waste and coordination with private contractors involved in future waste processing activities. However, these functions are outside the scope of this Final Safety Analysis Report (FSAR) and will not be discussed herein. Responsibilities of the LMHC TWRS divisions are shown in Figure 17-4 and summarized in the following subsections.

17.3.2.2.1 Tank Waste Operations Division. Tank Waste Operations manages and directs the operations, characterization, maintenance, and radiological control of tank activities pertaining to TWRS permitted treatment, storage, and disposal (TSD) facilities within the boundaries of all operating requirements ensuring compliance with applicable U.S. Department of Energy orders and federal, state, and local laws and regulations. The organizational structure of the Tank Waste Operations division is depicted in Figure 17-5. Responsibilities of the Tank Waste Operations division include, but are not limited to, the following activities:

- Maintaining standard of performance for formal conduct of operations, maintenance, and radiological control by all personnel in accordance with established procedures, DOE orders, laws, and regulations

- Ensuring that work is performed in a disciplined and professional manner that reflects the highest commitment to safety and excellence; actively applying "as low as reasonably achievable" (ALARA) techniques to all activities and processes

- Receiving liquid waste from approved generators; storing liquid waste in underground storage tanks; transferring liquid waste through the waste transfer system; ensuring all the foregoing activities are conducted in accordance with all requirements

- Performing liquid, vapor, and core sampling in support of process requirements, operations initiatives, safety issue resolution, and waste retrieval and disposal

- Performing in-tank photography and/or video pit examinations in support of tank sampling, abandoned equipment decontamination/disposal, and other tank intrusive work

- Ensuring facilities are maintained or promptly repaired, modified, or upgraded, as necessary, to preclude unplanned release of contamination to the environment or injury to personnel; and preparing facilities for ultimate retrieval and disposal activities

- Establishing appropriate training systems, processes, and controls to ensure that qualified individuals are available and ready to efficiently and effectively operate and maintain tank farms

- Managing and directing the Radiological Health and Safety Programs established for all TWRS activities; ensuring each facility meets their radiological protection goals by providing disciplined, technically sound professional radiological services

- Managing the required revisions and publication of TWRS technical and administrative procedures to ensure usability and implementation of requirements for users to complete work safely and efficiently.

The Tank Waste Operations division also is supported by Waste Management Federal Services of Hanford, Inc. (WMH), waste management projects (Figure 17-6).

Tank Farms Shift Operations Group. The Tank Farms Shift Operations organization is responsible for safe and efficient operations of all TWRS facilities following the principles and guidelines of good Conduct of Operations. The following is a partial list of areas and programs that the Tank Farms Shift Operations organization is responsible for: operations logbooks; shift routines and operating practices; drill/process upset program; required reading; facility status binder; temporary modification log; operator aids; temporary labels; procedure change authorization log; standing orders; shift instructions; excavation logbook; work package release; equipment deficiency lists; occurrence reporting; procedure review; critiques; lock and tag; and shift operations staff training and development (e.g., nuclear, chemical operators and stationary operations engineers, shift managers, operations engineers, administrative personnel).

Tank Farm Facility Operations Group. The Tank Farm Facility Operations group is responsible to ensure facilities are promptly repaired or modified to preclude unplanned release of contamination or hazardous materials to the environment or injury to personnel. The group adheres to the conduct of operations standard of performance for personnel in accordance with established procedures. They collect/maintain surveillance data for systems; conduct analysis and retain data; and maintain up-to-date status of facilities and equipment. The Tank Farm Facility Operations group also establishes team interfaces with Maintenance, Retrieval Operations, Shift Operations, Engineering, Health Physics, Safety, Environmental, Quality, Characterization, and Human Resources organizations to ensure safe, efficient operations.

SY Farm Project Group. The objective of the SY Farm Project (SY-101 Surface-Level-Rise-Remediation Project) is to remediate the 241-SY-101 surface-level rise by producing conditions in 241-SY-101 (without creating adverse conditions in other tanks) that support safe storage within an approved Authorization Basis and thus close the 241-SY-101 Crust Level USQ by September 30, 2001. A focused project team (the SY Farm Project Group) was established to develop, evaluate, and execute options for remediating the surface-level rise. The SY Farm Project Group is using a systems engineering, logic-based project planning approach. Members of the SY Farm Project group were chosen to represent major functions within TWRS (Technical Operations and Engineering; Operations; Nuclear Safety and Licensing; and Environmental, Safety, Health, and Quality Assurance), PNNL, Hanford contractors, and other contractors.

Retrieval Support Operations Group. The Retrieval Support Operations group is responsible for managing and directing activities within Tank Farm facilities that are required to retrieve waste and provide feed for immobilization. The Retrieval Support Operations group provides leadership for and review of the design, construction, and operations of systems to retrieve and transfer waste to privatization contractor facilities. This group also develops and maintains the operations and maintenance concept and philosophy, which will ensure the ability to retrieve and transfer waste to meet key privatization objectives.

Maintenance Group. The Maintenance group is responsible for maintaining designated equipment in a safe and reliable condition to ensure the support of TWRS operational needs and goals. Major program responsibilities include: performing production control and work planning/scheduling functions required for Tank Waste Operations, Characterization Program Operations, Interim Stabilization, and Maintenance (with the exception of construction projects); providing Vent and Balance services to the Hanford Site; developing and implementing program plans compliant with appropriate federal regulations, DOE Orders, and national standards; developing and implementing training programs to ensure personnel proficiency; developing and implementing improved procedures to control maintenance field activities; supporting multi-year planning and managing activities within authorized funding and budget levels; and providing responsive interface with all TWRS Maintenance stakeholders.

Characterization Project Operations Group. The Characterization Project Operations group administers the operational and field requirements for tank sampling and in-tank video/photography operations in support of TWRS high-level waste storage tanks and the Waste Characterization Program.

Interim Stabilization Group. The Interim Stabilization group manages and directs single-shell tanks saltwell pumping.

TWRS Nuclear Regulatory Compliance Support Group. TWRS Nuclear Regulatory Compliance Support group provides management direction and support during authorization basis document preparation, revision, implementation, and interpretation within Tank Waste Operations to ensure that the safety envelope is defined and implemented. To achieve these objectives, TWRS Nuclear Regulatory Compliance Support serves as a management interface with TWRS Nuclear Safety and Licensing, thereby ensuring a high level of management support within Tank Waste Operations for regulatory issues and problem resolution.

Radiological Control Group. The Radiological Control group manages and directs the Radiological Health and Safety Programs established for TWRS activities and supports facilities in meeting their radiological protection goals. This group conducts independent assessments of TWRS activities as a measure of compliance with radiological protection requirements and process effectiveness. The group also provides guidance and policy direction for continuous improvement in the conduct of radiological work.

TWRS Procedures, Startup Support and Training Group. The TWRS Procedures, Startup Support and Training group supports the Lockheed Martin Hanford Corporation goals

by: maintaining TWRS administrative and technical procedures current and available for use by initiating, preparing, revising, and performing periodic review of procedures; conducting acceptance and operational testing of modifications, additions, or upgrades to tank farm systems, structures, and equipment; managing a formal, structured approach to verify a state of readiness has been successfully achieved to start or restart facility operations; managing the technical and administrative execution of configuration management discipline that ensure the technical integrity and consistency among the requirements, physical configuration, and facility documentation for missing essential structures, systems, and components (SSCs); and providing training courses and services, such as coordination of training with other site training organizations and vendors, determination of training, needs, and support to line management by providing qualification programs for the entire TWRS organization.

Tank Operations Program Support Group. Tank Operation Program Support group is chartered to provide and manage support services pertaining to Tank Waste Operations for administrative services, Facility Excellence Program, and work integration.

17.3.2.2.2 TWRS Technical Operations and Engineering Division. TWRS Technical Operations and Engineering (Figure 17-7) is responsible for managing and directing TWRS Project technical and operational engineering integration, including coordination of research and development, process engineering, nuclear safety and licensing, configuration management, strategic planning, plant engineering, retrieval engineering, and technical operations retrieval and disposal. TWRS Technical Operations and Engineering establishes and maintains the technical baseline and safety basis for the life cycle of the Tank Waste Storage and the Tank Waste Disposal projects.

Process Engineering Group. The Process Engineering group establishes and maintains the technical baseline for waste behavior (chemical, physical, radiochemical, volume), including parameters of interest for safe storage, retrieval, preprocessing, and immobilization. This group also supports appropriate use of tank waste information by site programs and safety issue resolution organizations and classifies tanks with respect to safety issue categories.

Nuclear Safety and Licensing Group. Nuclear Safety and Licensing group develops and maintains the authorization basis documents for TWRS facilities including supporting safety analyses and attendant Technical Safety Requirements (TSR). This group also develops, implements, and maintains a system managing safety documentation and provides management of the Nuclear Criticality Safety program. In addition, Nuclear Safety and Licensing maintains an Unreviewed Safety Question (USQ) process, database, and records and coordinates the activities of the Plant Review Committee.

Configuration Management Group. The Configuration Management group establishes, coordinates, and maintains the process methods, mechanisms, and procedures that govern the "Conduct of Engineering" for the TWRS Technical Operations and Engineering organization. This group also coordinates the training and qualification program for the TWRS Technical Operations and Engineering staff.

In addition, the group develops and manages the implementation of the TWRS Project configuration management program. This program establishes consistency among the requirements, physical/functional configuration, and related information for TWRS baselines and products and maintains this consistency throughout the life cycle.

Strategic Planning Group. The Strategic Planning Group develops long-range TWRS program strategy and identifies TWRS research and technology development needs. This group also provides strategic analysis to ensure major decisions or planning documents have a sound technical basis (e.g., environmental impact statements, strategic plans, mission analysis reports).

TWRS Plant Engineering Group. TWRS Plant Engineering comprises the following groups: DST Engineering, SST Engineering, Characterization Engineering, Equipment Engineering, and Interim Stabilization Engineering. These groups provide technical expertise during facility operation through qualified cognizant engineers and design authorities. Other responsibilities for these groups include identifying and maintaining the facility system, structure, and components configuration in agreement with the technical baseline and the Authorization Basis and reviewing and controlling proposed changes to the facility/activity to ensure consistency with the design basis.

TWRS Retrieval Engineering Group. The TWRS Retrieval Engineering group provides engineering support for the Tank Waste Retrieval Program by defining system upgrades for both single-shell and double-shell tanks and developing the requirement documents for the construction projects for these system upgrades.

In addition, this group establishes and maintains the technical baseline for the future retrieval of the tank waste, and delivery to the processing facility. This baseline includes waste retrieval flowsheets/operational scenarios, and double-shell and single-shell tank system/component requirements for retrieval. Other functions include analyzing alternative strategies for tank waste retrieval and assessing tank farm systems to identify needs for upgrades.

Technical Operations for Retrieval and Disposal. The Technical Operations for Retrieval and Disposal group provides review support for selected projects, reports, and facility operations.

17.3.2.2.3 Life-Cycle Projects Division. The Life-Cycle Projects (Figure 17-4) manages and directs the design, construction, and acceptance testing of operations, retrieval, and disposal projects within TWRS. The scope of work assigned to Life-Cycle Projects includes congressional line item projects, general plant projects, and select expense and capital equipment/expense not related to construction funded projects.

17.3.2.2.4 Environment, Safety and Health and Quality Assurance Division. The ESH&QA division director reports to the LMHC President and is responsible for the management of all LMHC ESH&QA activities, including those for TWRS. The ESH&QA Director is responsible for oversight of ESH&QA activities through the use of self assessments. An organization chart of the LMHC ESH&QA division is shown in Figures 17-4 and 17-8.

The TWRS ESH&QA division is staffed with experts in industrial safety, industrial hygiene, fire protection, nuclear safety, QA, and environmental compliance. The ESH&QA division is supported by WMH waste management projects. The WMH functional areas and activities are shown in Figure 17-6. The TWRS ESH&QA division is responsible for the following:

- Coordination and development of implementation plans and strategies relating to safety and environmental compliance

- Coordination and interface with the TWRS Project division regarding safety and environmental reporting, permitting, and compliance activities

- Coordination and development of programmatic, facility-wide, and sitewide reports and documentation concerning safety, environmental compliance, and QA.

A continuing goal of TWRS is to approach a zero defects-and-accident operation by maintaining a comprehensive safety program and embracing the principles of the Occupational Safety and Health Administration Safety and Health Management Guidelines (29 CFR 1910 "Occupational Safety and Health Standards"). The functional responsibilities of the ESH&QA division encompass industrial safety, environmental compliance, QA, industrial hygiene, and fire protection activities. Details specific to these activity types follow.

- **Industrial Safety**—Develop and maintain a program for periodic survey and inspection and oversight of TWRS that covers all physical facilities, programs, procedures, and operations in order to identify actual or potential hazards or undesirable conditions; provide assistance to management in accident investigations, employee concerns, and safety integration

- **Environmental Compliance**—Provide compliance review support for environmental issues applicable to all TWRS program elements; assure that field environmental support to operations, projects, and facilities is provided to ensure that use of hazardous material is minimized, spills are cleaned up, and waste materials are properly packaged and removed from the Hanford Site expeditiously and in accordance with radioactive and hazardous waste management requirements

- **Quality Assurance**—Perform assessments for compliance with and effectiveness of management control systems; provide verification services for product acceptance; perform reviews and inspections in support of work package development and implementation

- **Industrial Hygiene**—Safeguard employee health and well-being by anticipating, recognizing, evaluating, and controlling exposures to harmful chemical, physical, biological, ergonomic, and environmental stresses

- **Fire Protection**—Develop and maintain the LMHC Fire Protection Program; act as the LMHC interpretive authority for fire protection codes and standards; provide guidance in flammable gas issues, assist facility management with fire protection compliance; perform facility assessments; assist in fire investigations; ensure the fire hazards analysis is performed under the direction of a fire protection engineer; and review and approve designs, specification, and modifications for fire protection systems, facility structures, supporting utilities, and associated documents.

17.3.2.2.5 Tank Waste Retrieval and Disposal Division. Tank Waste Retrieval and Disposal (Figure 17-4) is responsible for planning and managing the development and execution of the technical and programmatic baseline for the Tank Waste Retrieval and Disposal mission. Other responsibilities include developing the plans and providing the systems and facilities for retrieving waste from single-shell tanks (SST) and double-shell tanks (DST), providing waste feed to immobilization facilities, and safely storing or disposing of immobilized tank waste. The division also is responsible for providing infrastructure support for immobilization facilities, addressing existing subsurface contamination from past tank leaks, and developing plans for closing tank farms following waste retrieval. In addition, the division supports development of long range and strategic plans for completing the Tank Waste Remediation Mission, integrates all mission activities into a comprehensive programmatic (scope, schedule, cost) baseline, provides an integrated safety and environmental baseline, and provides technical support for issue resolution and alternative evaluation.

17.3.2.3 Other Project Hanford Management Contract Team Companies. In addition to LMHC, two companies directly support or interface with TWRS Projects. These companies are NHC and WMH.

WMH manages and operates the Hanford Site treatment, storage, and disposal facilities, as the Waste Management Projects division (Figures 17-1 and 17-2). These facilities include hazardous waste storage facilities, radioactive solid waste disposal sites, mixed waste storage areas, and radioactive and nonradioactive polychlorinated biphenyl storage facilities. WMH is responsible for managing the waste sites in accordance with state and federal regulations; DOE orders; Hanford Site requirements; and other rules, regulations, guidelines, and standards as they apply to acceptance of radioactive and hazardous solid waste at the Hanford Site. WMH provides secondary service to the TWRS Project by receiving, storing, and disposing of solid wastes generated during routine activities (Figure 17-6).

WMH manages and operates the Hanford Site analytical laboratories. As shown in Figure 17-6, WMH analytical services support the characterization group within Tank Waste Operations. As shown in Figure 17-6, the analytical services program is responsible for sample management, QA, and records, and industrial health and safety at the 222-S Laboratory and the Waste Sampling and Characterization Facility.

WMH also provides onsite environmental monitoring that includes the TWRS facilities. This activity directly supports the Waste Management Projects (Figure 17-6) as a group in the ESH&QA organization.

17.3.2.4 Enterprise Companies that Interface with Tank Waste Remediation System. Several enterprise companies provide support to TWRS organizations as matrixed functions. The interfaces between these support companies and the applicable TWRS organization are controlled by TWRS for matters related to cost, schedule, priorities, and safety management. A summary table (Table 17-1) identifies the enterprise companies and the PHMC activities supported. The support organizations report to organizations external to TWRS for methodology and standards guidance by which their work is conducted.

17.3.2.4.1 Hanford Fire Department. The Hanford Fire Department responsibilities and authorities apply to all DOE-owned facilities on the Hanford Site. DynCorp Tri-Cities Services, Inc., a FDH subcontractor, manages the department. The Hanford Fire Department is responsible for:

- Providing and maintaining a highly trained emergency response team certified under a 3-yr. Washington State-approved fire fighter apprenticeship program
- Acting as the lead emergency response organization and providing incident command for fire suppression, emergency medical and ambulance service, special emergency rescue, and hazardous material events
- Conducting functional testing, preventive maintenance, and corrective action of fire protection systems and servicing and maintaining respiratory equipment
- Providing and maintaining a fire and life safety permitting system
- Maintaining an active fire prevention program through prefire planning and inspections of facilities and ignitable/reactive waste sites.

17.3.2.4.2 Emergency Preparedness. See Chapter 15.0 for a description of the emergency preparedness organization responsibilities that apply to TWRS safety. This organization is managed by DynCorp Tri-Cities Services, Inc.

17.3.2.4.3 Safeguards and Security. The Safeguards and Security organization, managed by Protection Technology Hanford (PTH), is responsible for providing protection of government property. The Security Applications Center, operated by Safeguards and Security personnel, provides analytical and systems engineering support for cost-effective and uniform safeguards and security systems. Physical security entails command, control, and notification activities for all emergency conditions and 24-hour enforcement of applicable federal, state, and local laws. The security organizations conduct their activities in compliance with PTH, policies and procedures.

17.3.2.4.4 Procurement and Materials Management. The Procurement and Materials Management organization, managed by FDH with support from Fluor Daniel Northwest, Inc., is responsible for the procurement of goods and services that meet established standards and requirements. Prospective suppliers are evaluated and selected from specified criteria. Established processes ensure that approved suppliers continue to provide acceptable items and services. Inspection and testing of specified items, services, and processes are coordinated to ensure that established acceptance and performance criteria are used. TWRS procurement is performed following approved procedures and processes with graded levels of management controls.

17.3.2.4.5 Lockheed Martin Services, Inc. Lockheed Martin Services, Inc., provides information resource management services. These services include planning and information resource management in the areas of computing; telecommunications; records management; photography and audiovisual equipment and capabilities; printing, duplicating, and engineering reproduction; document processing, storage, and retrieval; and graphics illustration.

17.3.2.4.6 Transportation and Packaging Services. The Transportation and Packaging Services organization, managed by Waste Management Federal Services, Inc., Northwest Operations, provides sitewide policies and procedures governing hazardous materials transportation and packaging, qualification requirements and shipper training, preparation and maintenance of required shipping container safety documentation, hazardous materials packaging, design procurement support, analysis and testing, field support to the DOE Headquarters transportation management program, and all other transportation management activities.

17.3.3 Other Onsite Contractors

In addition to the PHMC Team and enterprise companies, two other contractors support TWRS. The contractors are contracted by RL to provide onsite dosimetry support (Section 17.3.3.1) and onsite health services (Section 17.3.3.2).

17.3.3.1 Pacific Northwest National Laboratory. PNNL is responsible for providing personnel monitoring services. These services include personnel dosimetry monitoring, internal dosimetry monitoring, dosimetry record management, and dose evaluation in emergency cases. The laboratory provides radiation instrument monitoring support to the RL and its contractors. This monitoring support includes new instrument evaluations, emergency response unit and instrument maintenance, and routine radiation survey instrument calibrations. PNNL personnel are also available to provide additional research and development review, consultation, and report preparation support.

17.3.3.2 Hanford Environmental Health Foundation. The HEHF serves two functions for TWRS: (1) maintains the medical monitoring programs for TWRS employees in compliance with Occupational Safety and Health Administration standards and DOE orders, and (2) monitors staff safety performance through reports of on-the-job injuries. The medical

monitoring responsibilities include performance of replacement, periodic, return-to-work, and fitness for duty examinations for all workers; performance of physicals for workers who handle hazardous waste; medical records maintenance; management consulting services; employee occupational exposure database management; and material safety data sheet database management.

17.3.4 Staffing and Qualifications

Safe and effective operation of TWRS is dependent upon a staff of qualified, competent personnel that conduct routine and long-range activities. Minimum education and experience requirements for TWRS facility managers and technical personnel meet the requirements of DOE 5480.20A. Qualifications are met through education and related industry experience and through company-sponsored, job-specific training. Division directors are the ultimate authority in determining candidate qualifications for division positions.

17.3.4.1 Training and Qualification. Training and qualification requirements for TWRS personnel are summarized in Chapter 12.0 and documented in accordance with the TWRS Qualification/Certification Manual (HNF-IP-0842, *TWRS Administration*, Volume III, Section 3.5). Other subject-specific training requirements are summarized in the applicable chapters of this document. In addition to meeting the TWRS- and subject-specific training requirements, each facility employee must also successfully complete the following Hanford Site training programs:

- Hanford General Employee Training
- New Employee Safety Orientation
- Appropriate TWRS Facility Orientation
- Appropriate TWRS Facility Building Emergency Plan.

17.3.4.2 Minimum Staffing Requirements. The number of managers, engineers, operators, and support personnel assigned to each facility shall be adequate to support safe operations. Abnormal plant conditions shall be considered when determining staffing assignments. Managers or engineers who have been trained in an approved facility-specific training program may be substituted for operators when necessary. Minimum staffing requirements for safe operation are identified in the TSRs.

17.3.4.3 Fitness for Duty. "Fitness for duty" refers to the ability of an individual to perform assigned tasks free from impairments caused by drug or alcohol abuse, emotional distress, and personal health problems. TWRS management is committed to providing a work environment free of the negative influences of substance abuse and other behaviors that jeopardize the safe work practices required for safe operations. Use, sale, or possession of illegal drugs or alcohol is prohibited on the Hanford Site, and employees who are found to be sellers, distributors, or repeated users of illegal drugs will be denied access to the facilities. Although random testing is not performed to ensure employee fitness for duty, managers and supervisors have been trained to recognize symptoms that indicate an employee may not be fit for duty.

17.4 SAFETY MANAGEMENT POLICIES AND PROGRAMS

17.4.1 Safety Review and Performance Assessment

The effectiveness of the TWRS safety program is formally assessed by FDH management and the TWRS ESH&QA organization. The FDH ESH&QA management team and the TWRS ESH&QA team consist of recognized experts. Each team conducts an independent safety review to assess the safety of the facility operations. The independent safety review team reviews existing technical documentation, records, and files; interviews facility personnel; and inspects facilities and equipment to determine if requirements are being met and safety questions are being addressed satisfactorily. The FDH management team reports to the President of FDH, and the TWRS team reports to the President of LMHC.

Members of the independent safety review teams assigned to TWRS facilities and operations have demonstrated expertise in the specific disciplines that apply to TWRS operations. The team members are experienced in one or more of the following disciplines: operational health physics, radiological engineering, nuclear safety, criticality engineering, industrial safety, industrial hygiene, chemistry, and fire protection. The team members also have a working knowledge of applicable federal and state codes, DOE regulations, and national standards applicable to TWRS facilities and operations.

17.4.1.1 Unreviewed Safety Questions. The concept of Unreviewed Safety Questions (USQ), as presented in DOE 5480.21, allows contractors to make physical changes to facilities and equipment, to enact procedural changes, and to conduct tests and experiments without prior DOE approval. These changes must not explicitly or implicitly affect the Authorization Basis of the facility or result in the need for a TSR change. For TWRS, the Nuclear Safety and Licensing group is responsible for maintaining the USQ process.

17.4.1.2 Technical Reviews. Technical reviews are performed to verify that all proposed changes are compatible with the facility design and that the changes will not adversely affect life safety, facility safety, reliability, or operation. The TWRS Technical Operations and Engineering division is responsible for all technical reviews of TWRS facilities and operations.

17.4.1.3 Lessons Learned. A TWRS Lessons Learned Program includes the means for identification, documentation, validation, and dissemination of lessons learned (HNF-IP-0842, Volume II, Section 4.6.3, "Lessons Learned Procedure"). The TWRS Lessons Learned Program information is used to improve day-to-day operations and to identify good practices and potential hazards. TWRS personnel are required to review lessons learned information contained in required reading files and incorporate appropriate practices into their daily work habits. (See Chapter 11.0 for details on the required reading program and on typical daily work practices.)

Lessons learned information is also used in the development of training curriculum and training materials, as well as the development and modification of operating procedures and controls (e.g., radiological work permits). Personnel are encouraged to participate in the lessons

learned process by providing feedback on information distributed and to identify information for potential inclusion in the process. Trend analyses of injuries, illnesses, and workers' compensation claims and root cause analyses are part of the Lessons Learned Program scope. Appropriate corrective actions are determined from the information resulting from these activities. The TWRS Lessons Learned Program is the responsibility of the Lessons Learned Coordinator who is a LMHC employee.

17.4.2 Configuration and Document Control

Configuration management establishes and maintains consistency among design requirements, physical configuration, and facility documentation. Physical configuration must conform to the design requirements established by the design output documents. Facility documentation must accurately represent physical configuration and design requirements. Facility documentation that supports facility operations will include the as-built configuration documentation and facility procedures for activities. Historically, this level of documentation has not been maintained for all TWRS facilities, but the documentation will be established for all Safety-Class and Safety-Significant Structures, Systems, and Components (SSCs) during the implementation phase of this FSAR. The as-built documentation of physical configuration and facility procedures for activities will be applied to the minimum SSCs that are required to establish the safety baseline and maintain the integrity of the controls described in the TSRs. Changes to facility design requirements will be reflected in the facility physical configuration and the facility documentation. Changes to the physical configuration or the facility documentation must be supported by design requirements. These configuration control activities are the responsibility of TWRS Configuration Management (Figure 17-4). The configuration control process comprises the following five elements:

- **Identification**—Potential changes to SSCs will be identified and initiated by any project participant who determines that a departure from the existing cost, schedule, or technical baselines is warranted. Identification is performed by way of the implemented USQ process.

- **Evaluation**—After identification, the project participant who identifies the change will perform an evaluation. This evaluation will establish that the potential change is both necessary and desirable. The precise evaluation process is determined by the importance of the change, cost, and schedule impacts of implementing the change. Evaluation is also performed by way of the USQ process, with input from the TWRS Safety Issue Resolution group in areas of design, configuration, and safety.

- **Approval**—Each change must be approved on the change documentation before authorization of work. Overall responsibility for approval resides with the TWRS Safety Issue Resolution group in the areas of design, configuration, and safety.

- **Authorization**—When a change is approved, it will be processed through the required contract and work authorization cycles. This process is dependent on the type and magnitude of the change.

- **Implementation**—After the change has been approved and authorized, the changes will be implemented in accordance with the authorized work control package.

HNF-1900, *Tank Waste Remediation System Configuration Management Plan*, describes the configuration management program the PHMC Team uses to manage and integrate its programmatic and functional operations to perform work. The configuration management program defined in HNF-1900 provides the necessary technical consistency for safe, economic, and environmentally sound management of TWRS facilities and systems throughout their life cycles.

17.4.3 Tank Waste Remediation System Safety Management System Process

17.4.3.1 Integrated Safety Management. An integrated safety management system is currently being developed by TWRS in response to Defense Nuclear Facilities Safety Board Recommendation 95-2 (DNFSB 1995). The integrated safety management system will implement the guidance identified in DOE P 450.4, *Safety Management System Policy*. The objective of the integrated safety management system is to provide a formal process to systematically integrate safety into management and work practices to assure work is performed safely and the public, the environment, and the workers are protected.

There are five essential safety functions or elements requiring consideration in an integrated safety management system: (1) define scope of work, (2) identify and analyze hazards, (3) develop and implement hazard controls, (4) perform work within controls, and (5) provide feedback (Figure 17-9). The purpose of the proposed TWRS integrated safety management system (HNF-SD-WM-PLN-114, *TWRS Safety Management Plan*) is to define and describe the TWRS safety management system using the five essential safety functions.

The following briefly discusses the management of each of the safety functions to ensure work is performed safely. For additional detail see HNF-SD-WM-PLN-114.

17.4.3.1.1 Define Scope of Work. As identified in Chapter 2.0, the TWRS work scope involves a variety of activities. These activities are performed in support of the TWRS mission and in accordance with the contractual agreement between LMHC and FDH. To assure work is performed safely each activity is broken down into discrete work packages. The proposed TWRS integrated safety management system identifies two work scopes: facility level and activity level.

Facility level work scope is directed and controlled based on the contractual agreement between LMHC and FDH. At the site level an integrated site baseline (ISB) is developed by FDH to integrate work scope and contractor interfaces between FDH, its subcontractors, and other Hanford Site Contractors. Baseline authorization is the mutual acceptance and approval between FDH and RL for performing the work described by the ISB. RL approves the ISB and authorized resources for the execution of work within a specific time period. FDH, in turn, authorizes work by its subcontractors (LMHC) through project authorization documents.

The TWRS input into the ISB comes in the form of a multiyear work plan which is reviewed by FDH and incorporated, if appropriate, in the final ISB. TWRS prioritizes the work identified in the project authorization documents in a final multiyear work plan. The prioritization is based on mission, compliance, cost, and risk containment objectives. At all working levels of TWRS, a risk-based prioritization process is used to establish a technically defensible logic for work planning and execution. This process is intended to balance priorities by using risk-based planning and resource allocation to meet regulatory requirements and control safety and environmental hazards during the safe execution of work. Risk-based prioritization of work ensures that the most significant hazards are mitigated in the most cost-effective manner.

Activity level work scope (e.g., work performed on SSCs within the TWRS facilities) can be identified during facility walkdowns, during SSC surveillance and corrective and preventive maintenance, engineered modifications to safety-related equipment; or through component or system failure. Work is prioritized according to the safety classification of the system and critical need to support mission requirement. Work at TWRS is categorized into three categories based on the required skill of the worker and the hazards associated with the task to be performed. The three categories are (1) routine, (2) skill-of-the-craft, and (3) planning required. See HNF-IP-0842, Volume V. Section 7.1, "TWRS Work Control," for additional discussion on work planning, categorization, and prioritization.

17.4.3.1.2 Identify and Analyze Hazards. Hazards are analyzed prior to initiating work activities. The hazards analyses are performed to identify conditions that could lead to undesired consequences to the public, the workers, and the environment. The hazard and accident analyses contained in Chapter 3.0, "Hazard and Accident Analyses," address the TWRS facility and its operations. The analyses contained in Chapter 3.0 are maintained and updated as part of the facility-level work scope. For new activities, including one-time and long-term activities, hazard analyses are performed based on the scope of work activity and, if appropriate, are incorporate in the FSAR as an addendum. The hazard analyses are designed to address all the hazards identified during the hazard identification activities, including material at risk, energy sources, natural phenomena, external events, and common cause failures. The results of the analyses are used to support the identification of requirements and controls specifically related to the task analyzed (e.g., radiological, industrial hygiene and safety, fire protection).

17.4.3.1.3 Develop and Implement Hazard Controls. The controls developed for safe operations of TWRS are graded based on the results of the hazard and accident analyses contained in Chapter 3.0 and environmental requirements and analyzes. The developed controls include TSRs, institutional controls and safety programs, facility-level operations documents, and

environmental regulations. TWRS also prepares and maintains environmental documentation based on the risks and hazards associated with the work being performed.

The TSRs, as discussed in DOE 5480.22, define acceptable conditions, safe boundaries, and Administrative Controls (or management) to ensure safe operations and reduce the potential risk to the public and onsite workers from uncontrolled releases of radioactive or other hazardous material or from radiation exposures caused by inadvertent criticality. The TSR controls (HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*) are based on the hazards and accident analysis contained in Chapter 3.0 and are considered necessary and sufficient for public safety, significant Defense-in-Depth, significant worker safety, and for maintained potential consequences below risk guidelines. These controls define the safety envelope approved by DOE using safety analyses.

As part of the implementation of the controls, TWRS maintains an auditable safety analysis program. The auditable safety analysis program maintains the existing boundary for safe operation by establishing a safety envelope and supports the identification, analysis, and control of previously unidentified hazards (e.g., hazards based on new work scope). The safety analysis program is used to ensure that each activity and operation within the facility or project is conducted under an approved Authorization Basis. An Authorization Basis is defined in DOE 5480.21 as those aspects of the facility design basis and operations requirements relied upon by DOE to authorize operation. The Authorization Basis Management System (HNF-IP-0842, Volume IV, Section 5.10, "Authorization Basis Amendments and Annual Updates") provides a process for developing Authorization Basis documents, evaluating and controlling changes, and implementing the Authorization Basis. All work, either in the form of proposed activities or new information (also known as a discovery), is screened to verify that the proposed change or discovery is within the Authorization Basis.

Applicable Standards and Requirements are identified and documented in a document known as a standards/requirements identification document. The standards/requirements identification document defines the requirements agreed to by the contractor and DOE and is implemented through contractor policies and procedures. The TWRS Standards/Requirements Identification Document captures the applicable safety requirements defined in the Code of Federal Regulations, Washington Administrative Code, DOE orders and regulations, and other requirement source documents (i.e., industry standards) that embody the necessary and sufficient requirements to ensure the safety of the public, the workers, and the environment. The process for identifying the applicable requirements is based on the results of hazards and accident analysis contained in Chapter 3.0. That is, the identified hazards, assumptions, and controls are listed. Currently the list of applicable requirements are contained in WHC-SD-TWR-SRID-003, *HLW Storage Tank Farms/242A Evaporator Standards Requirements Identification Document Phase 2 Assessment Report*. The requirements identified in this document have been selected and tailored to the current TWRS facility design and operations.

Based on the results of the hazards and accident analysis, the standards/requirements identification documents identification process, and the TSRs, institutional controls and safety

programs are developed at TWRS. These controls and programs, discussed in Chapters 6.0 through 17.0, address the following:

- "Prevention of Inadvertent Criticality" (Chapter 6.0)
- "Radiation Protection," including ALARA principles (Chapter 7.0)
- "Hazardous Material Protection" (Chapter 8.0)
- "Radioactive and Hazardous Waste Management" (Chapter 9.0)
- "Initial Testing, In-Service Surveillance, and Maintenance" (Chapter 10.0)
- "Operational Safety" (Chapter 11.0)
- "Procedures and Training" (Chapter 12.0)
- "Human Factors" (Chapter 13.0)
- "Quality Assurance" (Chapter 14.0)
- "Emergency Preparedness Program" (Chapter 15.0)
- "Provisions for Decontamination and Decommissioning" (Chapter 16.0)
- Configuration Control
- Authorization Basis management.

TWRS environmental documentation includes *National Environmental Policy Act of 1969* documentation and *Resource Conservation and Recovery Act of 1976* permits.

17.4.3.1.4 Perform Work Within Controls. Safe work is conducted in accordance with the controls, procedures, and commitments developed from and contained in the Authorization Basis. At the activity level, the formality, the degree to which work is proceduralized, and the degree of direct supervision is established based on the type and magnitude of hazards, the confidence that the hazards are well known, the confidence in the hazard controls that are selected, the complexity of the work, the comprehensiveness of the safety envelope, and worker qualifications. Worker involvement plays an important role throughout the work planning process and the performance of work.

The TWRS work planning process, as detailed in HNF-IP-0842, Volume V, Section 7.1, "TWRS Work Control," is used to prepare for work. This process defines work performance from planning to execution and includes confirming readiness, worker involvement and worker training and competence; designating responsibilities and approval authorities; and performing work. In the planning process, workers and support personnel (e.g., radiological control personnel) provide input to work documents, perform site walkdowns, and review completed work documents. Through a combination of training, required reading, prejob planning meetings, and prejob safety briefings, workers are made cognizant of hazards and controls required to perform work.

At TWRS, job hazards analyses are used to identify specific hazards and develop procedures, safety plans, instructions, or work permits to adequately address safety and health at the activity level. The safety instructions and controls identified following the job hazards analyses are written into the work packages. Work packages contain the necessary elements that are fundamental to worker safety. Within the work package the hazards are identified and safety boundaries are established for the work to be performed; the applicable requirements are

identified; worker skill needs are identified; and job site prerequisite conditions are identified. Work is executed upon approval of work packages developed in accordance with HNF-IP-0842, Volume V, Section 7.1.

At TWRS, workers always have the power to stop work if any conditions exist that are felt to be unsafe or hazardous to the environment. Workers will not proceed and will halt work if instructions are unclear or inadequate or the controls are not adequate to control the hazards present.

17.4.3.1.5 Provide Feedback. Self-assessments are performed at TWRS to provide measurable feedback and support continuous improvement. The self-assessments are incorporated into TWRS work processes through the use of performance indicators, in-process monitoring, occurrence reports, management assessments, worker assessments, self-assessments, independent assessments, and the lessons learned program.

The performance indicator program at TWRS (HNF-IP-0842, Volume I, Section 2.5, "Performance Indicators Program") was generated on the basis of requirements, good management practices, and requests from management with conformance to DOE 5480.26.

The TWRS procedure for occurrence reporting and reporting of operations information (HNF-IP-0842, Volume II, Section 4.6.2, "Occurrence Reporting and Processing of Operations Information") establishes and implements criteria for the identification, categorization, and notification of occurrences.

The Management Assessment Program (HNF-IP-0842, Volume I, Section 2.10, "Management Assessment Program") at TWRS is designed to integrate assessment schedules and use the resulting data for effective trending analysis. Program implementation includes guidance for preparation for and performance of assessments. Assessment results are entered into the identified corrective action tracking system.

The TWRS Lessons Learned Program (HNF-IP-0842, Volume II, Section 4.6.3) encourages improvements in safety and operations by communicating Hanford Site and related industry-wide operating experience. Lessons learned are obtained from the following sources:

- Occurrence reporting and processing system final reports
- DOE operations experience (weekly report)
- DOE lessons learned information system
- Sitewide lessons learned evaluation request
- Input from tank farm personnel
- Health physics radiological problem reports
- Facility monitoring program
- DOE facility representatives
- DOE safety notices
- Results of assessments
- Performance indicators and trends

- Postjob reviews
- Emergency preparedness drill program
- Outage critiques
- Operational readiness review lessons learned reports.

Guidance is provided on preparation and dissemination of Lessons Learned reports, evaluation of action notices, and performing trend analysis.

17.4.3.2 Integrated Safety Management System Roles and Responsibilities. The integrated safety management system roles and responsibilities are shown in Figure 17-10. FDH is the prime contractor of the PHMC and is supported by six major subcontractors that manage the various Hanford Site projects and activities. LMHC is the subcontractor responsible for the day-to-day management and operation of the TWRS project. The LMHC President and General Manager reports directly to the President of FDH. A Project Director assigned by FDH oversees the TWRS project. FDH is ultimately responsible for protecting the public, environment, and workers from hazards associated with Site operations. To support safe and compliant work practices and to ensure an integrated approach to safety, the FDH ES&H organization develops and communicates sitewide ES&H programs and policies to major subcontractors for incorporation into their projects and activities.

As the contractor responsible for TWRS, LMHC is responsible for establishing mechanisms that delineate responsibilities, establish work priorities, and use risk-informed planning to promote effective use of resources. LMHC is also responsible for designing and documenting work strategies (including stop-work authority) that effectively establish mitigative/preventive controls and consider hazard severity, worker qualifications, and operational conditions.

LMHC has the responsibility to establish and maintain hazards analysis processes and capabilities and to use these capabilities to perform hazards analysis at all levels of the organization. LMHC has the responsibility to identify, establish, and implement hazard controls at all levels of its organization. Whether work is performed by LMHC or by its subcontractors, LMHC has the responsibility and accountability for performing work safely. LMHC is responsible for ensuring that work is proceeding safely and in concert with the governing agreements. This obligation can be fulfilled in several ways, but is generally a combination of three factors:

- An established self-assessment program

- Monitoring against the measures established during the agreement process including data collection and evaluation, reporting, and improvement actions taken

- Conducting assessments, routine observation, and awareness.

LMHC is responsible for the implementation of ES&H requirements at TWRS and for performing work at the facility and activity levels safely. Line managers are responsible for the safety of workers and for the protection of the public and the environment. Line management accountability for planning and implementing ES&H requirements is fundamental to the management of the PHMC. Line manager responsibility is key to successful communication and implementation of an integrated safety management system. Line managers establish the operating procedures that clearly communicate the ES&H policies and directives. Line managers and supervisors also ensure employee understanding through the involvement of their employees.

At the worker level, employees are encouraged and, in some cases, required to participate in the completion of the enhanced work planning, job walkdowns, and monthly Zero Accident Council meetings. PHMC management requires that all employees participate in monthly safety meetings, whether that be a local Employee Zero Accident Council or other organized meeting devoted to a timely safety topic or discussion of the safety issues surrounding work. Employee input is welcomed for the purpose of continually improving the ES&H conditions at every work site.

Although the DOE does not actively participate in the activities performed at TWRS, through site planning and oversight activities, the DOE is an active member of the integrated safety management system process at TWRS. Cognizant DOE employees, including workers, have the authority to stop work when they identify violations that diminish the safety of workers, the public, or the environment. The following identifies the activities performed by DOE:

- Defines mission and program objectives and provides direction and guidance to contractors

- Establishes contract and other agreements with the contractor that define the scope of the work and provides sufficient resources for the safe conduct of the work

- Establishes agreements with the contractor for safety expectations and standards appropriate for the work based on an understanding of the hazards

- Establishes its expectations for the rigor of the contractor's hazard analysis and establishes its role in review and approval of the hazard analysis and controls (e.g., TSRs for nuclear facilities) that would be incorporated into the Authorization Basis

- Retains sufficient oversight to determine if applicable regulations for industrial hazards are being followed and, if they are not, what additional DOE action is required; through oversight, provides reasonable assurance that established controls conform to applicable regulations

- Using readiness review, directs observation of contractor operations, and monitoring for significant events, is aware of and monitors the conditions under which work is performed

- Evaluates both DOE and PHMC performance using DOE assessments to assess reported data, performance measures, occurrence reports, and other data

- Provides feedback to support the continuous improvement process.

An integrated management system has been developed and implemented to establish and maintain the TWRS Authorization Basis. This management system comprises four subsystems: Technical Baseline Management System, Risk Management System, Authorization Basis Management System, and the Site Safety Management Programs System (Figure 17-11). These subsystems operate as an integrated package, sharing information and resources. Each subsystem is described in more detail in the following subsections.

17.4.3.3 Technical Baseline Management System. The Technical Baseline Management System is used for management and maintenance of facility documents related to (1) configuration of facility SSCs, (2) site description and characteristics, (3) inventory of hazardous materials in the facility, (4) facility requirements, and (5) safety basis documents that support the facility Authorization Basis (Figure 17-11). This function is performed by the Technical Operations and Engineering division (Figure 17-7). This organization is responsible for the preparation of TWRS safety documentation and the management of that documentation. Implementation of the Authorization Basis is the responsibility of the Tank Waste Operations division.

17.4.3.3.1 Tank Waste Remediation System Structures, Systems, and Components Management. SSC configuration is defined in terms of engineering documents (e.g., drawings, design analyses, design requirements and criteria, equipment lists, vendor information). The TWRS SSCs management subsystem (1) identifies SSCs important to safety, (2) maintains the documents that describe the SSC configuration, (3) provides information about the status of items under configuration control, and (4) provides a process for evaluating and implementing proposed changes. Information about SSC configuration changes are also incorporated into the following subsystems: Risk Identification, Establish Prevention/Mitigation, Authorization Basis Control, and Site Safety Management.

17.4.3.3.2 Site Description Management. Site description information includes meteorological, seismic, lightning, flood, volcanic, and geophysical data. The Site Description Management subsystem entails a process for identifying data important to the Safety Management System. The Site Description Management subsystem is used to specify appropriate media for the documentation and retrieval of the data and the processes to control changes to the site description data. Changes in the site description are also incorporated in to the following subsystems: Risk Identification, Authorization Basis Control, and Site Safety Management.

17.4.3.3.3 Hazardous Material Inventory Tracking. The Hazardous Material Inventory Tracking subsystem entails a process for identifying and documenting important attributes (type, quantity, form, process or storage condition, and location) of the hazardous materials associated with the TWRS facilities. This hazardous materials information is used to determine the facility hazard category and resulting Authorization Basis documentation requirements. The inventory tracking also ensures that any changes to tank farm hazards will be identified and evaluated before new wastes are added to the tanks. Changes in hazardous materials information are incorporated into the Risk Identification and Authorization Basis Control subsystems.

17.4.3.3.4 Requirements Management. The Requirements Management subsystem entails a documented process for identifying and allocating the WHC-SD-MP-SRID-001, *High-Level Waste Storage Tank Farms/242-A Evaporator Standards/Requirements Identification Document*, requirements and systems engineering functions and requirements important to the TWRS Safety Management System. Changes in requirements are assessed and incorporated into affected subsystems. WHC-SD-MP-SRID-001 will be used with the systems engineering functions and requirements for the TWRS Safety Management System.

17.4.3.3.5 Safety Basis Document Management. RL approved modifications to HNF-SD-WM-BIO-001, *Tank Waste Remediation System Basis for Interim Operation*, that are not included in the FSAR. These differences will be evaluated and reconciled during FSAR implementation. The evaluation process will identify the differences between the approved basis for interim operation and FSAR, determine which differences need to be incorporated into this FSAR, and determine how and when the differences will be incorporated. The process for transitioning from HNF-SD-WM-BIO-001 to the FSAR will be formulated through negotiations with the U.S. Department of Energy Office of River Protection.

17.4.3.4 Risk Management System. The activities of the Risk Management System that support the TWRS Authorization Basis include (1) identification of potential hazards and accident initiators, (2) analysis of the identified hazards and accidents to determine the associated risks, (3) evaluation of the risks relative to established guidelines, and (4) determination of the appropriate controls necessary to reduce the identified risks to an acceptable level including Defense-in-Depth.

17.4.3.4.1 Risk Identification. Risk identification entails identification of accident initiators and establishes the processes for performing hazards analyses and accident analyses to determine the frequency and consequence associated with various postulated events. Actual or proposed changes in hazards identification (i.e., type, quantity, form, process or storage condition, and location) are incorporated into the hazardous material inventory tracking system in the site characteristics documentation.

Changes in frequency or consequence are considered when performing the following activities: Risk Evaluation, Establish Prevention/Mitigation, and Authorization Basis Control. Risks originating outside the scope of this TWRS project that may affect the functioning of

TWRS Safety-Class or Safety-Significant SSCs, or that may initiate accidents within TWRS, will be similarly considered.

17.4.3.4.2 Risk Evaluation. Risk evaluation includes a process for evaluating identified risks against approved risk guidelines to determine whether any controls are necessary or prudent to reduce the overall risk. Changes in frequency or consequences of the hazards analysis (or accident analysis) or changes in the approved risk guidelines are to be factored when performing this activity. Changes in the level of risk are also to be factored when performing Establish Prevention/Mitigation and the Authorization Basis Control activities.

17.4.3.4.3 Establish Prevention/Mitigation. The Establish Prevention/Mitigation activities include a process for determining the appropriate SSCs and Administrative Controls required to reduce identified risks. This process makes use of the risk guidelines and implements appropriate Defense-in-Depth. Changes in the level of risk associated with identified accidents and changes in the SSC Administrative Controls credited in the analyses are to be factored when performing this activity. Changes in the list of required SSCs and Administrative Controls are inputs to the TWRS SSC Management and the Authorization Basis Control activities.

17.4.3.5 Authorization Basis Management System. The Authorization Basis Management System provides a process for developing Authorization Basis documents, evaluating and controlling changes, and implementing the Authorization Basis.

17.4.3.5.1 Authorization Basis Document Development. The Authorization Basis Document Development activities provide a process for developing and revising Authorization Basis documents and maintaining a list of Authorization Basis documents. Changes to the Authorization Basis documents are factored into the Authorization Basis Control and Authorization Basis Implementation activities.

17.4.3.5.2 Authorization Basis Control. Authorization Basis Control activities include a process for screening, evaluating, documenting, tracking, and resolving Authorization Basis changes. The USQ process is a key component of this activity. Actual and proposed changes in the facility SSCs, site description, facility hazards, facility risks, safety basis documents, Authorization Basis documents, and operating and maintenance procedures must be factored when performing this activity. Discoveries and occurrences must also be factored in Authorization Basis Control activities. Changes to the Authorization Basis are factored when performing the Authorization Basis Implementation, Authorization Basis Document Development, and the Safety Basis Document Management activities.

17.4.3.5.3 Authorization Basis Implementation. Authorization Basis Implementation includes a process for implementing the Authorization Basis in the appropriate documents and procedures and developing the requisite training. Changes in the Authorization Basis documents and in the functional classification of SSCs are factored into Authorization Basis Implementation activities. Authorization Basis Implementation activities include tracking the implementation documents and producing a list of documents of use for Authorization Basis Control and Safety Basis Document Management activities.

17.4.3.6 Site Safety Management Programs. Other site administrative management programs interface with the Safety Management System. Examples of these administrative management programs include:

- Prevention of inadvertent criticality
- Radiation protection
- Hazardous material protection
- Radioactive and hazardous waste management
- QA
- Emergency preparedness
- Initial testing, in-service surveillance, and maintenance
- Operational safety
- Procedures and training
- Human factors
- Provisions for decontamination and decommissioning
- Management, organization, and institutional safety provisions.

Each program is evaluated to determine its impact on the Safety Management System and to determine when changes to that program must be factored into the TWRS Safety Management System.

17.4.4 Occurrence Reporting

DOE O 232.1 and implementing directive RLID 232.1, *Occurrence Reporting and Processing of Operations Information*, establish a system for reporting and processing operations information related to emergencies, unusual occurrences, and off-normal occurrences. The TWRS General Manager or a designee has ultimate responsibility for the requirements of these orders. Once personnel initiate the appropriate response to stabilize or return TWRS operations to a safe condition, the Occurrence Notification Center duty officer for unusual occurrences or emergencies is notified. The duty officer will assign a reportable occurrence number and contact the RL facility representative. The facility representative and duty officer use the current line organization management chain to provide TWRS program direction during the entire notification and reporting process.

The criteria for an event investigation are clearly established in WHC-CM-1-5[1], *Standard Operating Practices*, Section 6.1, "Guidelines for Supervisory Response to Abnormal Events and Conditions." The Tank Farms Operations Manager (single-shell or double-shell tanks) is responsible for event investigations.

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[1]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," for crosswalk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc. (FDH), procedures (e.g., HNF-PRO-XXX).

17.4.4.1 Corrective Action Determination. Appropriate corrective action is established for each event investigation, and specific personnel are assigned responsibilities for the corrective action. Corrective action can take the form of procedural changes, training, design modifications, or changes to administrative controls.

17.4.4.2 Event Training. The Shift Operations Manager evaluates in-house events in order to determine if the event should be included in the operations personnel training program. Immediate training of shift operations personnel is appropriate when the safety consequences of events are severe.

17.4.4.3 Notification Procedures. Events that require notification of DOE personnel (and state and local officials, when appropriate) require a systematic, controlled method for gathering and transferring information. The events that require DOE notification and the notification responsibilities and processes are contained in WHC-CM-1-5. The information provided in WHC-CM-1-5 supports the requirements of DOE O 232.1.

The operations manager or supervisor is responsible for ensuring that all appropriate personnel are notified of emergencies when required. Names of primary and alternate contacts and current phone and pager numbers are readily available to the individual who is assigned to make the notifications. All notifications are documented in the manager's or supervisor's narrative log. The general procedures for emergency notifications are discussed in Chapter 15.0.

17.4.4.4 Feedback and Trending. Occurrence reports will be used to ensure relevant operational history is incorporated into updates to the FSAR. Trending of occurrences will result in safety analyses that reflect both current and past operating practices and will be used to verify continuous improvement in TWRS management. Feedback, trending, and root cause evaluation (as discussed in Section 17.4.1.3) all serve to minimize recurrence.

17.4.5 Safety Culture

This section summarizes the policies and programs in place to facilitate evaluation to assure that safety awareness is a primary concern to management and that employees at all levels of TWRS operations are aware they have an obligation to assure operations are conducted safely.

17.4.5.1 Lockheed Martin Hanford Corporation. The fundamental principles at the core of the LMHC management approach to safety are summarized below. These principles support the FDH "safety first" emphasis and are infused throughout all layers of the organization and guide day-to-day decision-making and conduct:

- The TWRS Authorization Basis establishes the bounds within which all operations may be safely conducted. This principle permeates every chapter of this FSAR. LMHC has demonstrated its commitment to this principle by identifying and documenting the safety basis of every LMHC-managed facility and

activity and by implementing physical and administrative controls appropriate to risk in order to protect the public, the workers, and the environment against identified hazards.

- Management is responsible for providing leadership and support to site workers. This responsibility includes establishing goals and standards for work activities and providing the necessary resources and materials to allow workers to succeed. Management fulfills this responsibility through formal planning, coordinating, reporting, and budgeting processes, and through formal and informal interaction with workers. In addition, management has established policies and programs that reward workers for exemplary performance or penalize workers for blatant disregard of LMHC policies and procedures.

- Work must be performed in accordance with established controls. This assures repeatable, predictable operation that complies with regulatory requirements and implements safe work practices. The rigorous approach to procedural development, the performance-based approach to training, and the emphasis on following procedures when conducting operations demonstrate LMHC commitment to working in accordance with established controls (Chapters 11.0 and 12.0).

- Workers are responsible for ensuring excellence and are individually responsible for their own safety and the safety of their coworkers and the facility. As noted in Chapter 12.0, the concept of individual responsibility is exemplified by the fact that every worker has the authority to stop work if a procedural step cannot be implemented safely. Stop work authority is emphasized in the orientation training provided to all Hanford Site workers. Worker empowerment is further emphasized in WHC-CM-1-5, which contains guidance that encourages and requires employees to immediately notify their supervisor upon observing any event or condition adverse to safety, health, quality, safeguards and security to operations or the environment. An employee-concerns program provides another avenue for identifying problems to LMHC management if an employee is dissatisfied with resolution through normal channels. Employees may also relay concerns directly to regulatory authorities if other alternatives do not result in correction of the problem.

17.4.5.2 Other Project Hanford Management Contract Contractors. All other PHMC contractors (i.e., FDH, NHC, WMH, BWHC) support safe and compliant work practices through integrated environmental safety and health programs. The heart of the contractor environmental safety and health programs is the firm commitment by all managers, supervisors, and employees to prevent accidents and the conditions that could lead to injuries or endanger the environment. Through the emphasis on "safety first," management is improving the Hanford Site safety culture and demonstrating its commitment to effect change in the following key areas: management commitment, employee involvement, environmental safety and health training, work site analysis, and hazard prevention and control.

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Figure 17-1. The Project Hanford Management Contract Team Organization.

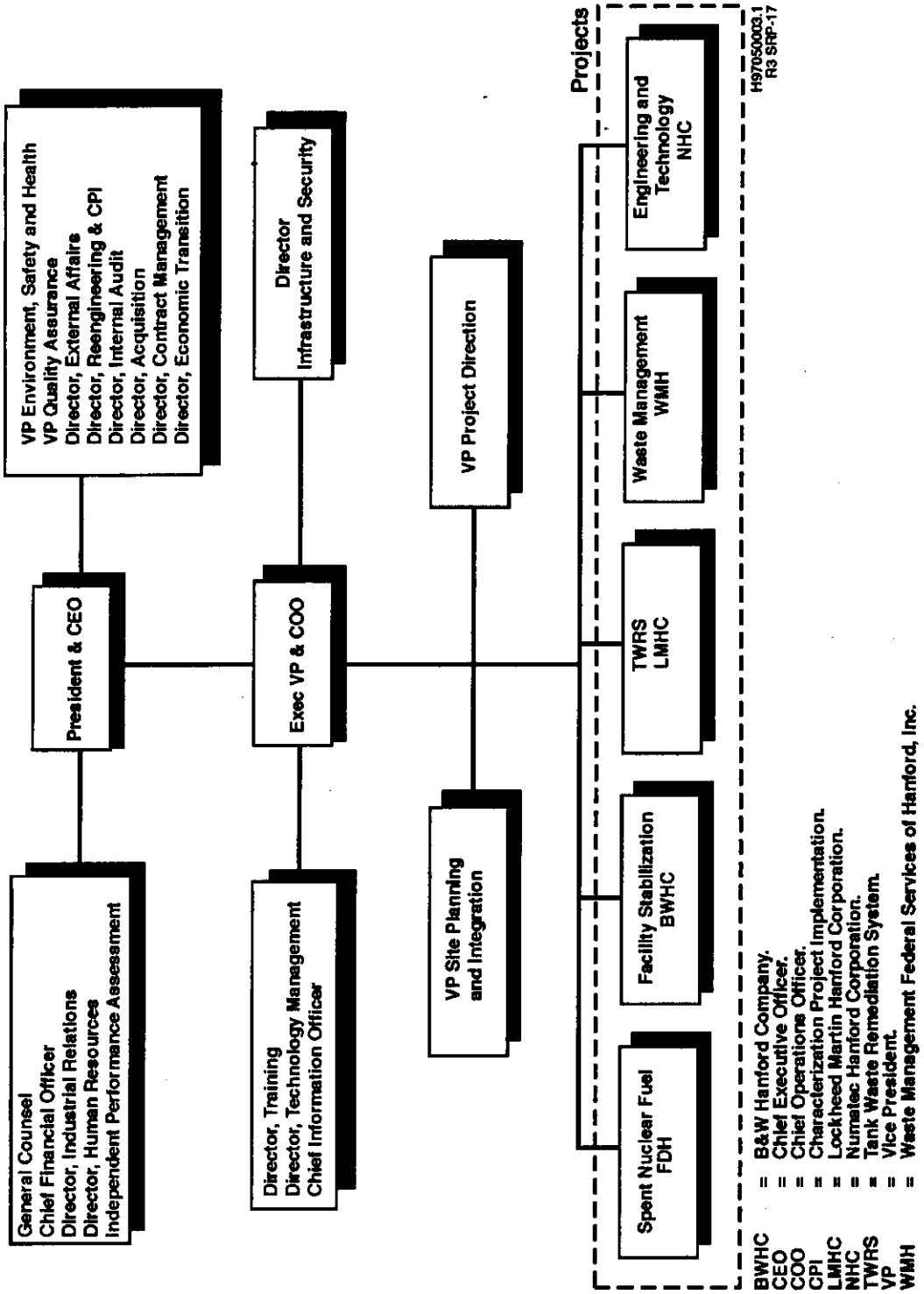


Figure 17-2. Project Hanford Management Contract Team Management and Integration Roles.

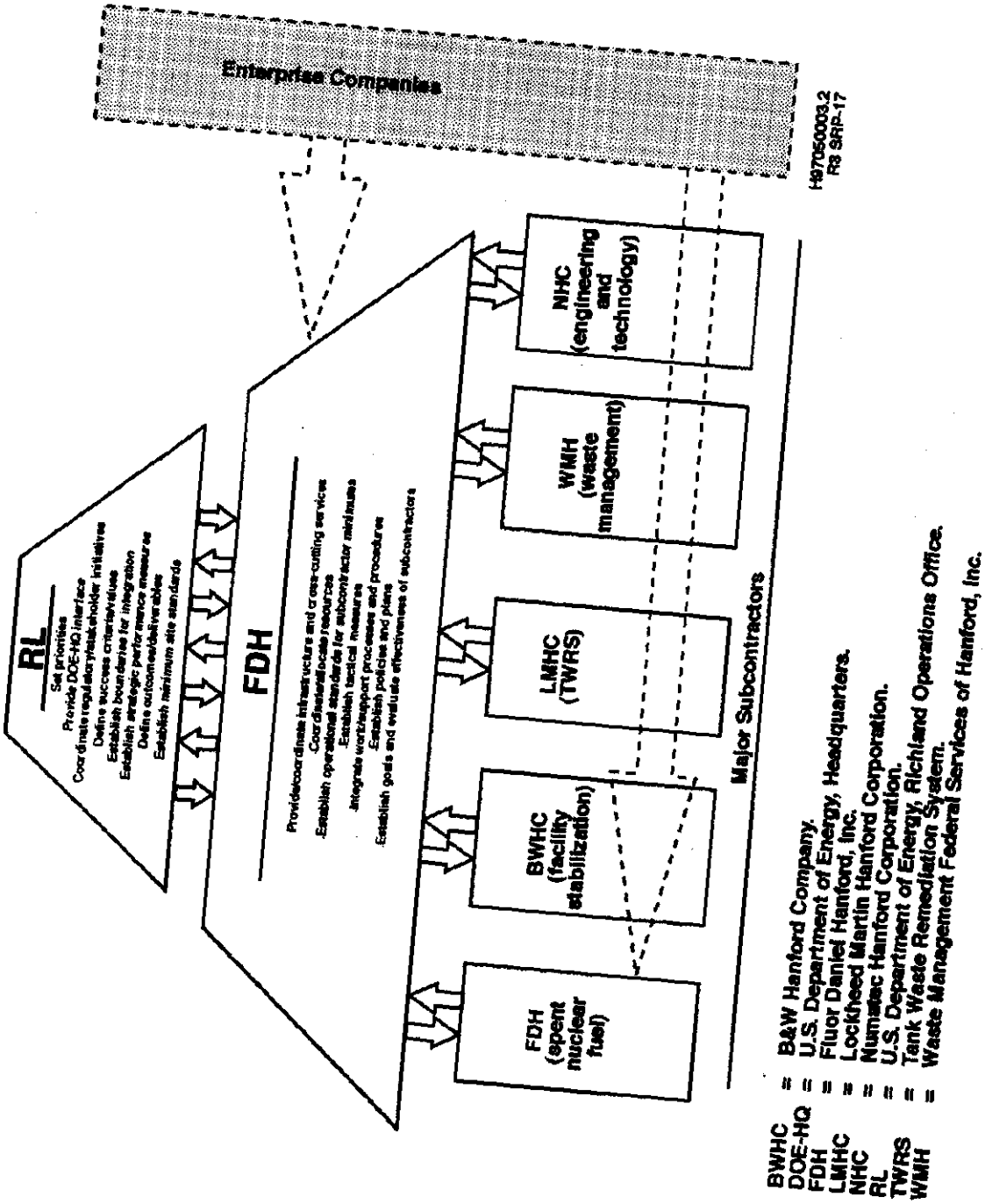
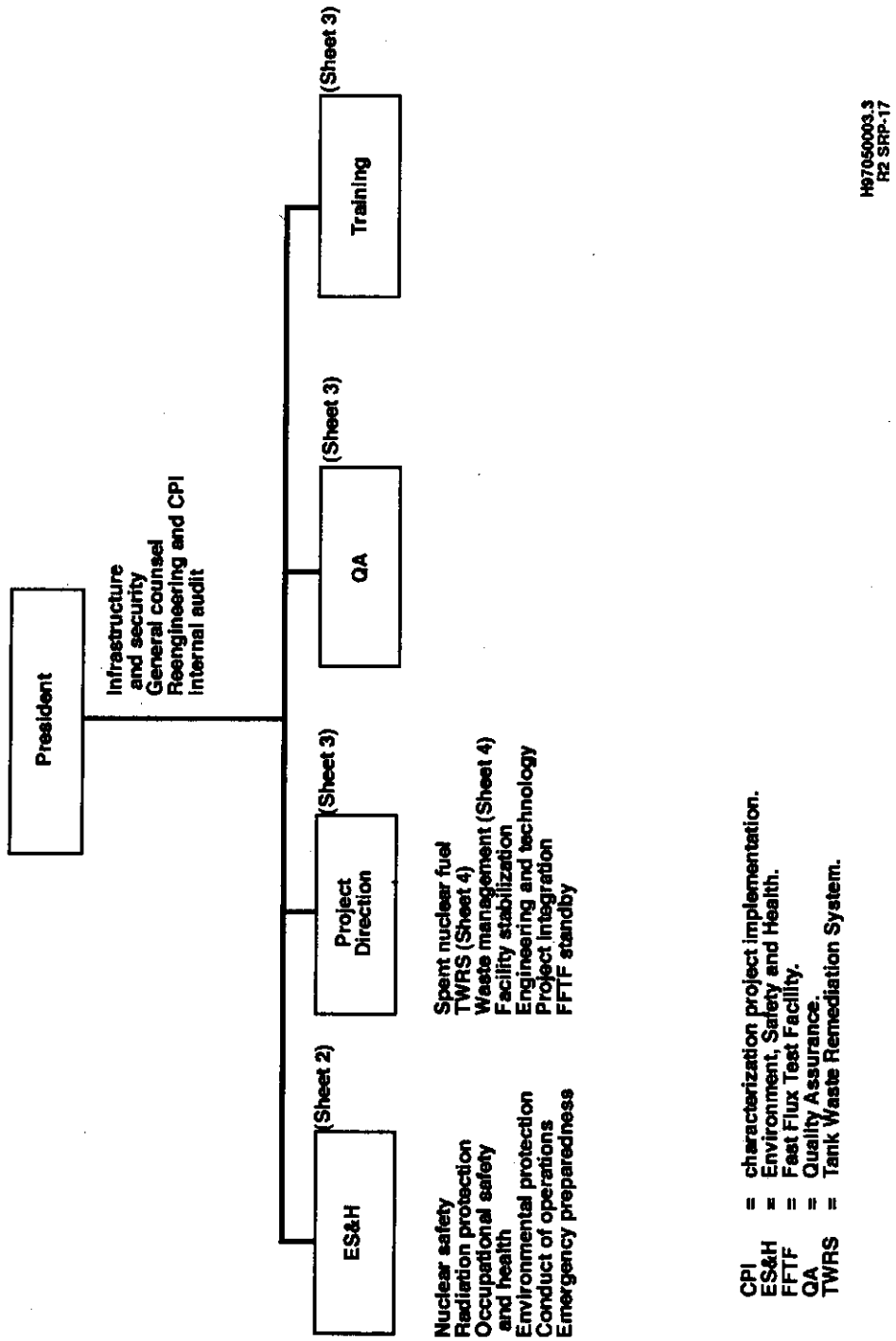


Figure 17-3. Fluor Daniel Hanford, Inc., Organizations that Interface with Tank Waste Remediation System. (4 sheets)



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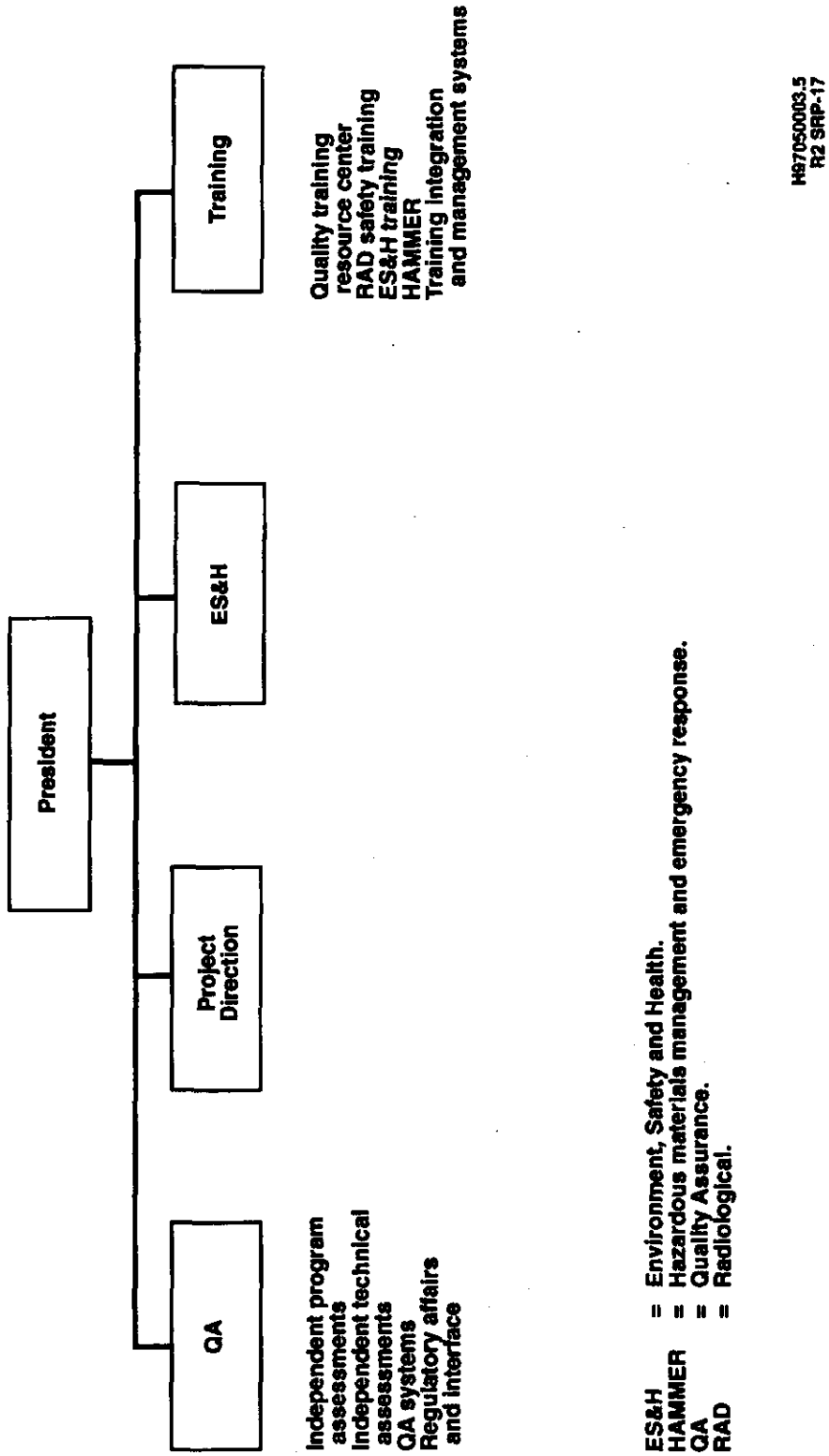

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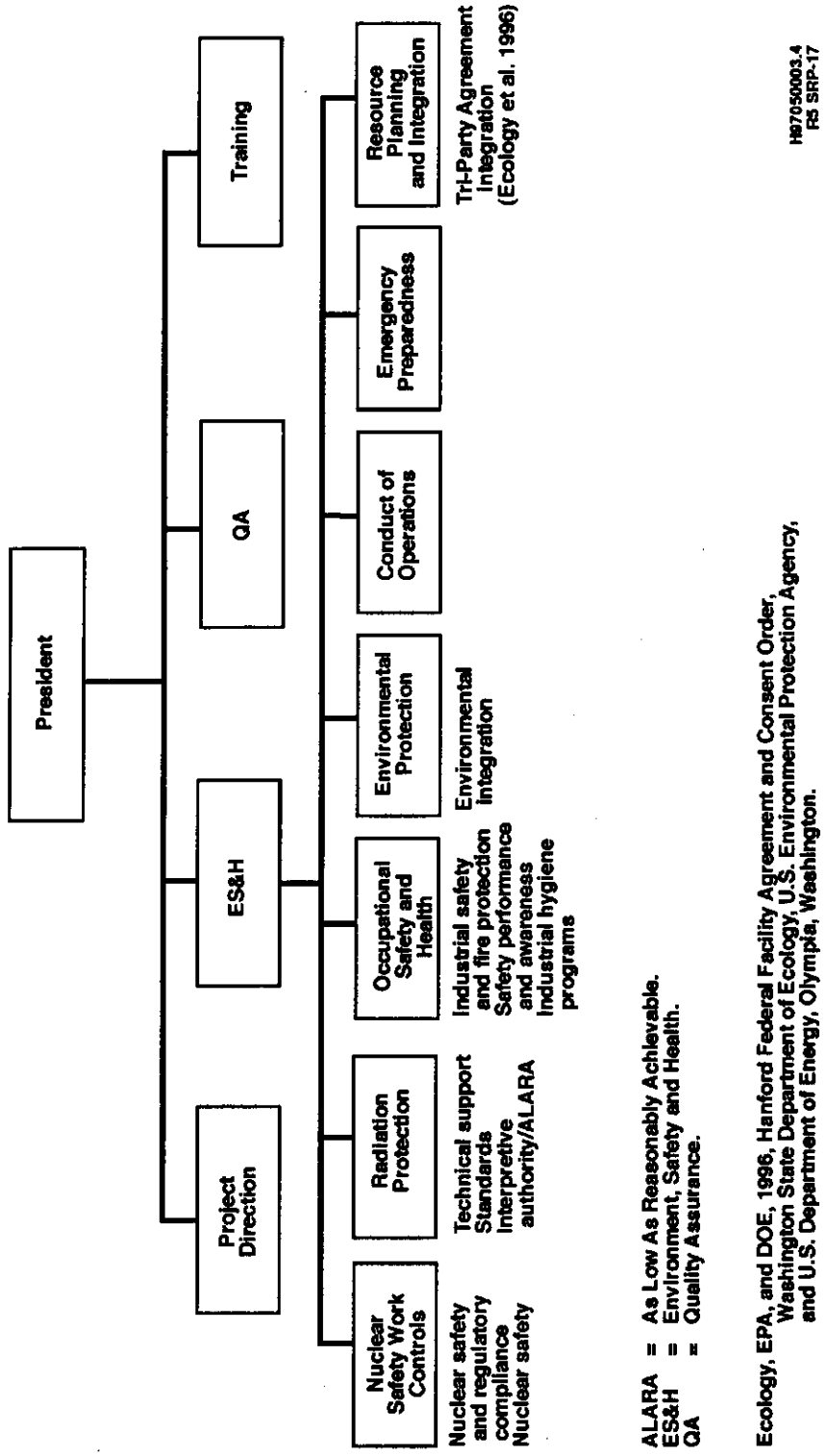

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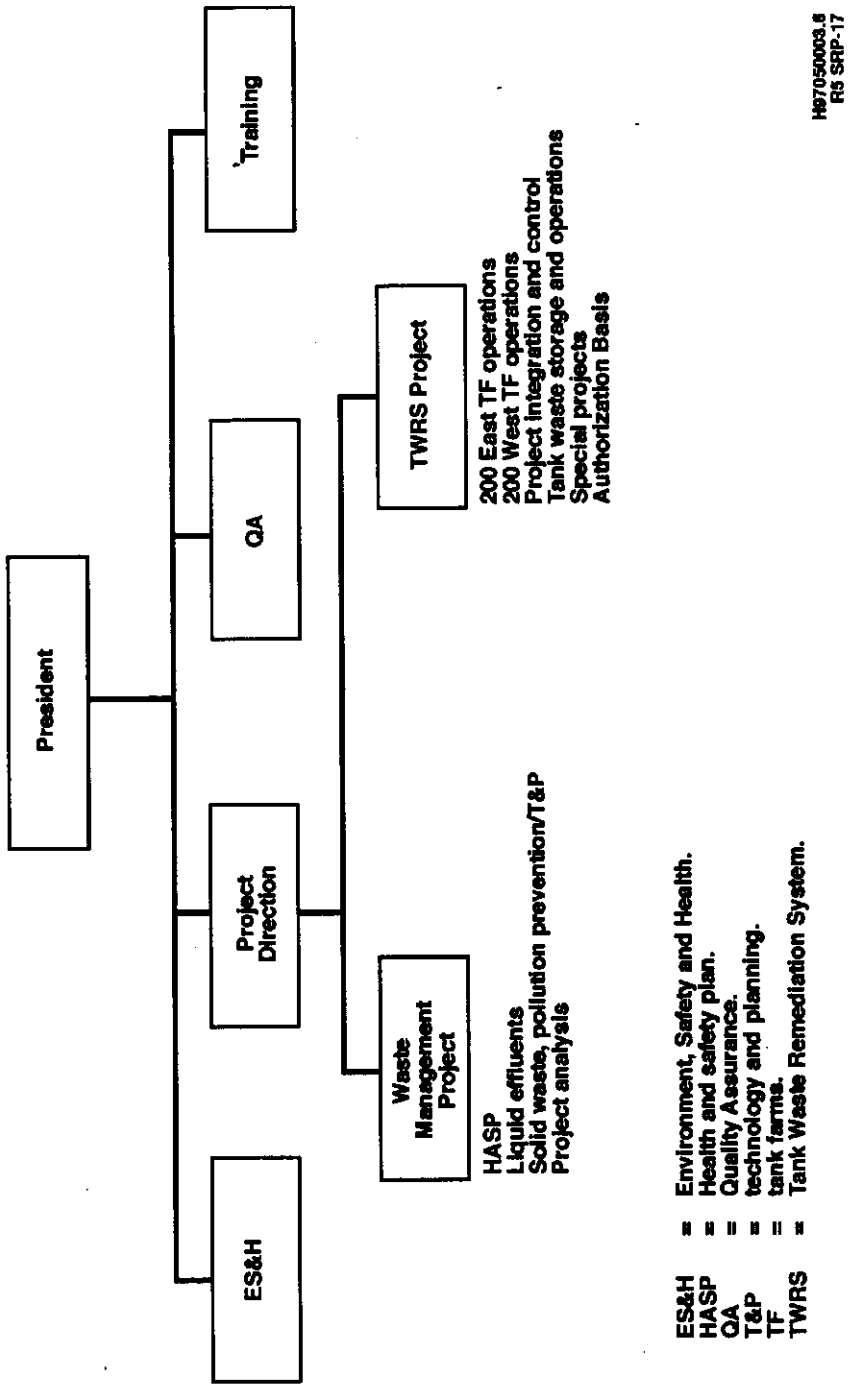


Figure 17-4. Lockheed Martin Hanford Corporation Tank Waste Remediation System Functional Areas.

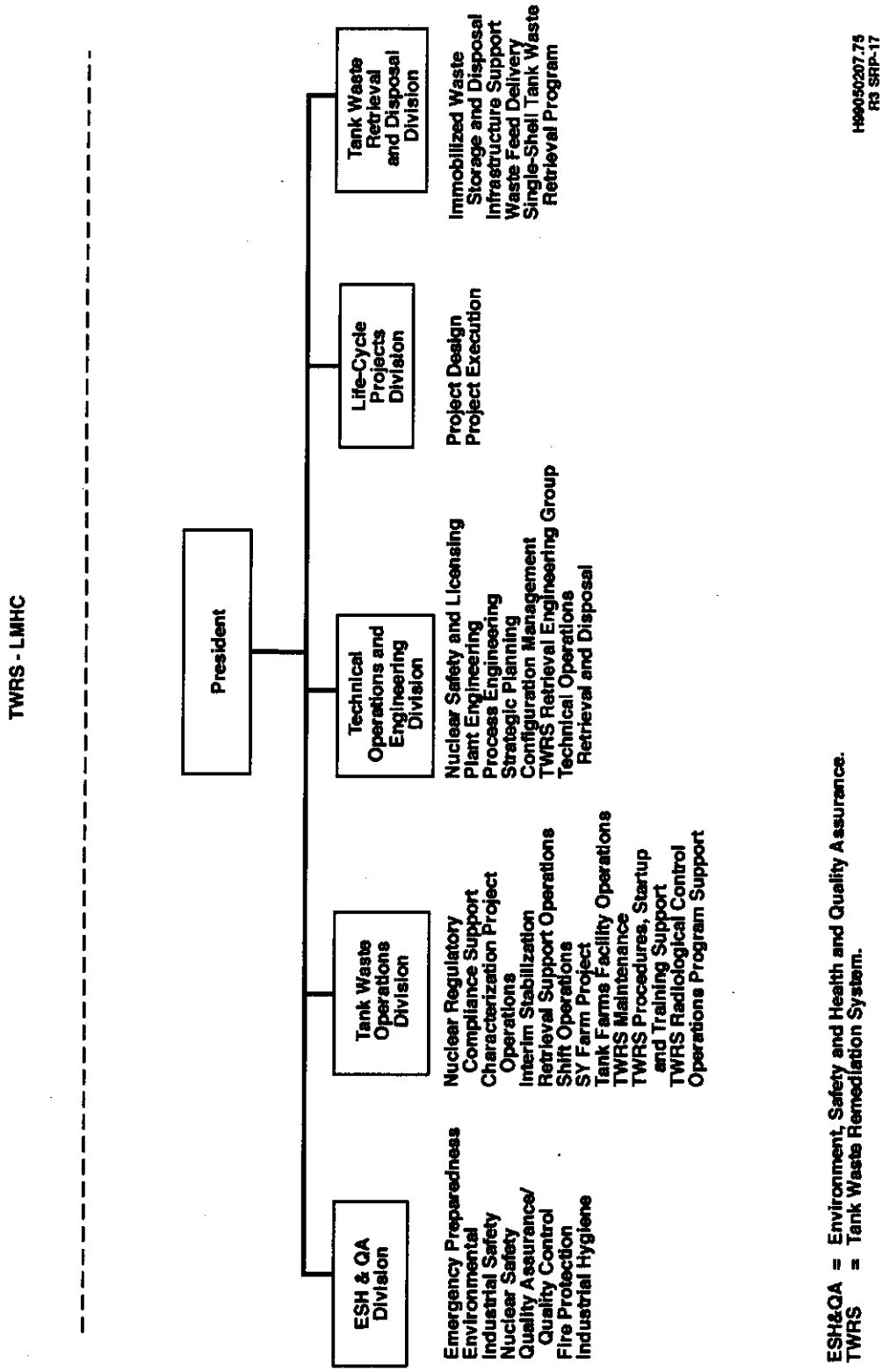


Figure 17-5. Tank Waste Remediation System Project Tank Waste Operations.

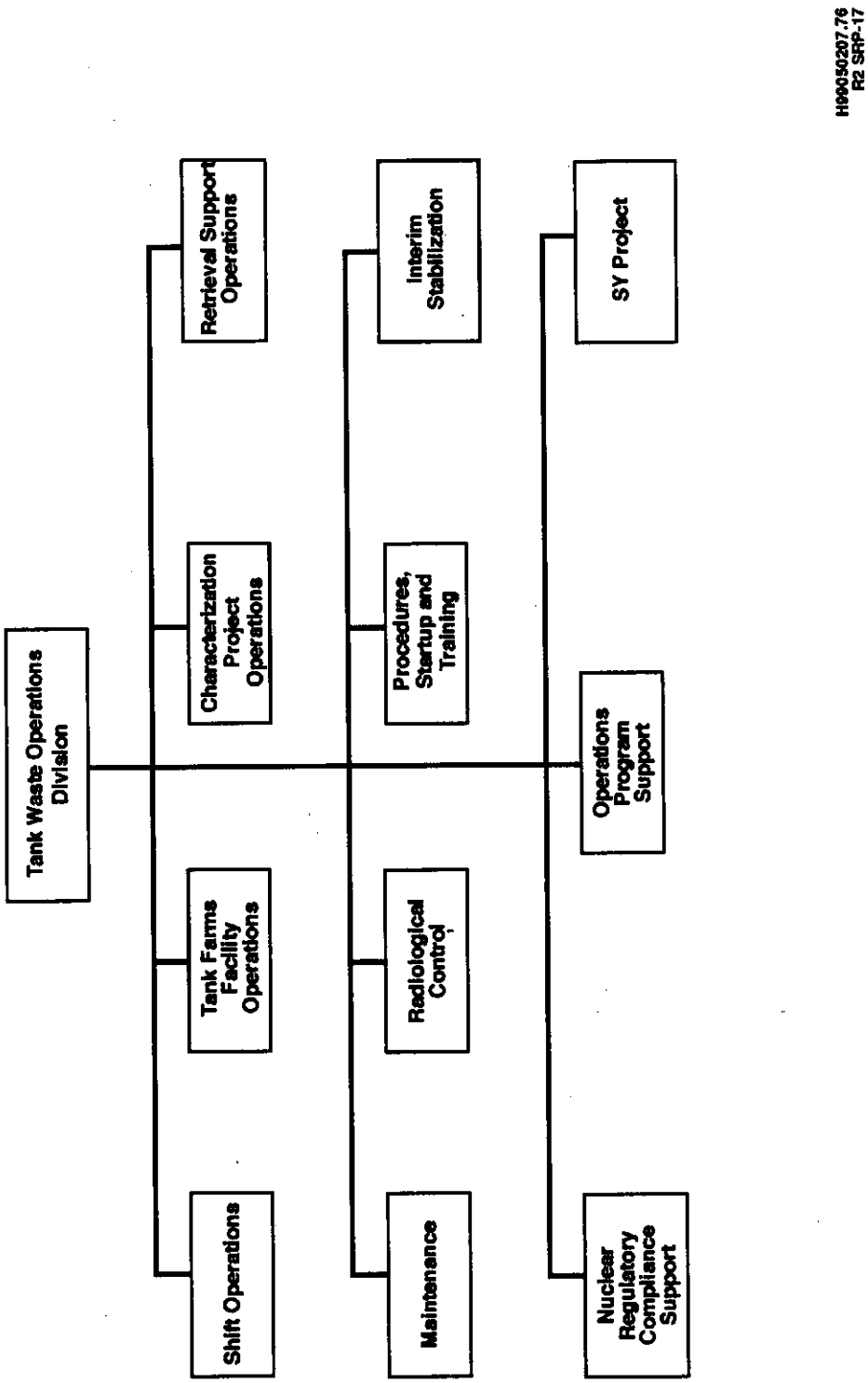


Figure 17-6. Waste Management Federal Services of Hanford, Inc., Functional Areas.

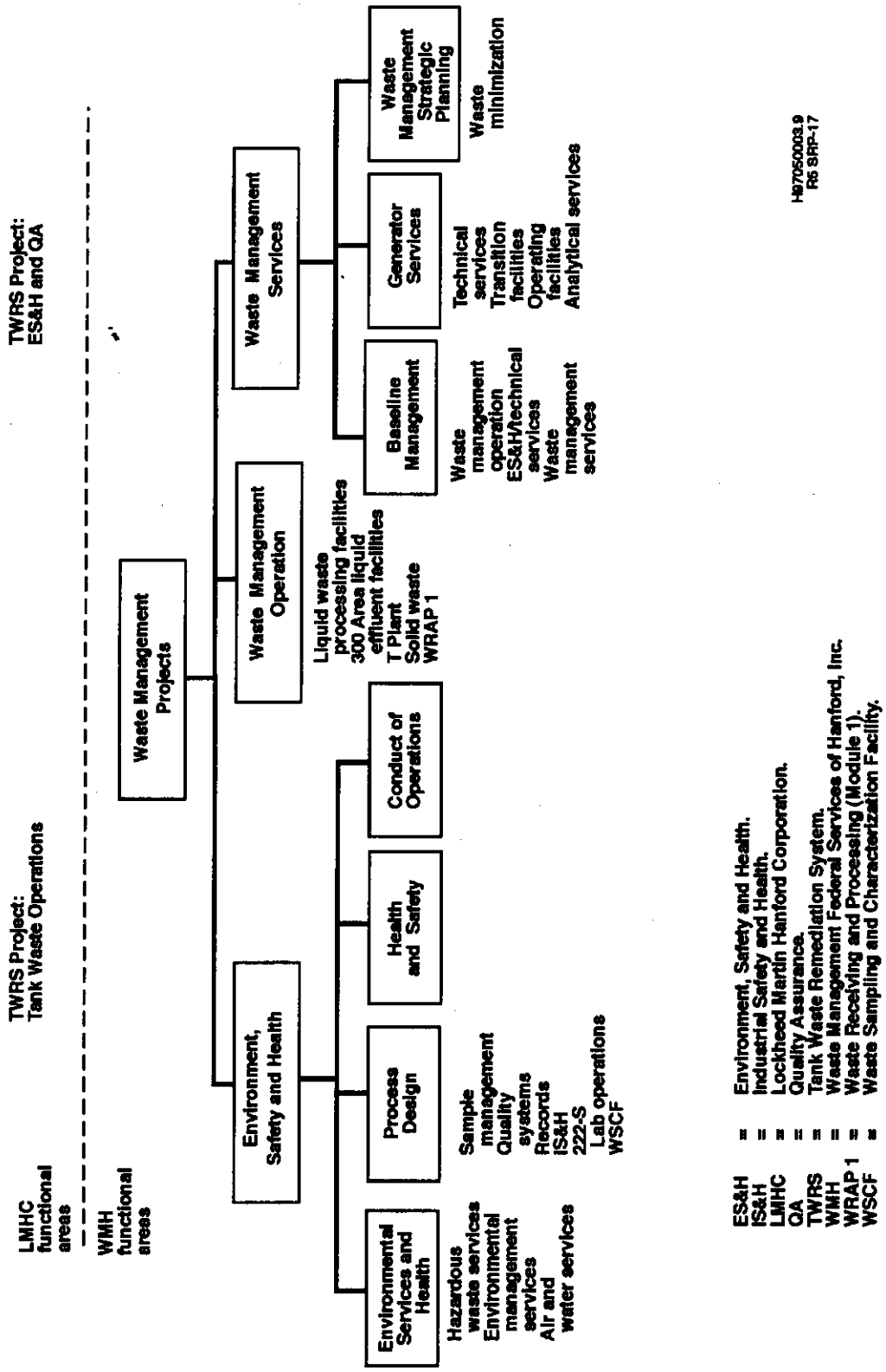
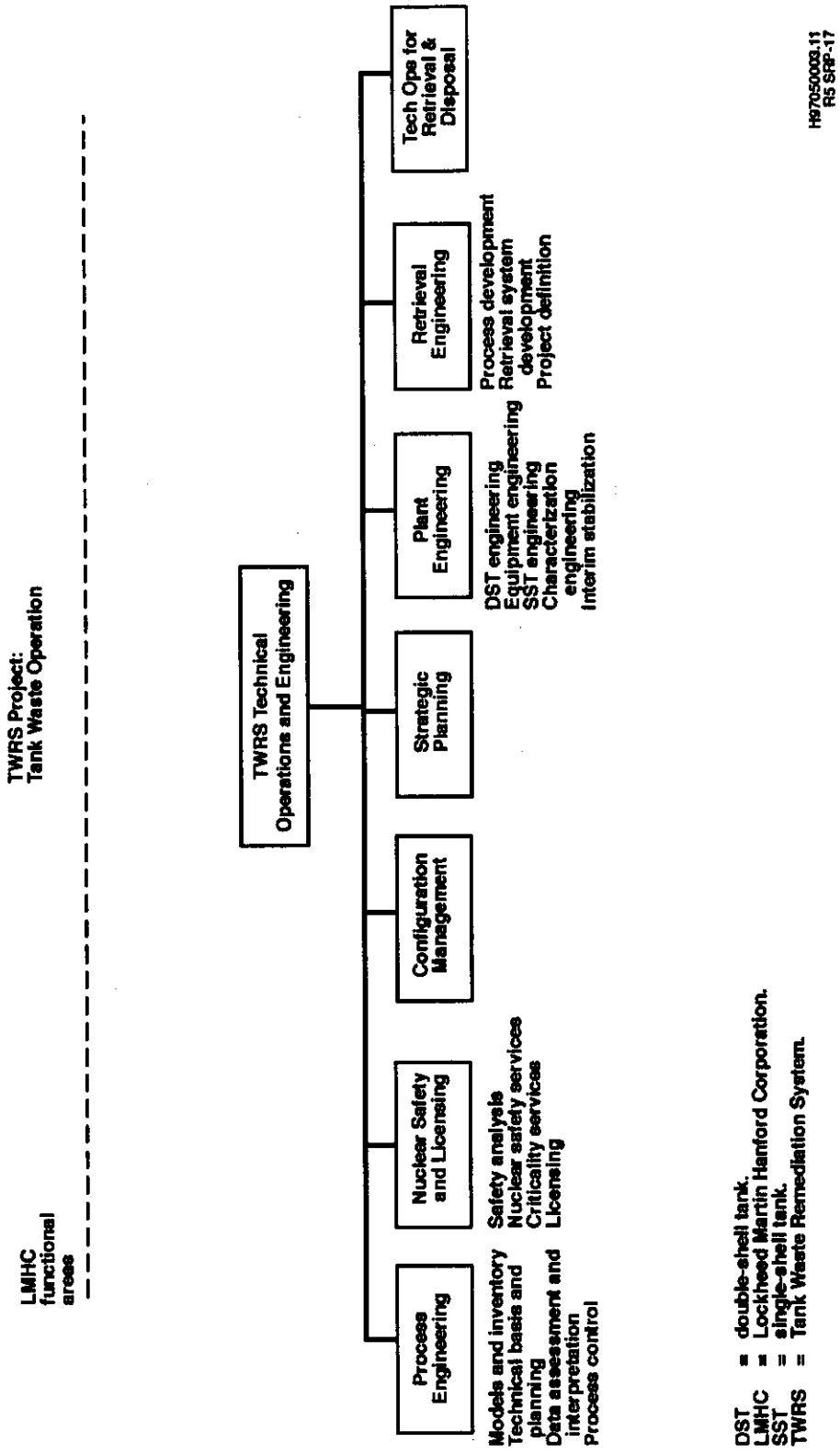


Figure 17-7. Lockheed Martin Hanford Corporation TWRS Technical and Operations Engineering.



DST = double-shell tank.
LMHC = Lockheed Martin Hanford Corporation.
SST = single-shell tank.
TWRS = Tank Waste Remediation System.

Figure 17-8. Tank Waste Remediation System Environment, Safety and Health and Quality Assurance Functional Areas.

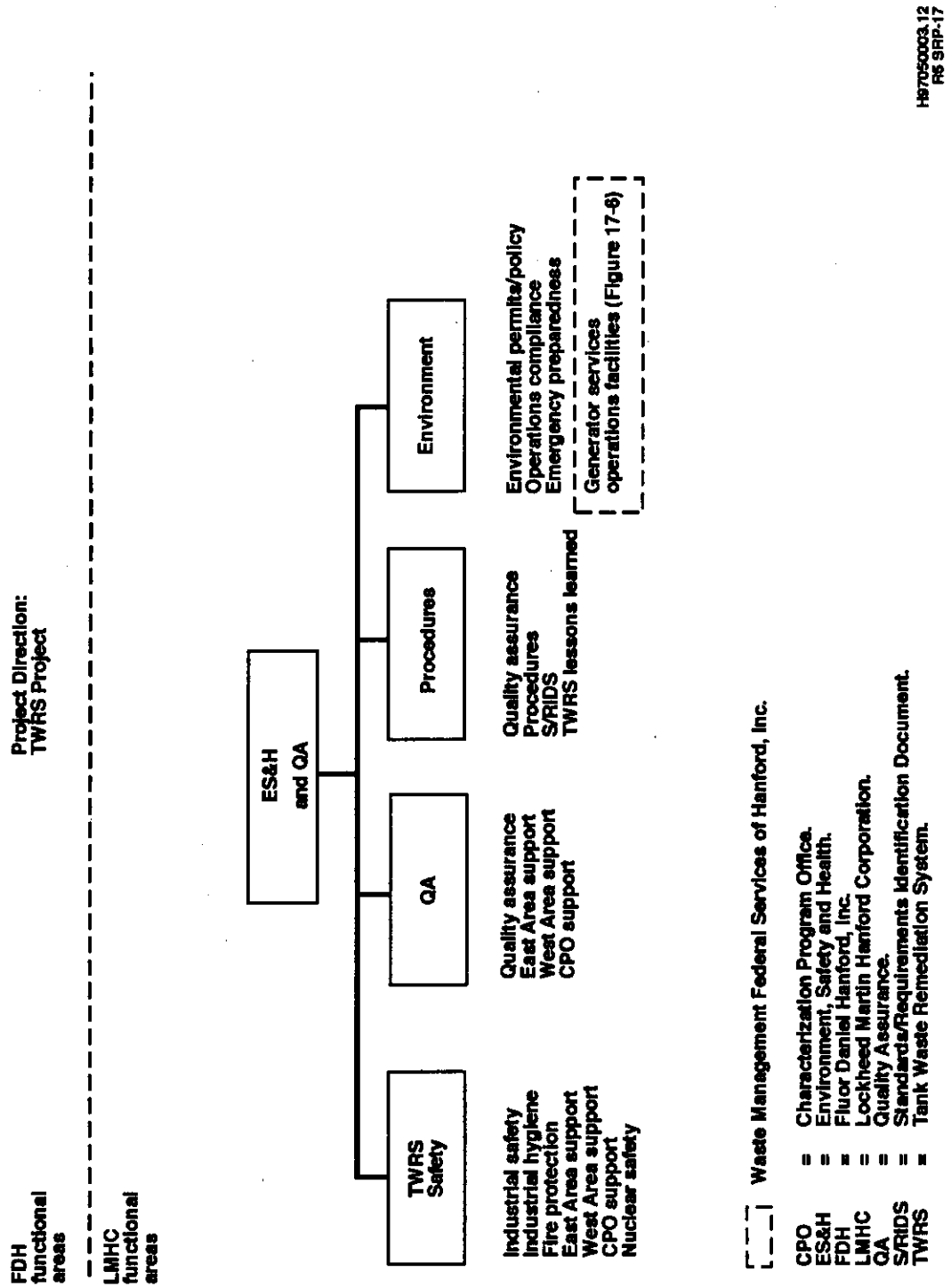


Figure 17-9. Tank Waste Remediation System Integrated Safety Management System Process.

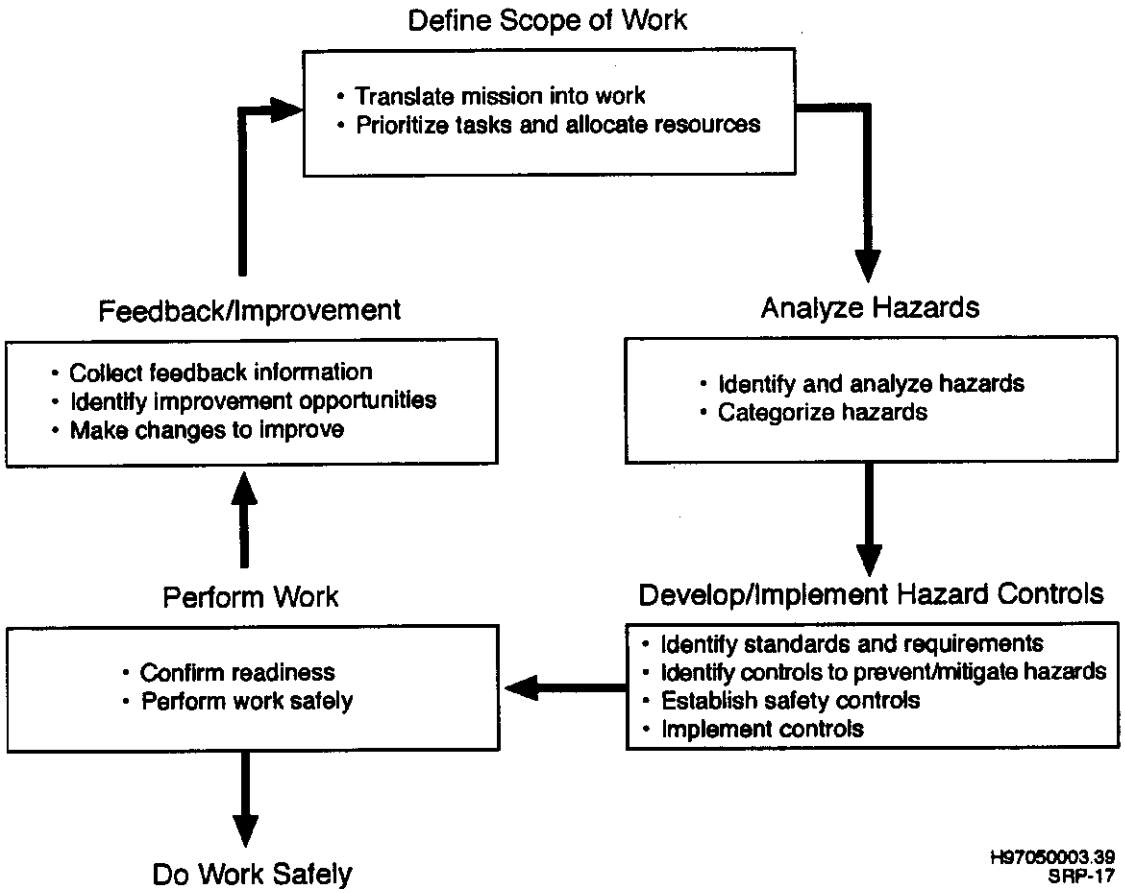
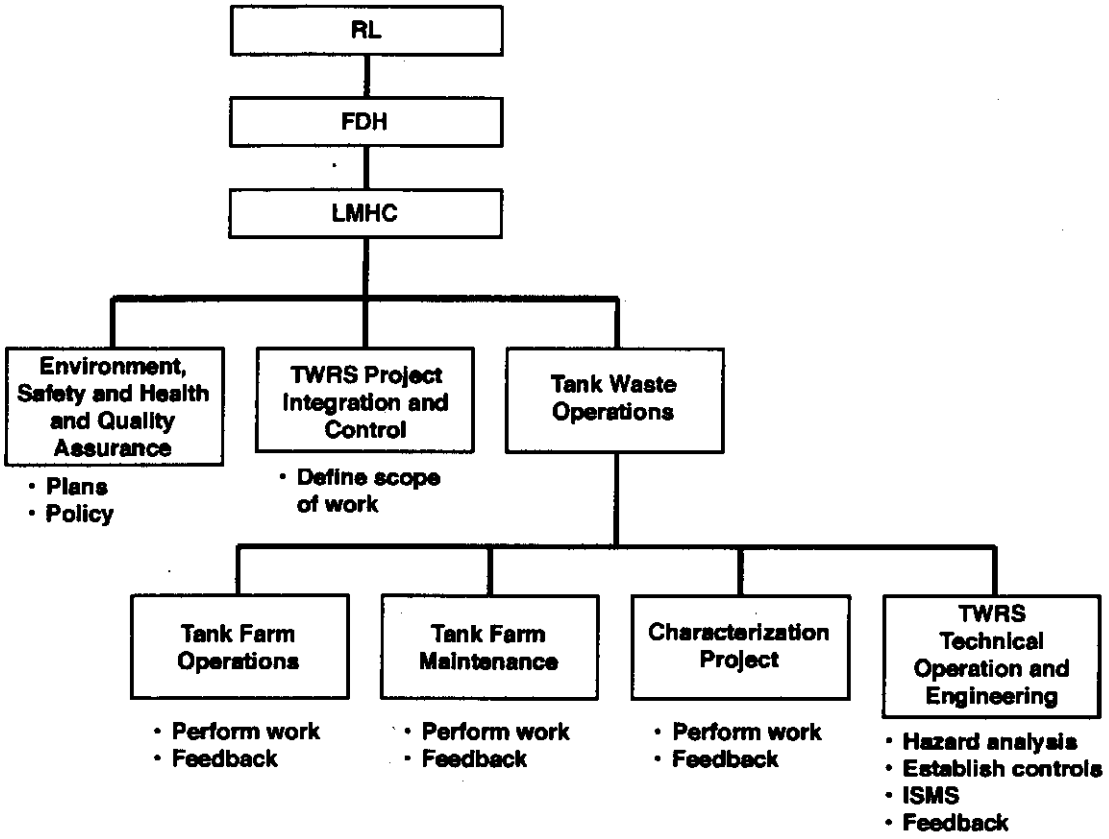


Figure 17-10. Integrated Safety Management System Responsibility Mapping.



FDH = Fluor Daniel Hanford, Inc.
ISMS = Integrated Safety Management System.
LMHC = Lockheed Martin Hanford Corporation.
RL = U.S. Department of Energy, Richland Operations Office.
TWRS = Tank Waste Remediation System.

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Figure 17-11. Tank Waste Remediation System Safety Management System.

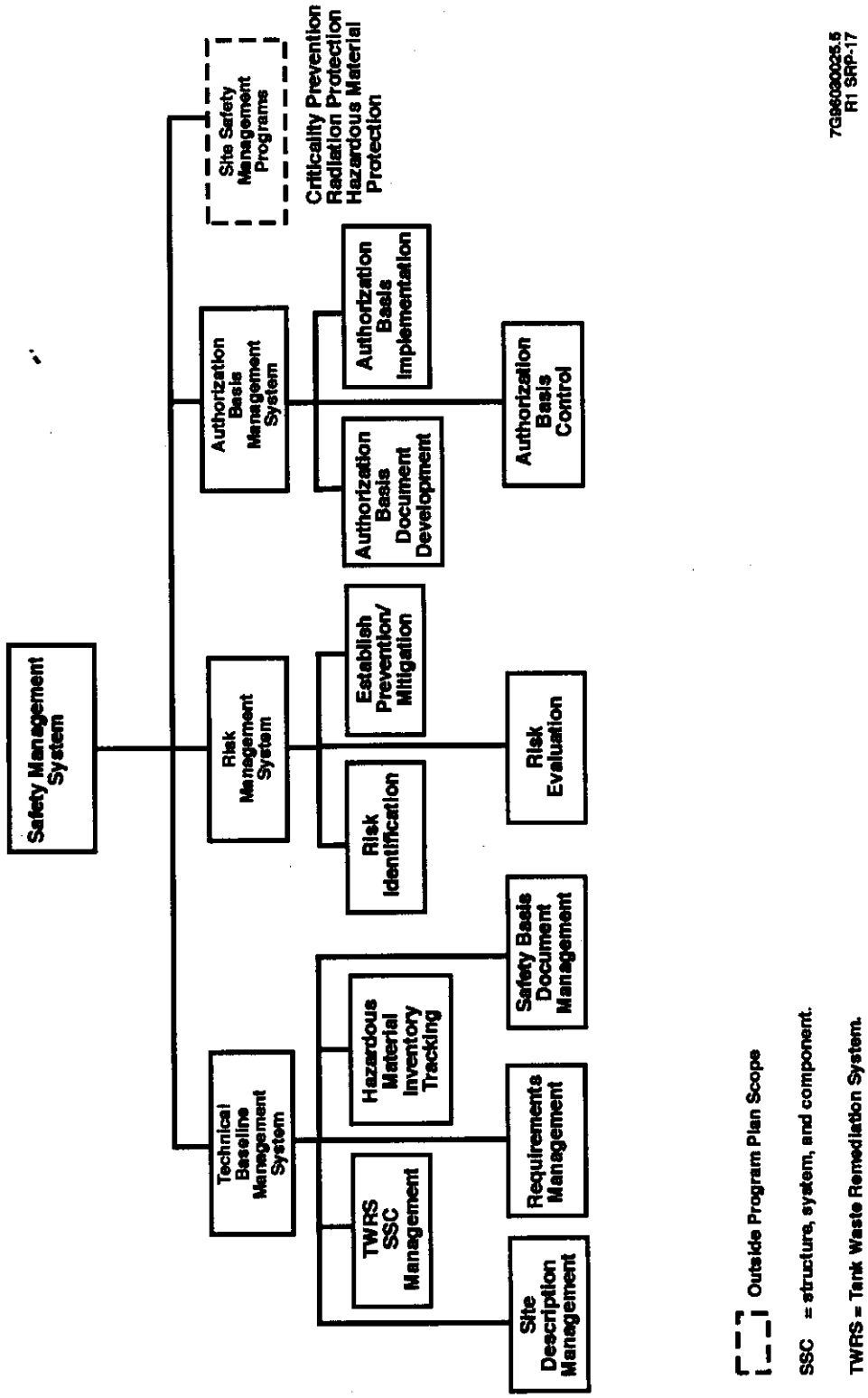

Table 17-1. Enterprise Companies and Project Hanford Management Contract Activities Supported by Enterprise Companies. (3 sheets)

Enterprise company	Activity supported by enterprise company
Fluor Daniel Northwest, Inc.	Site planning and integration project control cost estimating scheduling Systems engineering value engineering Quality control procurement receipt inspection* QC force account work Government acceptance inspection Nondestructive testing* Engineering/procurement/construction of major projects engineering A/E design central engineering criticality safety & shielding support as-built drawings condition assessment surveys Americans with Disabilities Act inspections surplus facilities inventory inspections surveying engineering documentation CADD CM/Construction force account construction fixed-price construction welder qualification well drilling field engineering Procurement Procurement to support mission

Table 17-1. Enterprise Companies and Project Hanford Management Contract Activities Supported by Enterprise Companies. (3 sheets)

Enterprise company	Activity supported by enterprise company
Lockheed Martin Services, Inc.	Information and communications media services video presentation photography graphics Telecommunications telephone service microwave telefax service Computer network operations HLAN Document control and records management system project data control project information control document distribution center and record storage End user support troubleshoot problems Information and scientific systems mainframe and microcomputer application support software engineering computing requirements
Protection Technology Hanford (PTH)	Safeguards and security classification safeguards personnel security communications security establish policy

Table 17-1. Enterprise Companies and Project Hanford Management Contract Activities Supported by Enterprise Companies. (3 sheets)

Enterprise company	Activity supported by enterprise company
DynCorp Tri-Cities Services, Inc.	Emergency preparedness Emergency Operations Center* Operations and maintenance provide general purpose space utilities transportation infrastructure site transportation services Fire Department emergency response service* janitorial disposal municipal waste Real estate and property management inventory, warehousing, materials management investment recovery program real property management calibration and engineering labs land use planning and management excess general purpose facilities Contractor site traffic manager household goods small package delivery Procurement office supply procurement
Quanterra	Hanford Site analytical services program offsite analytical labs

*Shared activities with Project Hanford Management Contract Team.

49 CFR 27.19, "Compliance with Americans with Disabilities Act Requirements," *Code of Federal Regulations*, as amended.

A/E = architect/engineer.

CADD = computer-aided design and drawing.

CM = configuration management.

HLAN = Hanford Local Area Network.

QC = quality control.

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Document #	**SD-WM-SAR-067**	**Revision**	**1**
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Recipient		**Recipient Co.**	
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Keywords			
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Other Information	Vol 3 Appendix A Pages A-i thru TAB-66		

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Volume III:
Appendixes A through D

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Richland, Washington

Hanford Management and Integration Contractor for the
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Lockheed Martin Hanford Corporation

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APPENDIX A
HAZARD TOPOGRAPHY

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LIST OF TERMS

209E	209-E Storage Area
90D	209-E Storage Area
ALC	air lift circulator
Bld.	building
BND	bonding
CC	concentrated complexant
CCF	common cause failure
CCTV	closed-circuit television
CDP	cribs, ditches and ponds
cfm	cubic feet per minute
COB	cleanout box
con.	condensate
cond dr	condensate drain
CP	concentrated phosphate (waste)
CPLX	complexed waste
CRN	crane operations
CVR	coverblock installation and removal
D. E.	diatomaceous earth
DC	dilute complexed waste
DCRT	double-contained receiver tank
DN	dilute noncomplexed waste
DOT	U.S. Department of Transportation
DP	differential pressure
DSS	double-shell slurry
DSSF	double-shell slurry feed
DST	double-shell tank
EE	external events
enc	enclosure
FFTF	Fast Flux Text Facility
FIC	Food Instrument Corporation
FSAR	Final Safety Analysis Report
GRE	gas release event
HazOp	hazard and operability study
HCN	hydrogen cyanide
HEDL	Hanford Engineering Development Laboratory
HEPA	high-efficiency particulate air (filter)
HPT	health physics technician
ID	identification
IMUST	inactive miscellaneous underground storage tank
ITK	in-tank equipment installation, operation, and removal
LANL	Los Alamos National Laboratory
LFL	Lower Flammability Limit
lk det	leak detector

LIST OF TERMS (Cont.)

M	million/molar
MAR	material at risk
misc	miscellaneous
MISF	miscellaneous inactive storage facility
MO	mobile office
N	north
NA	not applicable
NCAW	neutralized current acid waste
NCPLX	non-complexed waste
NE	northeast
NHW	neutralized high-level waste
OGT	overground transfer
PCB	polychlorinated biphenyl
PCM1B	personal contamination monitor 1B
PD	PUREX decladding
PFP	Plutonium Finishing Plant
PHA	preliminary hazard analysis
PNNL	Pacific Northwest National Laboratory
ppm	parts per million
PRV	pressure relief valve
prv sta	pressure relief valve station
psi	pounds per square inch
PUREX	Plutonium Uranium Extraction (Facility)
RAD	radiological monitoring and surveys
RCRA	*Resource Conservation and Recovery Act of 1976*
RMW	radioactive mixed waste
RW	raw water
Rxtns	reactions
SAA	satellite accumulation area
SAIC	Science Applications International Corporation
SAR	safety analysis report
SARA	*Superfund Amendments and Reauthorization Act of 1986*
SE	Southeast
SHMS	Standard Hydrogen Monitoring System
SST	single-shell tank
st.	steam
SW	southwest
SWP	special work procedure (refers to protective clothing worn in radiation zone)
TK	tank
TOC	total organic carbon
TSF	tank farm waste transfer syphoning events
TWRS	Tank Waste Remediation System

LIST OF TERMS (Cont.)

USQ	Unreviewed Safety Question
VEH	vehicle operations
VIP	ventilation instrument pit
VSU	vertical storage unit
W058	existing cross site transfer (historical/applicable information from previous PHA)
WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System
WL	watchlist
XS	existing cross site transfer

KEY TO TABLE HEADINGS IN APPENDIX A

Air Lift Circulator—This field contains the answer to the following question: "Are there air lift circulators (ALCs) active in the waste tank (yes/no)?"

Applicable Hazard Evaluation—This field contains information about which Hazard Evaluation Study (Preliminary Hazards Analysis [PHA], Hazards and Operability Study [HazOp], What if) results are applicable to a particular facility.

Capacity—Material capacity of facility

Columns A-M in A-5 table series—Types of hazards identified during the facility walkthrough.

Comment ALC—Air lift circulator comments.

Comment Steam Coils—Steam coil comments.

Comment Ventilation—Ventilation system comments.

Comments Mixer Pumps—Mixer pump comments.

Comments—Comments about the material at risk.

Corrosivity—This field contains the answer to the following question: "Does a potential corrosive condition exist at this facility (yes/no) and provide reference?"

Criticality—This field contains the answer to the following question: "Does a potential criticality condition exist at this facility (yes/no) and provide reference?"

Facility—Facility designation (used in A-5 table series).

Facility Name—Facility designation.

Facility Type—This field identifies the type of facility.

Ferrocyanide (Historical Record)—This field contains the answer to the following question: "Does the ferrocyanide hazard exist in this facility (yes/no) and provide reference?"

Field Name—Name of Facility used, by the facility workers, for the field verification process. This field is common to Tables A-2 and A-4.

Flammable Gas—This field contains the answer to the following question: "Does the flammable gas hazard exist in this facility (yes/no) and provide reference?"

Hazard Evaluation Identifier—An alpha-numeric code which relates the type of representative analysis performed to the associated Tank Waste Remediation System (TWRS) facilities.

High Heat—This field contains the answer to the following question: "Is the heat load of the waste in this facility greater than 26,000 Btu/hr (yes/no) and provide reference?"

MAR-classification—Material at risk (MAR) classification

MAR-description—Material at risk description

MAR-subject—Material at risk subject

Material Type—The type of material in the facility

Mixer Pumps—This field contains the answer to the following question: "Is there a pump associated with the waste tank (yes/no)?"

Organics Separable Phase—This field contains the answer to the following question: "Does an organic separable phase exist in this facility (yes/no) and provide reference?"

Physical Form—The physical form of the material in the facility

Pyrophorics—This field contains the answer to the following question: "Does a pyrophoric condition exist at this facility (yes/no) and provide reference?"

Quantity—Number of drums, pits, boxes, bottles, cleanout boxes (COBs), etc.

Steam Coils—This field contains the answer to the following question: "Are there steam coils active in the waste tank (yes/no)?"

Syphoning—This field contains the answer to the following question: "Does a potential syphoning condition exist at this facility (yes/no) and provide reference?"

TOC in Liquids—This field contains the answer to the following question: "Does organic carbon in the liquid phase exist in this facility (yes/no) and provide reference?" (Note: TOC = total organic carbon)

TOC in Solids—This field contains the answer to the following question: "Does organic carbon in the solid phase exist in this facility (yes/no) and provide reference?" (Note: TOC = total organic carbon)

Transient—Transient nature of the particular type of material stored at the facility

Type—This field identifies the type of facility. This field is common to Tables A-3, A-4, and A-5.

Ventilation—This field contains the answer to the following question: "What type of ventilation is used in the specified waste tank (passive or active)?"

Volume or Activity—The volume or activity of the material present in the facility

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APPENDIX A
HAZARD TOPOGRAPHY

Appendix A provides a concise compilation of data that is used to perform the hazard analysis of Tank Waste Remediation System (TWRS) facilities and in making control decisions. It contains information on all the TWRS facilities within the scope of the Final Safety Analysis Report (FSAR). The data is used to assure that all the TWRS facilities have been adequately assessed by the hazard analysis, either by explicit hazards evaluations for that facility or by implicit representation in a hazard evaluation of a similar facility, and to support the identification of controls for each by providing facility configuration information.

The tables in this appendix have been produced using a relational database tool, which is used to manage the hazard analysis database. This database tool has character limitations which sometimes results in the truncation of the longer text fields. Each table has been reviewed and supplemented as necessary to correct text truncations. Minor editing, which has not affected technical content, has also been performed to enhance FSAR presentation and clarity. This results in some minor differences between the information presented in this appendix and the results documented in WHC-SD-WM-HIE-007, *Tank Waste Remediation System FSAR Hazard Identification/Facility Configuration Verification Report.*

This appendix consists of five tables:

- Table A-1, "Applicable Hazard Evaluations for Tank Waste Remediation System Facilities," lists TWRS facilities, the general facility category for each facility, hazard evaluations that represent each facility, and hazard evaluation abbreviation(s) that will be associated with each facility. The information in this table is historical in nature and, therefore, has not been updated.

- Table A-2, "Material at Risk," lists the TWRS facilities or locations within a given facility and describes various characteristics of the material at risk associated with the location/facility.

- Table A-3, "Tank Waste Remediation System Facility Configurations," lists the single shell and double shell tank TWRS facilities and provides information about instrumentation and equipment associated with the tanks such as ventilation, air lift circulators, steam coils, and mixer pumps.

- Table A-4, "TWRS Tank Unique Phenomena," lists the TWRS tanks and provides information related to flammable gas, ferrocyanide, organics, heat content, pyrophorics, syphoning, criticality, and corrosivity. Information regarding ferrocyanide is provided as a historical record. The ferrocyanide safety issue was formally closed in 1996.

- Table A-5 comprises a set of tables, titled "TWRS Facility Hazard Identification," which contain the results of the hazard identification of potential energy sources for each TWRS tank and facility. The results are based on the checklist described in the hazard analysis methodology.

Because of the many similarities in TWRS facilities and operations, development of hazard analysis results for TWRS is accomplished by analyzing representative cases and appropriately applying the results to all of the facilities and operations within the scope of the FSAR. Appendix A provides information to identify which hazard analyses apply to which facilities (Table A-1) and what data was used to select the specific cases and situations to be analyzed (Tables A-2, -3, -4, and -5).

Table A-1 maps individual hazard analyses to all TWRS facilities. It is important to note that only those portions of the representative hazard analysis that are appropriate are applied to each facility. For example, any waste storage tank containing a mixer pump or transfer pump has the hazardous conditions associated with a pump applied. This information is in the column titled "Facility Type". This information has not been updated to be consistent with other tables in Appendix A. This will be done as part of the next planned field verification exercise. Some facilities, such as the 204-AR Waste Unloading Facility, have their own hazard analysis because of their unique configuration.

Tables A-2 thru A-5 represent data taken from a field inspection and document review to identify situations to be included in the hazard analysis. The results of the effort are documented in WHC-SD-WM-HIE-007. These results are replicated in the FSAR as a historical record of the data used to support the hazard analysis activities. As a result, these tables may contain information which is potentially confusing to a reader.

A few of the major areas to be aware of in using this information follow:

1) The data contain some entries indicating that the information was not available or unknown. This did not pose a difficulty for development of the hazard analysis because the information was gathered to identify the types of situations to be analyzed, not the specific situations at each facility.

2) There were multiple teams performing the verification activities, therefore some of the reference designators in the tables (e.g., d1, d2, etc.) are not unique. The references can be identified by going to the appropriate table in WHC-SD-WM-HIE-007.

3) Much of the information in this Appendix is historical in nature. For example, information in Table A-4 regarding ferrocyanide is provided as a historical record. The ferrocyanide safety issue was formally closed in 1996.

4) Because the information was taken directly from the verification effort, there are some accommodations made to the form of the raw data. For example, some facilities identifiers are followed by -M and -O to indicate the 'miscellaneous' and 'other' categories of information in the field data tables.

The hazard analysis identifies a set of conditions which could exist within TWRS. Therefore, the information in Appendix A is used to support the development of a comprehensive hazard analysis result for the TWRS facilities as a group. Even though there are some unknowns and inconsistencies in the data in Appendix A, all presently known conditions are represented, have been evaluated, and any known deviations are insignificant. The hazard analysis identified a variety of conditions with the bounding cases quantified by the accident analysis.

The data in this appendix is not used directly in the Unreviewed Safety Question (USQ) process. It can provide general background information, but the USQ process is based primarily on the hazard evaluation and accident analysis results coupled with current conditions in TWRS at the time of the USQ evaluation. USQ evaluators must, therefore, refer to the configuration controlled hazard analysis database for the most accurate and current information on TWRS hazards.

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Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-A TANK FARM			
216-A-08C	Crib	PHA: CDP	CDP
216-A-08S	Sample pit	HAZOP: AW-102, SY-102	102AW, XS
216-A-28	Crib	PHA: CDP	CDP
216-A-30	Crib	PHA: CDP	CDP
216-A-36A	Crib	PHA: CDP	CDP
216-A-36B	Crib	PHA: CDP	CDP
216-A-37-1	Crib	PHA: CDP	CDP
216-A-37-2	Crib	PHA: CDP	CDP
216-A-39	Crib	PHA: CDP	CDP
216-A-45	Crib	PHA: CDP	CDP
241-A-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-A-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-A-COB	Cleanout box	PHA: COB	COB
241-A-101	Single shell tank, flammable gas, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-A-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-A-103	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-A-104	Single shell tank, high heat load	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-A-105	Single shell tank, high heat load	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-A-106	Single shell tank, high heat load	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-A-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-A-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-A-302-A	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, PUREX PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF, I-PUREX
241-A-350	DCRT Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-S, PFP, PUREX, T Plant, Siphoning, Overground Transfers PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242S,, I-PFP, I-PUREX, I-TPLANT, TSF, OGT
241-A-417	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,PUREX PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF, I-PUREX

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AN TANK FARM			
241-AN-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AN-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AN-COB-1	Cleanout box	PHA: COB	COB
241-AN-COB-2	Cleanout box	PHA: COB	COB
241-AN-COB-3	Cleanout box	PHA: COB	COB
241-AN-COB-4	Cleanout box	PHA: COB	COB
241-AN-COB-5	Cleanout box	PHA: COB	COB
241-AN-COB-6	Cleanout box	PHA: COB	COB
241-AN-COB-7	Cleanout box	PHA: COB	COB
241-AN-COB-8	Cleanout box	PHA: COB	COB
241-AN-101	Double shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AN-102	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AN-103	Double shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AN-104	Double shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AN-105	Double shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AN-106	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AN-107	Double shell tank, air lift circulators, caustic, active transfer/mixer pumps, active ventilation	HAZOP: AN-107, AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	107AN, 102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AP TANK FARM			
241-AP-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AP-101	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AP-102	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AP-103	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AP-104	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AP-105	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AP-106	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AP-107	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AP-108	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AW TANK FARM			
241-AW-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AW-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AW-COB-01	Cleanout box	PHA: COB	COB
241-AW-COB-02	Cleanout box	PHA: COB	COB
241-AW-COB-03	Cleanout box	PHA: COB	COB
241-AW-COB-04	Cleanout box	PHA: COB	COB
241-AW-COB-05	Cleanout box	PHA: COB	COB
241-AW-COB-06	Cleanout box	PHA: COB	COB
241-AW-COB-07	Cleanout box	PHA: COB	COB
241-AW-COB-08	Cleanout box	PHA: COB	COB
241-AW-COB-09	Cleanout box	PHA: COB	COB
241-AW-COB-10	Cleanout box	PHA: COB	COB
241-AW-COB-11	Cleanout box	PHA: COB	COB
241-AW-COB-12	Cleanout box	PHA: COB	COB
241-AW-101	Double shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AW-102	Double shell tank, air lift circulators, evaporator feed, active transfer/mixer pumps, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AW-103	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AW-104	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AW-105	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AW-106	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AX TANK FARM			
241-AX-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AX-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AX-COB	Cleanout box	PHA: COB	COB
241-AX-101	Single shell tank, flammable gas	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AX-102	Single shell tank, flammable gas, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-AX-103	Single shell tank, flammable gas	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-AX-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-AX-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AX-152	Diverter station	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR,EE, CCF
241-AX-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AX-155	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AX-501	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AY TANK FARM			
241-AY-1	Cleanout box	PHA: COB	COB

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AY-101	Double shell tank, air lift circulators, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AY-102	Double shell tank, air lift circulators, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AY-151	Pumpout pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AY-152	Valve box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AY-501	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AZ TANK FARM			
241-AZ-COB-01	Cleanout box	PHA: COB	COB
241-AZ-COB-02	Cleanout box	PHA: COB	COB
241-AZ-COB-03	Cleanout box	PHA: COB	COB
241-AZ-COB-04	Cleanout box	PHA: COB	COB
241-AZ-COB-05	Cleanout box	PHA: COB	COB
241-AZ-COB-06	Cleanout box	PHA: COB	COB
241-AZ-COB-07	Cleanout box	PHA: COB	COB
241-AZ-COB-08	Cleanout box	PHA: COB	COB

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AZ-COB-09	Cleanout box	PHA: COB	COB
241-AZ-COB-10	Cleanout box	PHA: COB	COB
241-AZ-101	Double shell tank, air lift circulators, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AZ-102	Double shell tank, air lift circulators, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-AZ-151	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
241-AZ-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AZ-153	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AZ-154	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
241-AZ-155	Contaminated storage pit	HAZOP: AW-102, SY-102	102AW, XS
241-AZ-161	Check valve caisson	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AZ-162	Check valve caisson	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-AZ-562	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-B TANK FARM			
216-B-3	Pond (B pond)	PHA: CDP	CDP
216-B-55	Crib	PHA: CDP	CDP
216-B-62	Crib	PHA: CDP	CDP
216-B-63	Ditch	PHA: CDP	CDP
241-B-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-103	Single shell tank, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-105	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-B-106	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-107	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-108	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-109	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-110	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-111	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-112	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-B-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-B-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-B-154	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-B-201	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-202	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-203	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-B-204	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
242-B-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-B-252	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-BX TANK FARM			
241-BX-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-103	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-105	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-106	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-107	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-108	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-109	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-BX-110	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-111	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BX-112	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BXR-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-BXR-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-BXR-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-BY TANK FARM			
241-BY-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-103	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-BY-104	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-105	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-106	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-107	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-108	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-109	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-110	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-111	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BY-112	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-BYR-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-BYR-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-BYR-154	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-BYR-155	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-C TANK FARM			
241-C-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-103	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-105	Single shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-106	Single shell tank, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-C-107	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-108	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-109	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-110	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-111	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-112	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-C-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-C-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-C-154	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-C-201	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-202	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-203	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-204	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-C-252	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-S TANK FARM			
216-S-25	Crib	PHA: CDP	CDP
216-S-26	Crib	PHA: CDP	CDP
241-S-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-S-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-S-C	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-S-D	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-S-VSU	Vertical Storage Units	PHA: VSU	VSU
241-S-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-102	Single shell tank, flammable gas, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-103	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-105	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-S-106	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-107	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-108	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-109	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-110	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-111	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-112	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-S-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-S-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-S-304	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-SX TANK FARM			
241-SX-101	Single shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-102	Single shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-103	Single shell tank, flammable gas, organics, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-104	Single shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-105	Single shell tank, flammable gas, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-106	Single shell tank, flammable gas, organics, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-107	Single shell tank, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-108	Single shell tank, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-109	Single shell tank, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-SX-110	Single shell tank, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-111	Single shell tank, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-112	Single shell tank, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-113	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-114	Single shell tank, dry crust, high heat load, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-115	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-SX-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-SX-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-SX-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-SX-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-SY TANK FARM			
241-SY-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-SY-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-SY-COB-1	Cleanout box	PHA: COB	COB
241-SY-COB-2	Cleanout box	PHA: COB	COB
241-SY-COB-3	Cleanout box	PHA: COB	COB
241-SY-COB-4	Cleanout box	PHA: COB	COB
241-SY-COB-5	Cleanout box	PHA: COB	COB
241-SY-COB-6	Cleanout box	PHA: COB	COB
241-SY-101	Double shell tank, flammable gas, active transfer/mixer pumps, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-SY-102	Double shell tank, active transfer/mixer pumps, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-SY-103	Double shell tank, active ventilation	HAZOP: AW-102, C-106, S-102, SX-114, SY-102,222-S, 242-A, 242-S, AW-102, PFP, PUREX, B Plant, T Plant PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-222S, I-242A, I-242S, 102AW, I-PFP, I-PUREX, I-BPLANT, I-TPLANT
241-T TANK FARM			
216-T-1	Ditch	PHA: CDP	CDP
216-T-32	Crib	PHA: CDP	CDP
216-T-4-2	Ditch	PHA: CDP	CDP
216-T-7	Crib	PHA: CDP	CDP
240-T-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
240-T-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
240-T-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
240-T-252	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
240-TR-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
240-TR-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-T-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-103	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-105	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-106	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-107	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-108	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-109	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-T-110	Single shell tank, flammable gas	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-111	Single shell tank, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-112	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-T-201	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-202	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-203	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-T-204	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX TANK FARM			
241-TX-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-TX-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-103	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-105	Single shell tank, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-106	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-107	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-108	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-109	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-110	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-111	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-TX-112	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-113	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-114	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-115	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-116	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-117	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-118	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TX-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-TX-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-TX-154	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-TX-155	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-TXR-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-TXR-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-TXR-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-TX-302C	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
241-TY TANK FARM			
241-TY-101	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TY-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-TY-103	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TY-104	Single shell tank, ferrocyanide	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TY-105	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-TY-106	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U TANK FARM			
216-U-12	Crib	PHA: CDP	CDP
216-U-14	Ditch	PHA: CDP	CDP
216-U-17	Crib	PHA: CDP	CDP
241-U-A	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-B	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-C	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-U-D	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-101	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-102	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-103	Single shell tank, flammable gas, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-104	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-105	Single shell tank, flammable gas, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-106	Single shell tank, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-107	Single shell tank, flammable gas, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-108	Single shell tank, flammable gas	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-109	Single shell tank, flammable gas	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-U-110	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-111	Single shell tank, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-112	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-154	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-201	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-202	Single shell tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-U-203	Single shell tank, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-204	Single shell tank, organics	HAZOP: AW-102, C-106, S-102, SX-114, SY-102, 242-T, Overground Transfers PHA: AZ-102/BX-109/SY-101/ITK WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF,I-242T,OGT
241-U-252	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-U-301B	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
241-UR-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-UR-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-UR-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-UR-154	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-UX-154	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-UX-302A	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
DCRTs, CATCH TANKS, CATCH STATIONS, AND LIFT STATIONS			
244-A	DCRT catch station	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
244-BX	DCRT catch station	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
244-CR	DCRT catch station	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
244-S	DCRT catch station	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
244-TX	DCRT catch station	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
244-U	DCRT catch station	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
MISCELLANEOUS DIVERSION BOXES, CAISSONS, VENT STATIONS			
241-AR-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-CR-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-CR-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-CR-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-ER-151	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-ER-152	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-ER-153	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-ER-311	Catch tank	HAZOP: AW-102, C-106, S-102, SX-114, SY-102 PHA: AZ-102/BX-109/SY-101 WHAT IF: CCF, EE	102AW, 106C, 102S, 114SX, XS, BND, CRN, ITK, RAD, VEH, EE, CCF
241-EW-151	Vent station	HAZOP: XS	XS
241-F-505	Diverter caisson	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
241-F-562	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
MISCELLANEOUS FACILITIES			
Located in each tank farm	Caisson	HAZOP: AW-102, SY-102	102AW, XS
Located in each tank farm	Catch tank pit	HAZOP: AW-102, SY-102	102AW, XS
Located in each tank farm	Cleanout box	PHA: COB	COB
Located in each tank farm	Diversion box	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
Located in each tank farm	Diverter station	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
Located in each tank farm	Flush pit	HAZOP: AW-102, SY-102	102AW, XS
Located in each tank farm	Leak detection pit	HAZOP: AW-102, SY-102	102AW, XS
Located in each tank farm	Pump pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
Located in each tank farm	Service pit	HAZOP: AW-102, SY-102	102AW, XS
Located in each tank farm	Sluice transfer box	PHA: COB	COB
Located in each tank farm	Valve pit	HAZOP: 222-S, 242-A, 242-S, 242-T, AW-102, C-106, S-102, SX-114, SY-102, B Plant, T Plant, U Plant, PFP, PUREX, Overground Transfers PHA: AZ-102/BX-109/SY-101	I-222S, I-242A, I-242S, I-242T, 102AW, 106C, 102S, 114SX, W058, XS, I-BPLANT, I-UPLANT, I-TPLANT, I-PFP, I-PUREX, OGT, CVR
Located in various tank farms	Vertical Storage units	PHA: VSU	VSU

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
Located in various tank farms	MISF-Miscellaneous inactive storage facilities (includes inactive underground storage facilities and other inactive facilities)	PHA: MISF	-I (Identifier ends in -I, e.g., CRN-05-I)
Overground Transfer Line	Portable Overground Transfer Line	HAZOP: Overground Transfers	OGT
PFP Pond	Pond	PHA: CDP	CDP
Vertical Storage Units	12" - 20' in depth	PHA: VSU	VSU
209-E	90 day storage pad	PHA: 209E	90D
216-Z-20	Crib	PHA: CDP	CDP
216-Z-21	Pond	PHA: CDP	CDP
241-AR-204	Railcar/truck receiving facility	HAZOP: 204AR	204AR
241-AR-244	Vault	HAZOP: 244AR PHA: 244AR	244AR, 244AR-PH
2727-W	Sodium storage bldg	PHA: 2727W	2727W
PIPING			
Double Encased Piping	Transfer Line Piping	HAZOP: 242-A, 242-S, AW-102, PFP, SY-102 WHAT IF: EE	I-242A, I-242S, 102AW, I-PFP, W058, XS, EE
Secondary Containment Piping	Transfer Line Piping	HAZOP: 222-S, PUREX, SY-102/XS, B Plant, T Plant, U Plant	I-222S, I-PUREX, XS, I-BPLANT, I-TPLANT, I-UPLANT

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
Single Encased Piping	Transfer Line Piping	HAZOP: AN-107, S-102, SY-102	107AN, 102S, XS
SATELLITE ACCUMULATION AREAS			
A Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
AN Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
AP Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
AW Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
AX Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
AY Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
B Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
C Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
S Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
T Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities. (40 sheets)

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
TX Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D
U Satellite Accumulation Area	Satellite Accumulation Area	PHA: 209E	90D

209E = 209-E Storage Area.
90D = 209-E Storage Area.
BND = bonding.
CCF = common cause failure.
CDP = cribs, ditches and ponds.
COB = cleanout box.
CRN = crane operations.
CVR = coverblock installation and removal.
DCRT = double-contained receiver tank.
EE = external events.
HazOp = hazard and operability study.
ITK = in-tank equipment installation, operation, and removal.
MISF = miscellaneous inactive storage facility.
OGT = overground transfer.
PFP = Plutonium Finishing Plant.
PHA = preliminary hazard analysis.
PUREX = Plutonium Uranium Extraction (Facility).
RAD = radiological monitoring and surveys.
TSF = tank farm waste transfer syphoning events.
VEH = vehicle operations.
VSU = vertical storage unit.
XS = existing cross site transfer.
W058 = existing cross site transfer (historical/applicable information from previous PHA).

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
2727-WA-M	Tank Contents	None	NA	NA	NA	NA	NA	NA	NA	No tanks associated with 2727-WA.
2727-WA-M	Tank Headspace	None	NA	NA	NA	NA	NA	NA	NA	No tanks associated with 2727-WA.
2727-WA	Rail or Truck Tanker Contents	Tanker truck heel	NA	5000 gal estimated	NA	Liquid/ Residual	Heel of liquid	Yes	NA	An abandoned truck tankers is parked within the fenced area near 2727-WA. Inside has been rinsed out, radioactive heel expected to remain.
2727-WA	Contamination on Vehicle	Tanker truck (noted above)	NA	NA	NA	Residual	One spot about 1 mR/hr	Yes	NA	Contaminated tanker truck stored near 2727-WA.
2727-WA-M	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	2727-WA is a clean storage area with the exception of the truck tanker noted above and a buffer area with possibly contaminated wood pallets.
2727-WA-M	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with 2727-WA.
2727-WA-M	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No de-entrainer.
2727-WA-M	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No seal loops.
2727-WA-M	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
2727-WA-M	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No sumps or encasements.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
2727-WA-M	Contamination in Pit or Box	None	NA	NA	NA	NA	NA	NA	NA	No pits or boxes.
2727-WA-M	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
2727-WA-O	Other	Unlabeled drum	Unknown	55 gal drum	NA	Unknown	Unknown, up to 55 gallons	Yes	NA	Recently dropped off. Found in the Northwest corner of the fenced area, outside the building.
2727-WA-O	Other	Gas bottles	Acetylene (1), oxygen (1), Ar (2)	480 cubic feet per bottle	NA	Vapor	Four bottles @ 480 cubic feet, max.	Yes	4 bottles, 2 Ar, 1 oxygen, 1 acetylene	Used as a mobile welding unit. Stored behind 2727-WA.
2727-WA-O	Other	Calcium chloride	Calcium chloride	55 gallons	NA	Solid	<55 gallons	Yes	One container	Stored in connex near 2727-WA.
2727-WA-O	Other	Scale clean	Scale clean	55 gallons	NA	Liquid	55 gallons	Yes	One container	Stored in connex near 2727-WA.
2727-WA-O	Other	Dry inhibited acid descier	Dry inhibited acid descier	55 gallons	NA	Solid	<55 gallons	Yes	One container	Stored in connex near 2727-WA.
2727-WA-O	Other	Neutrasorb	Neutrasorb	55 gallons	NA	Liquid	30 gallons	Yes	One container	Stored in connex near 2727-WA.
2727-WA-O	Other	Kenite D.E., celite	Diatamaceous earth	55 gallons	NA	Solid	55 gallons	Yes	One drum	Stored in connex near 2727-WA.
2727-WA-O	Other	Sodium carbonate	Sodium carbonate	110 gallons	NA	Liquid	55 gallons	Yes	One drum	Stored in connex near 2727-WA.
2727-WA-O	Other	Neutracit 2	Caustic neutralizer	165 gallons	NA	Solid	165 gallons	Yes	Three drums	Stored in connex near 2727-WA.
2727-WA-O	Other	Absorbent	Solid absorbent	500 lbs estimated	NA	Solid	About 20 bags, each about 10 lbs	Yes	About 20 bags, each about 10 lbs.	Stored in connex near 2727-WA.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
2727-W	Tank Contents	Tank 1	Sodium	About 15,000 gal (12' dia x 21'-3" with dished head)	NA	Solid	300 gal heel	No	NA	No data available in ref d3. Total of 178 tons of sodium remaining in all three tanks.
2727-W	Tank Contents	Tank 2	Sodium	About 15,000 gal (12' dia x 21'-3" with dished head)	NA	Solid	300 gal heel	No	NA	Ref d3 (1981) states there is 50,503 kg of sodium in this tank. This material was transferred to FFTF. Total of 178 tons of sodium remaining in all three tanks.
2727-W	Tank Contents	Tank 3	Sodium	About 15,000 gal (12' dia x 21'-3" with dished head)	NA	Solid	7500 gal (half full)	No	NA	Ref d3 (1981) states there is 43,127 kg in this tank. Some of the sodium was removed at FFTF. Total of 178 tons of sodium remaining in all three tanks.
2727-W	Tank Contents	Tank 4	Sodium	About 15,000 gal (12' dia x 21'-3" with dished head)	NA	Solid	15000 gal (full) 50,855 kg	No	NA	Total of 178 tons of sodium remaining in all three tanks.
2727-W	Tank Contents	Tank 5	Sodium	About 15,000 gal (12' dia x 21'-3" with dished head)	NA	Solid	15000 gal (full) 48,828 kg	No	NA	Total of 178 tons of sodium remaining in all three tanks.
2727-W	Tank Headspace	Tank 1	Nitrogen	NA	NA	Vapor	14700 gal (capacity - contents)	No	NA	Tank headspace filled with nitrogen cover gas.
2727-W	Tank Headspace	Tank 2	Nitrogen	NA	NA	Vapor	14700 gal (capacity - contents)	No	NA	Tank headspace filled with nitrogen cover gas.
2727-W	Tank Headspace	Tank 3	Nitrogen	NA	NA	Vapor	7500 gal (capacity - contents)	No	NA	Tank headspace filled with nitrogen cover gas.
2727-W	Tank Headspace	Tank 4	Nitrogen	NA	NA	Vapor	Minimal	No	NA	Tank headspace filled with nitrogen cover gas.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
2727-W	Tank Headspace	Tank 5	Nitrogen	NA	NA	Vapor	Minimal	No	NA	Tank headspace filled with nitrogen cover gas.
2727-W-M	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with sodium storage building.
2727-W-M	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with sodium storage building.
2727-W-M	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated tools or equipment associated with sodium storage building.
2727-W-M	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation filters associated with sodium storage building.
2727-W-M	Contamination In Ventilation System	None	NA	NA	NA	NA	NA	NA	NA	No ventilation system associated with sodium storage building.
2727-W-M	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
2727-W-M	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No sumps or encasements in sodium storage building.
2727-W-M	Contamination in Pit or Box	None	NA	NA	NA	NA	NA	NA	NA	No pits or boxes associated with sodium storage building.
2727-W-M	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
2727-W-O	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
209-E	Tank Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
209-E	Tank Headspace	NA	NA	NA	NA	NA	NA	NA	NA	No tanks

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
209-E-M	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with 209 E.
209-E-M	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with 209 E.
209-E-M	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated tools or equipment associated with 209 E.
209-E-M	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with 209 E.
209-E-M	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with 209 E.
209-E-M	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with 209 E.
209-E-M	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
209-E-M	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No sump associated with 209 E.
209-E-M	Contamination in Pit or Box	None	NA	NA	NA	NA	NA	NA	NA	No pits or boxes associated with 209 E.
209-E-M	SARA 313 Materials	Pyrofoam	NA	875 lbs (max reported in 1995)	NA	Solid	850 lbs on 12/19/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	Granular urea	NA	360 lbs (max reported in 1995)	NA	Solid	0 lbs on 12/19/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	3M super 77 spray adhesive	NA	247 fluid oz (max reported in 1995)	NA	Liquid	192 fluid oz. on 12/19/95	Yes	NA	Aerosol cans; not observed on walkdown.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
209-E-M	SARA 313 Materials	AS527 polyurethane satin water based paint	NA	732 fluid oz. (max reported in 1995)	NA	Liquid	732 fluid oz. on 12/19/95	Yes	NA	Aerosol cans; not observed on walkdown.
209-E-M	SARA 313 Materials	"Clean up"	NA	5600 lbs (max reported in 1995)	NA	Solid	1600 lbs on 12/19/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	CRC-2-26 (aerosol)	NA	112 fluid oz. (max reported in 1995)	NA	Liquid	112 fluid oz on 12/19/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	Argon/ methane gas 90/10	NA	720 cubic feet (max reported in 1995)	NA	Gas	720 cubic feet on 11/30/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	Krylong 1601-25012 spray enamel	NA	247 fluid oz. (max reported in 1995)	NA	Liquid	156 fluid oz on 12/19/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	Propane	NA	50 gallons (max reported in 1995)	NA	Liquid	50 gallons on 11/30/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	Shell alvania EP grease 2	NA	5 gallons (max reported in 1995)	NA	Liquid	5 gallons on 1/1/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	Spray on primers	NA	72 fluid oz. (max reported in 1995)	NA	Liquid	72 fluid oz. on 12/19/95	Yes	NA	Not observed on walkdown.
209-E-M	SARA 313 Materials	WD-40 aerosol	NA	272 fluid oz. (max reported in 1995)	NA	Liquid	144 fluid oz. on 12/19/95	Yes	NA	Not observed on walkdown.
209-E-O	Other	Drums	Tank contacted toxic wastes (mixed waste)	55 gallons each	NA	Solid	Forty-four 55 gallon drums	Yes	44 drums	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
209-E-O	Other	DOT boxes (7A)	Tank contacted toxic wastes (mixed waste)	400 gallons (3' x 3' x 6') or 180 gallons (2' x 2' x 6')	NA	Solid	Two 400 gallon boxes and one 180 gallon box	Yes	Three boxes	NA
209-E-O	Other	DOT box (7A)	Tank contacted persistent waste* (mixed waste)	1700 gallons (5' x 5' x 9')	NA	Solid	One 1700 gallon box	Yes	One box	*Generated at 241-A valve pit.
209-E-O	Other	Drums	Toxics* (mixed waste)	55 gallons each	NA	Solid	Three 55 gallon drums	Yes	Three drums	*Generated at 241-U farm and 241-S farm.
209-E-O	Other	Drums	Flammable material (Non-rad)	55 gallons each	NA	Solid	Two 55 gallon drums	Yes	Two drums	NA
209-E-O	Other	Drum	Regulated rags (non-rad)	55 gallon	NA	Solid	One 55 gallon drum	Yes	One drum	NA
209-E-O	Other	Drum	Corrosive materials (Non-rad)	55 gallon	NA	Solid	One 55 gallon drum	Yes	One drum	Incompatible materials segregated within the storage area.
209-E-O	Other	Drum	Ethylene glycol (Non-rad)	55 gallon or 25 gallon	NA	Liquid	Four 55 gallon drums and one 25 gallon drum	Yes	Five drums	NA
AR-204	Tank Contents	Tank 1 - catch tank	Same matl as tank car, tank trailer or chemical make-up solutions identified below	1,500 gal [H-2-70704]	NA	Liquid	500 gal	No	NA	Floor drains through 204-AR drain to the catch tank.
AR-204	Tank Contents	Tank 2 - chemical make-up	1 lb/gal sodium nitrite solution [H-2-70704]	500 gal [H-2-70704]	NA	Liquid	120 gal	No	NA	NA
AR-204	Tank Contents	Tank 3 - chemical make-up	5.4 M caustic [H-2-70704]	500 gal [H-2-70704]	NA	Liquid	80 gal	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-204	Tank Contents	Tank 4 - chemical make-up	High pH buffer solution (sodium hydroxide and sodium phosphate) [H-2-70704]	200 gal [H-2-70704]	NA	Liquid	0.00	No	NA	Solution was used for pH probe calibration. Currently not in use.
AR-204	Tank Contents	Tank 5 - chemical make-up	50% sodium hydroxide [H-2-70704]	1800 gal [H-2-70704]	NA	Liquid	0 gal Residual	No	NA	Currently not in use.
AR-204	Tank Contents	Underground storage tank	Diesel fuel	550 gal [H-2-99036]	NA	Liquid	550 gal	No	NA	For diesel generator.
AR-204	Tank Headspace	Catch tank	NA	NA	NA	NA	NA	NA	NA	No data available.
AR-204	Tank Headspace	Tank 2 - chemical make-up	NA	NA	NA	NA	NA	NA	NA	No data available.
AR-204	Tank Headspace	Tank 3 - chemical make-up	NA	NA	NA	NA	NA	NA	NA	No data available.
AR-204	Tank Headspace	Tank 4 - chemical make-up	NA	NA	NA	NA	NA	NA	NA	No data available.
AR-204	Tank Headspace	Tank 5 - chemical make-up	NA	NA	NA	NA	NA	NA	NA	No data available.
AR-204	Tank Headspace	Underground storage tank	NA	NA	NA	NA	NA	NA	NA	No data available.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-204	Rail or Truck Tanker Contents	Railroad tank car	Between 7-14 pH, chloride <0.01 M, no separable organic phase, <0.01 g/gal fissile material [OSD-T-151-00008, Rev. E-2]	20,000 gal [H-2-71502/1]	NA	Liquid	Up to 20,000 gal*	No	NA	Transporting waste from 340 facility. *Railcar just being hooked up during walkdown, exact volume unknown.
AR-204	Rail or Truck Tanker Contents	Tank trailer	Between 7-14 pH, chloride <0.035 M, no separable organic phase, <0.01 g/gal fissile material [OSD-T-151-00008, Rev. E-2]	5,000 gal [WHC-SD-WM-SARR-006, Rev. 0]	NA	Liquid	Up to 5,000 gal*	No	NA	Waste from 222-S laboratory. Other facilities hope to send waste to 204-AR in the future *No tank trailer present during walkdown.
AR-204-M	Contamination on Vehicle	See vehicles above	NA	NA	NA	NA	NA	NA	NA	NA
AR-204-M	Contamination on Equipment or Tools	Contaminated equipment (e.g., pumps) in unloading area	Residual contamination	NA	NA	Residue	NA	Yes	NA	NA
AR-204-M	Contamination on Equipment or Tools	Shed with contaminated material	Soiled laundry	NA	NA	Solid	NA	Yes	NA	Located outside building on east side. Shed locked up, not entered during walkdown.
AR-204-M	Ventilation Filter Contents	Primary HEPAs HSG-1 and HSG-2*	NA	1 R/hr at six inches	NA	Particulate	NA	Yes, filters disposed of in accord with EP-0063, Rev 4 (9/93)	NA	*For main unloading area ventilation system.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-204-M	Ventilation Filter Contents	HEPA HSG-3*	NA	1 R/hr at six inches	NA	Particulate	NA	Yes, filters disposed of in accord with EP-0063, Rev 4 (9/93)	NA	*For catch tank ventilation.
AR-204-M	Contamination In Ventilation System	Moisture separators	Process condensate	NA	NA	Liquid	NA	No	2 moisture separators	Moisture separators on main unloading area vent system and on catch tank vent system.
AR-204-M	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No seal loops identified associated with ventilation system.
AR-204-M	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
AR-204-M	Contents of Sump or Encasement	Catch tank pit sump	None*	5 gal (1' x 1' x 8") [H-2-70691]	NA	NA	None*	NA	NA	*No known spills from catch tank.
AR-204-M	Contamination in Pit or Box	Catch tank pit	None*	3300 gal (6' x 7' x 10'-6") [H-2-70691]	NA	NA	None*	NA	NA	*No known spills from catch tank.
AR-204-M	SARA 313 Materials	Plastic bottles/jugs of disodium phosphate	Disodium phosphate	20 lbs = max reported in 1995	NA	Solid	20 lbs on 12/19/95	Yes	NA	Not observed on walkdown. Cog unaware of this - no longer used.
AR-204-M	SARA 313 Materials	Bag of sodium hydroxide	Sodium hydroxide, 100%	1100 lbs = max reported in 1995	NA	Solid	650 lbs on 12/19/95	Yes	NA	Not observed on walkdown. Make-up material for sodium hydroxide solution.
AR-204-M	SARA 313 Materials	Sodium hydroxide solution	18.6% sodium hydroxide solution	145 gal = max reported in 1995	NA	Liquid	45 gal on 12/19/95	Yes	NA	Material is located in Tank 3 noted above.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-204-M	SARA 313 Materials	Sodium nitrite solution	11% sodium nitrite solution	265 gal = max reported in 1995	NA	Liquid	187 gal on 12/19/95	Yes	NA	Material is located in Tank 2 noted above.
AR-204-M	SARA 313 Materials	Diesel fuel	Diesel fuel	500 gal	NA	Liquid	500 gal on 1/1/95	No	NA	Material is located in below ground tank, noted above.
AR-204-O	Other	204-AR spill kit	Spill clean-up materials	Small shed*	NA	Solid	NA	Yes	NA	*Small shed behind (North of) 204-AR. Locked, not entered during walkdown.
213 Compactor Bldg	Tank Contents	213-W-TK-1	Believed to be rainwater [WHC-EP-0861, Rev. 0]	1875 gal [WHC-EP-0861, Rev. 0]	NA	Liquid	1875 [WHC-EP-0861, Rev. 0]	No	NA	This IMUST is on the non-TWRS owned IMUST list. [WHC-SD-WM-PD-046, Rev. 0]
213 Compactor Bldg	Tank Headspace	213-W-TK-1	NA	NA	NA	NA	0 gal (tank believed to be full of rainwater)	NA	NA	No available headspace believed present. [WHC-EP-0861, Rev. 0]
213 Compactor Bldg*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with 213-W.
213 Compactor Bldg*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles stored in 213-W.
213 Compactor Bldg	Contamination on Equipment or Tools	Possibly contaminated instruments*	NA	Small shelf in work room, all <100 mR/hr	NA	Residue	<100 mH/hr	Yes*	NA	*Possibly contaminated instruments are brought into the work area for repairs. All contamination is low level.
213 Compactor Bldg	Ventilation Filter Contents	HEPA filters for 213-W bldg. ventilation	NA	1 R/hr at six inches	NA	Residue	NA	Yes	4 HEPA filters	Two parallel sets of two HEPAs in series.
213 Compactor Bldg	Ventilation Filter Contents	Breather filter for IMUST (213-W-TK-1)	NA	1 R/hr at six inches	NA	Residue	NA	Yes	NA	Breather filter on IMUST adjacent to 213-W.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
213 Compactor Bldg*	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No de-entrainer.
213 Compactor Bldg*	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No seal loops.
213 Compactor Bldg	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
213 Compactor Bldg*	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No sumps or encasements.
213 Compactor Bldg	Contamination in Pit or Box	IMUST pit	Looked empty	About 240 gal (4' x 4' x 2'?)	NA	NA	Looked empty, no warnings of contamination	No	NA	Concrete pit with steel lid. Opened lid on walkdown; could see risers to tank, no evidence of contaminated material in pit.
213 Compactor Bldg*	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
213 Compactor Bldg	Other	Asphalt emulsion cleaner	Cleaning compound	55 gal drum	NA	NA	Unknown, up to 55 gallons	Yes	NA	Believed to be temporarily stored in building, not used in building.
213 Compactor Bldg	Other	Chemical cleaners, degreasers*	Solvent cleaners	Small quantities, < 1 gal	NA	Liquid	None during walkdown*	Yes	NA	*Chemical cleaners/degreasers may be brought into facility temporarily. None observed during walkdown.
AR-244	Tank Contents	244-AR-001	Unknown*	46,400 gal (20' dia x 19'-9") [H-2-62090]	NA	Liquid	2300 gal	No	NA	*No data obtained.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-244	Tank Contents	244-AR-002	Strontium sludge from Tank 104-AX and flush water*	46,400 gal (20' dia x 19'-9") [H-2-62090]	Liquid Sludge	Liquid Solid	23,000 gal total, believed to be 600 gal of sludge, remainder = liquid* Activity of 200 Ci/gal for the sludge calculated in ref d2, (196 Ci/gal Sr90 and 3.22 Ci/gal Cs137)	No	NA	*Ref d3 indicates 600 gallons of sludge from AX-103 stored in Tank 4, word-of-mouth from retired operator recalls transfer of sludge and other liquids in Tank 4 to Tank 2. Remainder of liquid believed to be water transferred from cell 3 sump, flush water from Tank 4, and sump transfers conducted when new filter vault was installed.
AR-244	Tank Contents	244-AR-003	Unknown*	4700 gal (9'-6" dia x 9') [H-2-62097	NA	Liquid	2000 gal	No	NA	*No data on tank contents obtained.
AR-244	Tank Contents	244-AR-004	Unknown*	4700 gal (9-6" dia x 9') [H-2-62097	NA	Liquid	<300 gal	No	NA	*Ref d3 indicates 600 gallons of sludge from AX-103 stored in Tank 4, word-of-mouth from retired operator recalls transfer of sludge and other liquids in Tank 4 to Tank 2.
AR-244	Tank Contents	Underground fuel tank	Diesel fuel	550 gal [H-2-63906]	NA	Liquid	525 gal	No	NA	Reading read off level gauge during walkdown.
AR-244	Tank Headspace	244-AR-001	No hydrogen or organics	NA	NA	Vapor	About 44,100 gal (capacity - contents) activity unknown	No	NA	NA
AR-244	Tank Headspace	244-AR-002	0.222 mole % hydrogen	NA	NA	Vapor	About 23,400 gal (capacity - contents) activity unknown	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-244	Tank Headspace	244-AR-003	No hydrogen or organics	NA	NA	Vapor	About 2700 gal (capacity - contents) activity unknown	No	NA	NA
AR-244	Tank Headspace	244-AR-004	No hydrogen or organics	NA	NA	Vapor	About 4400 gal (capacity - contents) activity unknown	No	NA	NA
AR-244-M	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with 244-AR vault.
AR-244-M	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with 244-AR vault.
AR-244-M	Contamination on Equipment or Tools	Contaminated equipment stored in wind reduction facility	NA	62'-8" x 40' x 18' are dimensions of wind reduction facility	NA	Solid	Unknown*	Yes*	NA	This building contained numerous bags of waste material. Old cameras and other equipment, possibly contaminated have been stored within this building and are currently being sorted out. Four 55 gal drums of material with labels indicating lead were stored at the far west end of the building, actual contents unknown.
AR-244-M	Contamination on Equipment or Tools	Failed equipment in storage tubes	NA	Each 4200 gal (4'-6" dia x 35') [H-2-61997]	NA	Solids	Unknown*	Yes	NA	*Failed equipment was put in tubes below cover blocks within the canyon. The vault has been in stand-by mode for years. Actual contents of the storage tubes is currently unknown.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-244-M	Ventilation Filter Contents	Canyon ventilation filters	NA	NA	NA	Residue	Unknown*	Yes	NA	*The ventilation associated with 244-AR has not been operated since 1993. Some filters have been removed for use in other locations. Most are located in underground vaults (current quantities and activity levels are unknown).
AR-244-M	Ventilation Filter Contents	Vessel ventilation filters	NA	NA	NA	Residue	Unknown*	Yes	NA	*The ventilation associated with 244-AR has not been operated since 1993. Most filters are located in underground vaults (current quantities and activity levels are unknown).
AR-244	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No de-entrainer associated with ventilation, but liquids are collected in a seal pot.
AR-244	Contamination In Ventilation System	Seal pot	Process condensate	100 gal (2' dia x 4'-1") [H-2-36499]	NA	Liquid	Unknown*	No	NA	*The ventilation associated with 244-AR has not been operated since 1993. (current quantity and activity level of liquid in seal pot is unknown).
AR-244-M	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AR-244	Contents of Sump or Encasement	Vault cell sumps	NA	25 gal (18" x 18" x 18") estimated from H-2-58790	NA	Liquid	2400 gal in cell 3* about 15 gal in cell 1 (wt factor reading of 23) and about 2 gal in cell 2 (wt. factor reading of 3) [roundsheet TF-O-EF-244-AR, Rev. B-2, week of 2/26/96]	No	One sump in each of the three cells	*Sump has overflowed; liquid in the bottom of the cell.
AR-244	Contamination in Pit or Box	Valve pit	Residual contamination*	1300 gal (4'-6" dia x 11') [H-2-93632]	NA	Residue	NA	No	NA	*Lines 717 and 716 (drain lines) pass through this valve pit on the way to tanks in the 244 AR vault.
AR-244-M	SARA 313 Materials	None*	NA	NA	NA	NA	NA	NA	NA	Diesel fuel noted above.
AR-244-M	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AR-151*	Tank Contents	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.
241-AR-151*	Tank Headspace	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.
241-AR-151*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with diversion box.
241-AR-151*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with diversion box.
241-AR-151*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated tools associated with diversion box.
241-AR-151*	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AR-151*	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-AR-151*	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-AR-151*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-AR-151*	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No sump associated with diversion box. See transfer line Table 7 for encasement discussion.
241-AR-151	Contamination in Pit or Box	Diversion box	Residual contamination*	2800 gal (7' x 7' x 7'-8"') [H-2-93631]	NA	Residue*	NA	No	NA	*Diversion box contents drain to 244-AR vault. Diversion box transports mixed waste solutions from processing and decontamination operations. Also NCAW (neutralized current acid waste)and NHW (neutralized high level waste). [WHC-SD-WM-EV-040, Rev. 1]
241-AR-151*	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AR-151*	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-151*	Tank Contents	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.
241-ER-151*	Tank Headspace	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-ER-151*	Rail or Truck Tanker Contents	NA	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with diversion box.
241-ER-151*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with diversion box.
241-ER-151*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated equipment or tools associated with diversion box.
241-ER-151*	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-151*	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-151*	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-151*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-ER-151*	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No sumps associated with diversion box. See transfer line Table 7 for encasement discussion.
241-ER-151	Contamination in Pit or Box	Nozzle Pit	Residual*	15,750 gal (6' x 27' x 13') [H-2-2338/47]	NA	Residue*	NA	No	NA	*Diversion box contents drain to catch Tank-241-ER-311. Diversion box transports flush water mixed with waste from SY farm, B plant, and B farm. [WHC-SD-WM-EV-040, Rev. 1]

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-ER-151	Contamination in Pit or Box	Pipe Pit	Residual*	14,300 gal (28'-10" x 9'-6" x 7') [H-2-43042]	NA	Residue*	NA	No	NA	*Diversion box contents drain to catch Tank 241-ER-311. Diversion box transports flush water mixed with waste from SY farm, B plant, and B farm. [WHC-SD-WM-EV-040, Rev. 1]
241-ER-151	Contamination in Pit or Box	Jumper Storage Pit	Residual*	6600 gal (6' x 11'-4.5" x 13') [H-2-2338/47]	NA	Residue*	NA	No	NA	*Diversion box contents drain to catch Tank 241-ER-311. Diversion box transports flush water mixed with waste from SY farm, B plant, and B farm. [WHC-SD-WM-EV-040, Rev. 1]
241-ER-151*	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-151*	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-152*	Tank Contents	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.
241-ER-152*	Tank Headspace	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.
241-ER-152*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with diversion box.
241-ER-152*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with diversion box.
241-ER-152*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated tools or equipment associated with diversion box.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-ER-152*	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-152*	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-152*	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-152	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-ER-152	Contents of Sump or Encasement	Diversion box sump	Residual contamination*	25 gal (18" x 18" x 18") [H-2-37965]	NA	Residue*	NA	No	NA	*Diversion box drains to 241-ER-311 catch tank. See transfer line Table 7 for encasement discussion.
241-ER-152	Contamination in Pit or Box	Diversion box	Residual contamination*	9850 gal (10' x 10' x 13'-2") [H-2-37965]	NA	Residue*	NA	No	NA	*Diversion box drains to 241-ER-311 catch tank. Diversion box transports flush water mixed with wastes from SY farm, B plant, and B farm. [WHC-SD-WM-EV-040, Rev. 1]
241-ER-152*	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-152*	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-153*	Tank Contents	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.
241-ER-153*	Tank Headspace	NA	NA	NA	NA	NA	NA	NA	NA	No tanks within the diversion box.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-ER-153*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with diversion box.
241-ER-153*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with diversion box.
241-ER-153*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated tools or equipment associated with diversion box.
241-ER-153*	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-153*	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-153*	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with diversion box.
241-ER-153	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-ER-153	Contents of Sump or Encasement	Diversion box sump	Residual contamination*	25 gal (18" x 18" x 18") [H-2-37966]	NA	Residue*	NA	No	NA	Diversion box drains to 244-A lift station. Diversion box transfers flush water and leaks from SY farm, B plant, B farm, and C farm [WHC-SD-WM-EV-040, Rev. 1]. See transfer line Table 7 for encasement discussion.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-ER-153	Contamination in Pit or Box	Diversion box	Residual contamination*	11,400 gal (13' x 13' x 9') [H-2-37966]	NA	Residue*	NA	No	NA	*Diversion box drains to 244-A lift station. Diversion box transfers flush water and leaks from SY farm, B plant, B farm, and C farm [WHC-SD-WM-EV-040, Rev. 1].
241-ER-153*	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-153*	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-311A	Tank Contents	241-ER-311	Process condensate and flush water from diversion box 241-ER-151 and 241-ER-152 (from B Plant and B tank farm) [WHC-SD-WM-EV-040, Rev. 1, WHC-EP-0182-93]*	22,000 gal (10' diameter x 37' long) [H-2-2537]	NA	Liquid	4911 gal [WHC-EP-0182-93]	No	NA	*Exact composition unknown
241-ER-311A	Tank Headspace	241-ER-311	NA	NA	NA	Vapor	NA	No	NA	No data available.
241-ER-311*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with catch tank.
241-ER-311*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles associated with catch tank.
241-ER-311*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated tools associated with catch tank.
241-ER-311*	Ventilation Filter Contents	None	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with catch tank.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-ER-311*	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with catch tank.
241-ER-311*	Contamination In Ventilation System	Seal loop	NA	NA	NA	NA	NA	NA	NA	No ventilation associated with catch tank.
241-ER-311*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-ER-311*	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No sump associated with catch tank. See transfer line study for encasement discussion.
241-ER-311	Contamination in Pit or Box	Pump pit	Residual contamination*	660 gal (5' diameter x 4'-6") [H-2-71643]	NA	Residue*	NA	No	NA	*Any liquid will drain to catch tank.
241-ER-311*	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
241-ER-311*	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-A-101	Tank Contents	A-101	DSSF	1 Mgal	Sludge Saltcake	Solid Solid	3 Kgal 950 Kgal - saltcake contains an estimated 390 Kgal of pumpable liquid.	No	NA	A-101 is a watch list tank (hydrogen/flammable gas, organics). A-101 will be pumped pending completion of the LANL Safety Assessment.
241-A-102	Tank Contents	A-102	DSSF	1 Mgal	Supernate Sludge Saltcake	Liquid Solid Solid	4 Kgal 15 Kgal 22 Kgal	No	NA	Interim stabilized.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-A-103	Tank Contents	A-103	DSSF	1 Mgal	Supernate Sludge	Liquid Solid	5 Kgal 366 Kgal	No	NA	Recommended to be added as a watchlist tank for hydrogen/flammable gas. Assumed leaker, interim stabilized.
241-A-104	Tank Contents	A-104	NCPLX	1 Mgal	Sludge	Solid	28 Kgal	No	NA	Assumed leaker, interim stabilized.
241-A-105	Tank Contents	A-105	NCPLX	1 Mgal	Sludge	Solid	19 Kgal	No	NA	Assumed leaker, interim stabilized.
241-A-106	Tank Contents	A-106	CP	1 Mgal	Sludge	Solid	125 Kgal	No	NA	Interim stabilized.
241-A-101	Tank Headspace	A-101	NA	NA	NA	Vapor	117 m^3, total NH_3 67 g	No	NA	NA
241-A-102	Tank Headspace	A-102	NA	NA	NA	Vapor	4629 m^3, no NH_3 present	No	NA	NA
241-A-103	Tank Headspace	A-103	NA	NA	NA	Vapor	3380 m^3, no NH_3 present	No	NA	NA
241-A-104	Tank Headspace	A-104	NA	NA	NA	Vapor	4678 m^3, no NH_3 present	No	NA	NA
241-A-105	Tank Headspace	A-105	NA	NA	NA	Vapor	4712 m^3, no NH_3 present	No	NA	NA
241-A-106	Tank Headspace	A-106	NA	NA	NA	Vapor	4311 m^3, no NH_3 present	No	NA	NA
241-A*	Rail or Truck Tanker Contents	NA	NA	NA	NA	NA	NA	NA	NA	There are no rails or truck tankers in A Farm.
241-A*	Contamination on Vehicle	NA	NA	NA	NA	NA	NA	NA	NA	There are no vehicles permanently stationed in A farm.
241-A*	Contamination on Equipment or Tools	NA	NA	NA	NA	NA	NA	NA	NA	There are no tools in A Farm at this time.
241-A*	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-A*	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	Single shell tanks have no annulus.
241-A*	Ventilation Filter Contents	Breather	NA	1 R/hr at six inches	NA	Particulate	<100 mR/hr.* WHC-SD-WM-EMP-031, Rev 2, summarizes the assay results of HEPA filters for the DCRT stack 296-A-25 for 244-A	Yes, filters disposed of in accord with EP-0063, Rev 4 (9/93)	NA	One breather per tank. Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area [rad survey report 221830, 5/2/96] SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs. Filters are tested annually for efficiency and replaced if they fail.
241-A-702	Contamination In Ventilation System	De-entrainer	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-A-702	Contamination In Ventilation System	Seal loop	Silicon based oil	<1 gallon	NA	Liquid	Residual	NA	NA	One seal loop per breather filter.
241-A*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	Refer to transfer line Table 7.
241-A*	Contents of Sump or Encasement	Warm water sump	Residual contamination	7.2 Kgal	NA	Residue	Unknown	No	1 sump	Drawing identifies as "warm water sump."
241-A-01A	Contamination in Pit or Box	Central pump pit A-101	Residual contamination	4.9 Kgal	NA	Residue	Unknown	No	1 central pump pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-A-01H	Contamination in Pit or Box	Distributor pit 01H	Residual contamination	1.3 Kgal	NA	Residue	Unknown	No	1 distributor pit	Distributor pit was to support future saltwell jet pumping of 241-A-101.
241-A-A	Contamination in Pit or Box	Valve pit A-A	Residual contamination	4.3 Kgal	NA	Residue	Unknown	No	1 valve pit	NA
241-A-B	Contamination in Pit or Box	Valve pit A-B	Residual contamination	4.3 Kgal	NA	Residue	Unknown	No	1 valve pit	NA
241-A-151	Contamination in Pit or Box	Diversion box A-151	Residual contamination	64.1 Kgal	NA	Residue	Unknown	No	1 diversion box	NA
241-A-152	Contamination in Pit or Box	Diversion box A-152	Residual contamination	78.9 Kgal	NA	Residue	Unknown	No	1 diversion box	NA
241-A-401	Contamination in Pit or Box	Diverter caisson A-401	Residual contamination	2.6 Kgal	NA	Residue	Unknown	No	1 caisson	NA
241-A-501	Contamination in Pit or Box	Control valve pit A-501	Residual contamination	See comment	NA	Residue	Unknown	No	1 valve pit	This is no pit or cover block, consists of a room w/ a door.
241-F-562	Contamination in Pit or Box	Valve pit F-562	Residual contamination	1.9 Kgal	NA	Residue	Unknown	No	1 valve pit	NA
241-A-COB	Contamination in Pit or Box	Clean-out boxes	Residual contamination	.08 Kgal	NA	Residue	Unknown	No	11 COBs	NA
241-AX-80	Contamination in Pit or Box	Service pit AX-80	Raw water	2.1 Kgal	NA	Residue	Unknown	No	1 service pit	NA
241-A-350	Contamination in Pit or Box	Lift station A-350 (catch tank)	Residual contamination	6.3 Kgal	NA	Residue	Unknown	No	1 lift station	NA
244-A	Contamination in Pit or Box	Lift station 244-A	Residual contamination	25 Kgal	NA	Residue	Unknown	No	1 lift station	NA
241-A*	Contamination in Pit or Box	Lift station (no ID)	Residual contamination	Unknown	NA	Residue	Unknown	No	1 lift station	This facility is located outside of the fence NE of A Farm.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-A-302-A	Contamination in Pit or Box	Catch Tank A-302-A	Residual contamination	7.9 Kgal	NA	Residue	Unknown	No	1 catch tank	NA
241-A-417	Contamination in Pit or Box	Catch Tank A-417	Residual contamination	48.5 Kgal	NA	Residue	Unknown	No	1 catch tank	NA
241-F-505	Contamination in Pit or Box	Diverter caisson F505	Residual contamination	.68 Kgal	NA	Residue	Unknown	No	1 caisson	This facility is located outside of the fence NE of A farm.
216-A-08	Contamination in Pit or Box	Crib, sample pit and weir pit 216-A-08	Residual contamination	Control structure #1: 9 Kgal, control structure #2: 19 Kgal, sampler pit #1: 3.8 Kgal, sampler pit #2: 8 Kgal	NA	Residue	Unknown	No	1 crib, 2 control structures, 2 sampler pits	Facilities are associated with crib 216-A-08. The crib of this facility received 1,150 M liters of condensate and cooling water from 241-A, AX, AY and AZ farms, and 241-A-431. This facility is located outside of the fence NE of A farm.
241-F-561	Contamination in Pit or Box	Raw water valve pit F-561 (part of 216-A-08)	Raw water	2.4 Kgal	NA	Residue	Unknown	No	1 RW pit	This facility is located outside of the fence NE of A farm.
216-A-28	Contamination in Pit or Box	Crib 216-A-28	Residual contamination	NA	NA	Residue	Unknown	No	1 crib	This crib received 30 K liters of liquid waste from enclosure sumps and heating coil condensate from 231-A. The waste is low salt and neutral/basic. This crib is located SW of A farm.
216-A-30	Contamination in Pit or Box	Crib 216-A-30	Residual contamination	NA	NA	Residue	Unknown	No	1 crib	This crib received 7,110 M liters of steam condensate, floor drainage, and storage basin overflow waste from 202-A. This crib is located SE of A Farm.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
216-A-36A	Contamination in Pit or Box	Crib 216-A-36A	Residual contamination	NA	NA	Residue	Unknown	No	1 crib	This crib received 1,070 K liters of ammonia scrubber waste from 202-A. The waste is low salt and neutral/basic. This crib is located SW of A Farm.
216-A-36B	Contamination in Pit or Box	Crib 216-A-36B	Residual contamination	NA	NA	Residue	Unknown	No	1 crib	This crib received 317 M liters of ammonia scrubber waste from 202-A. The waste is low salt and neutral/basic. This crib is located SW of A Farm.
216-A-37-1	Contamination in Pit or Box	Crib 216-A-37-1	Residual contamination	NA	NA	Residue	Unknown	No	1 crib	This crib received 377 M liters of process condensate from 242-A. The condensate was determined to be mixed waste due to halogenated and nonhalogenated solvents and the toxicity of ammonia This crib is located SE of A farm.
216-A-37-2	Contamination in Pit or Box	Crib 216-37-2	Residual contamination	NA	NA	Residue	Unknown	No	1 crib	Crib permanently isolated by filling the distribution box with concrete. The site received steam condensate from PUREX.
216-A-45	Contamination in Pit or Box	Crib 216-A-45	Residual contamination	NA	NA	Residue	Unknown	No	1 crib	This crib received 103 M liters of process condensate from 202-A. This crib is located SW of A Farm.
244-A*	SARA 313 Materials	Change trailer for 244-A	10 % Methane/ 90% Argon	480 f3 / bottle	NA	Gas	NA	Yes	2 bottles	PCM1B support. The change trailer is located at the 244-A facility.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-A*	SARA 313 Materials	Fuel storage tank	Unknown	Unknown	NA	Unknown	Unknown	No	Unknown	This facility is located underground outside of the fence NE of A Farm.
241-A*	Other	Hazardous material storage	See comment	NA	See comment	Solid	Did not look in building as it was locked	Yes	Unknown	This facility is located outside of the fence NE of A farm, and is locked and controlled by HPTs.
241-A-401	Other	Condenser building A-401	Low level waste	NA	NA	Solid	Low level	No	Isolated old condenser s	This facility is located outside of the fence NE of A farm, and is locked and controlled by HPTs.
241-A*	Other	Contaminated burial boxes	Low level waste	NA	NA	Solid	Low level	Yes	2 boxes	NA
241-A-702	Other	Ventilation building 241-A-702	Low level waste	NA	NA	Residue	Low level	No	1 building	NA
241-A*	Other	Leak detection lateral buildings 103A, 105A, 106A	Low level waste	NA	NA	Residue	Low level	No	3 buildings	NA
241-A*	Other	Ion exchange facility	Low level waste	NA	NA	Residue	Low level	No	1 facility	Inactive.
241-A-831	Other	Old ventilation storage building A-831	Low level waste	NA	NA	Residue	Low level	No	1 building	NA
A Satellite Accumulatio n Area	Other	Satellite accumulation area for 244-A	RCRA mixed waste	6 - 55 gallon mixed waste drums (maximum)	Soil, HEPA filters, misc. RMW wastes	Solid	Low level (less than class C)	Yes	6-55 gal drums max capacity	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-A*	Other	Oil	Compressor oil	2 quarts	NA	Liquid	2 quarts	Yes	1 container	Located in compressor building.
241-A*	Other	Heavy duty antifreeze	For compressors	55 gallon drum	NA	Liquid	55 gal drum	Yes	1 drum	Located in compressor building.
241-AN-101	Tank Contents	AN-101	DN	1.16 Mgal	Supernate	Liquid	1080 Kgal	No	NA	AN-101 will be pumped to 105-AP.
241-AN-102	Tank Contents	AN-102	CC	1.16 Mgal	Supernate Solid	Liquid Unknown	993 Kgal 89 Kgal	No	NA	NA
241-AN-103	Tank Contents	AN-103	DSS	1.16 Mgal	DSS	Liquid	955 Kgal	No	NA	NA
241-AN-104	Tank Contents	AN-104	DSSF	1.16 Mgal	Slurry	Liquid	1060 Kgal	No	NA	NA
241-AN-105	Tank Contents	AN-105	DSSF	1.16 Mgal	Slurry	Liquid	1128 Kgal	No	NA	NA
241-AN-106	Tank Contents	AN-106	DSSF	1.16 Mgal	Supernate Solid	Liquid Solid	400 Kgal 17 Kgal	No	NA	NA
241-AN-107	Tank Contents	AN-107	CC	1.16 Mgal	Supernate Solid	Liquid Solid	923 Kgal 134 Kgal	No	NA	NA
241-AN-101	Tank Headspace	AN-101	NA	NA	NA	Vapor	1235 m^3, no NH_3 present	No	NA	NA
241-AN-102	Tank Headspace	AN-102	NA	NA	NA	Vapor	1228 m^3, no NH_3 present	No	NA	NA
241-AN-103	Tank Headspace	AN-103	NA	NA	NA	Vapor	1708 m^3, no NH_3 present	No	NA	NA
241-AN-104	Tank Headspace	AN-104	NA	NA	NA	Vapor	1311 m^3, no NH_3 present	No	NA	NA
241-AN-105	Tank Headspace	AN-105	NA	NA	NA	Vapor	1053 m^3, no NH_3 present	No	NA	NA
241-AN-106	Tank Headspace	AN-106	NA	NA	NA	Vapor	3745 m^3, no NH_3 present	No	NA	NA
241-AN-107	Tank Headspace	AN-107	NA	NA	NA	Vapor	1322 m^3, no NH_3 present	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AN*	Rail or Truck Tanker Contents	NA	NA	NA	NA	NA	NA	NA	NA	There are no rails or trucks in AN Farm.
241-AN*	Contamination on Vehicle	NA	NA	NA	NA	NA	NA	NA	NA	There are no vehicles in AN Farm.
241-AN*	Contamination on Equipment or Tools	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-AN	Ventilation Filter Contents	Primary	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	<200 mR/hr WHC-SD-WM-EMP-031, Rev 2, summarizes the assay results of HEPA filters for the DCRT stack 296-A-29	Yes - disposal in accord w/ WHC-EP-0063-4 (9/93)	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufacturer's spec.
241-AN	Ventilation Filter Contents	Annulus	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	<200 mR/hr	Yes - disposal in accord w/ WHC-EP-0063-4 (9/93)	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufacturer's spec.
241-AN*	Ventilation Filter Contents	Breather	NA	NA	NA	NA	NA	NA	NA	There are no breathers on AN tanks.
241-AN	Contamination In Ventilation System	Demisters	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AN	Contamination In Ventilation System	Seal loop	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AN	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	Refer to transfer line Table 7.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AN	Contents of Sump or Encasement	NA	NA	NA	NA	NA	NA	NA	NA	Refer to transfer line Table 7.
241-AN-01A-07A	Contamination in Pit or Box	Central pump pits: AN 01A-07A	Residual contamination	3.8 K gal each	NA	Residue	Unknown	No	7 pits	NA
241-AN-01B-07B	Contamination in Pit or Box	Annulus pump pits: AN 01B 07B	Residual contamination	1.7 K gal each	NA	Residue	Unknown	No	7 pits	NA
241-AN-01C-07C	Contamination in Pit or Box	Leak detection pump pits: AN 01C-07C	Residual contamination	1.7 K gal each	NA	Residue	Unknown	No	7 pits	NA
241-AN-01D	Contamination in Pit or Box	Condensate pit AN 01D	Residual contamination	2.4 K gal each	NA	Residue	Unknown	No	2 pits	NA
241-AN-01E	Contamination in Pit or Box	Supernate receiver pit AN 01E	Residual contamination	1.4 K gal	NA	Residue	Unknown	No	1 pit	NA
241-AN	Contamination in Pit or Box	AN tank pit	Residual contamination	1.9 K gal	NA	Residue	Unknown	No	1 pits	Exists on drawing. Not found in the field.
241-AN-A	Contamination in Pit or Box	Valve pit AN-A	Residual contamination	5.4 K gal	NA	Residue	Unknown	No	1 valve pit	NA
241-AN-B	Contamination in Pit or Box	Valve pit AN-B	Residual contamination	5.4 K gal	NA	Residue	Unknown	No	1 valve pit	NA
241-AN-FP	Contamination in Pit or Box	Flush pit	Residual contamination	1 K gal	NA	Residue	Unknown	No	1 flush pit	NA
241-AN-273	Contamination in Pit or Box	Service pit	Raw Water	2.4 K gal	NA	Residue	No	No	1 service pit	NA
COB-AN-1	Contamination in Pit or Box	Clean out box AN-1	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA
COB-AN-2	Contamination in Pit or Box	Clean out box AN-2	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
COB-AN-3	Contamination in Pit or Box	Clean out box AN-3	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA
COB-AN-4	Contamination in Pit or Box	Clean out box AN-4	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA
COB-AN-5	Contamination in Pit or Box	Clean out box AN-5	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA
COB-AN-6	Contamination in Pit or Box	Clean out box AN-6	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA
COB-AN-7	Contamination in Pit or Box	Clean out box AN-7	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA
COB-AN-8	Contamination in Pit or Box	Clean out box AN-8	Residual contamination	.047 K gal each	NA	Residue	Unknown	No	9 COBs	NA
241-AN	Contamination in Pit or Box	Vent pits AN #1,2,3,4	Residual contamination	.6 K gal each	NA	Residue	Unknown	No	4 vent pits	NA
241-AN	Contamination in Pit or Box	Demister pit	Residual contamination	1.9 K gal	NA	Residue	Unknown	No	demister pit	NA
241-AN	SARA 313 Materials	Outside change trailer	10% methane/ 90% argon	480 f3	NA	Gas	NA	Yes	2 bottles	Bottles support PCM1B personnel rad monitor.
241-AN	Other	Caustic addition building and skid	See comment	1 unit	NA	NA	NA	NA	NA	No caustic present at this time.
AN Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	6 55gal mixed waste drums (maximum)	Soil, paint waste, tank contacted, mask cartridges, HEPA filters, misc. RMW wastes	Solid	Low level (less than class C)	Yes	6-55 gal drums max capacity for SAA	Inventories removed when filled, transported to 209-E 90 day storage facility.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AN	Other	Buildings	Low level waste	2 small buildings roped off for rad buffer area	SWPs, other low level waste	Solid	Low level	Yes	Did Not look in buildings as they were roped off	2 small buildings near change trailer.
241-AP-101	Tank Contents	241-AP-101	DSSF	1.16 Mgal	Supernate	Liquid	735 Kgal	No	NA	NA
241-AP-102	Tank Contents	241-AP-102	CP	1.16 Mgal	Supernate	Liquid	1098 Kgal	No	NA	NA
241-AP-103	Tank Contents	241-AP-103	DN	1.16 Mgal	Supernate	Liquid	25 Kgal	No	NA	NA
241-AP-104	Tank Contents	241-AP-104	DN	1.16 Mgal	Supernate	Liquid	1123 Kgal	No	NA	NA
241-AP-105	Tank Contents	241-AP-105	DSSF	1.16 Mgal	Sludge	Solid	155 Kgal	No	NA	NA
241-AP-106	Tank Contents	241-AP-106	DN	1.16 Mgal	Supernate	Liquid	107 Kgal	No	NA	NA
241-AP-107	Tank Contents	241-AP-107	DN	1.16 Mgal	Supernate	Liquid	25 Kgal	No	NA	NA
241-AP-108	Tank Contents	241-AP-108	DN	1.16 Mgal	Supernate	Liquid	29 Kgal	No	NA	NA
241-AP-101	Tank Headspace	241-AP-101	NA	NA	NA	Vapor	2533 cubic meters, no NH_3 present	No	NA	NA
241-AP-102	Tank Headspace	241-AP-102	NA	NA	NA	Vapor	1167 cubic meters, no NH_3 present	No	NA	NA
241-AP-103	Tank Headspace	241-AP-103	NA	NA	NA	Vapor	5228 cubic meters, no NH_3 present	No	NA	NA
241-AP-104	Tank Headspace	241-AP-104	NA	NA	NA	Vapor	2166 cubic meters, no NH_3 present	No	NA	NA
241-AP-105	Tank Headspace	241-AP-105	NA	NA	NA	Vapor	4740 cubic meters, no NH_3 present	No	NA	NA
241-AP-106	Tank Headspace	241-AP-106	NA	NA	NA	Vapor	4918 cubic meters, no NH_3 present	No	NA	NA
241-AP-107	Tank Headspace	241-AP-107	NA	NA	NA	Vapor	5228 cubic meters, no NH_3 present	No	NA	NA
241-AP-108	Tank Headspace	241-AP-108	NA	NA	NA	Vapor	5217 cubic meters, no NH_3 present	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AP*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers at AP location.
241-AP*	Contamination on Vehicle	Contaminated vehicles	Residual surface contamination on farm vehicles	Surface residual	Residual	NA	Unknown	NA	NA	Contaminated vehicle housed in storage area (outside of AP farm fence).
241-AP*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	Tool crib located in AP farm contained misc. small tools, no contamination detected on rad survey.
241-AP	Ventilation Filter Contents	Primary	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	Unknown	Yes - disposal in accord w/ WHC-EP-0063-4 (9/93)	NA	HEPA filters monitored for DP drop/loading in accordance w/manufacturers specs.
241-AP	Ventilation Filter Contents	Annulus	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	Unknown	Yes - Disposal in accord w/ WHC-EP-0063-4 (9/93)	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufactures specs.
241-AP*	Ventilation Filter Contents	Breather	NA	NA	NA	NA	NA	NA	NA	NA
241-AP*	Contamination In Ventilation System	De-entrainer	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AP*	Contamination In Ventilation System	Seal loop	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AP*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	Refer to transfer line Table 7.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AP-273	Contents of Sump Contents of Pipeline and/or Source Tank During Transfer	Service pit sump	Raw water	NA	NA	Liquid	NA	NA	NA	No standing water noted during site walkdown.
241-AP	Contamination in Pit or Box	Process pits	Residual contamination	NA	NA	Residue	Unknown	No	NA	No standing water noted.
241-AP-A	Contamination in Pit or Box	241 AP valve pit	Residual contamination	~21.5 K gal	NA	Residue	Unknown	No	1 central valve pit to AP	NA
241-AP-01A	Contamination in Pit or Box	Central pump pits 101	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pits total (1 pit per tank)	NA
241-AP-02A	Contamination in Pit or Box	Central pump pits 102	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pit total (1 pit per tank)	NA
241-AP-03A	Contamination in Pit or Box	Central pump pits 103	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pit total (1 pit per tank)	NA
241-AP-04A	Contamination in Pit or Box	Central pump pits 104	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pit total (1 pit per tank)	NA
241-AP-05A	Contamination in Pit or Box	Central pump pits 105	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pit total (1 pit per tank)	NA
241-AP-06A	Contamination in Pit or Box	Central pump pits 106	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pit total (1 pit per tank)	NA
241-AP-07A	Contamination in Pit or Box	Central pump pits 107	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pit total (1 pit per tank)	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AP-08A	Contamination in Pit or Box	Central pump pits 108	Residual contamination	~5.4 K gal	NA	Residue	Unknown	No	8 pit total (1 pit per tank)	NA
241-AP*	SARA 313 Materials	Flammable storage cabinet - compressor bldg.	NA	NA	NA	Liquids	Unknown	Yes	NA	Standard small quantity classified materials (paints, cleaning solvents).
241-AP*	SARA 313 Materials	Flammable storage cabinet - near change trailer	NA	NA	NA	Liquids	Unknown	Yes	NA	Standard small quantity classified materials (paints, cleaning solvents).
241-AP*	Other	Bottle storage area	Nitrogen	28 bottles (max)	NA	Gas	480 ft3	Yes	28 bottles	Bottle storage area located adjacent to AP instrument Bld.
241-AP*	Other	Bottle storage area	Hydrogen	3 bottles	NA	Gas	480 ft3	Yes	1 bottle	Bottle storage area located adjacent to AP instrument Bld.
241-AP*	Other	Bottle storage area	H2 / He Mix	14 bottles	NA	Gas	480 ft3	Yes	4 bottles	Bottle storage area located adjacent to AP instrument Bld.
241-AP*	Other	Bottle storage area	10% methane / 90% argon	14 bottles	NA	Gas	480 ft3	Yes	9 bottles	Bottle storage area located adjacent to AP instrument Bld.
241-AP*	Other	Outside change trailer	10% methane / 90% argon	2 bottles	NA	Gas	480 ft3	Yes	2 bottles	Bottles support PCM1B personnel rad monitor.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
AP Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed wastes	6- 55 gallon mixed waste drums (maximun)	Soil, paint waste, tank contacted, mask cartridges, HEPA filters, misc. RMW wastes	Solid	Low level (less than class C)	Yes	6-55 gal drums max capacity for each satellite enclosure	Inventories removed when filled, transported to 209-E 90 day storage facility.
241-AW-101	Tank Contents	241-AW-101	DSSF	1.16 Mgal	Supernate	Liquid	1043 kgal	No	NA	NA
241-AW-101	Tank Contents	241-AW-101	DSSF	NA	Saltcake	Solid	84 kgal	No	NA	NA
241-AW-102	Tank Contents	241-AW-102	DN	1.16 Mgal	Supernate	Liquid	39 kgal	No	NA	NA
241-AW-102	Tank Contents	241-AW-102	DN	NA	Saltcake	Solid	55 kgal	No	NA	NA
241-AW-103	Tank Contents	241-AW-103	DN/PD	1.16 Mgal	Supernate	Liquid	149 kgal	No	NA	NA
241-AW-103	Tank Contents	241-AW-103	DN/PD	NA	Saltcake	Solid	363 kgal	No	NA	NA
241-AW-104	Tank Contents	241-AW-104	DN	1.16 Mgal	Supernate	Liquid	834 kgal	No	NA	NA
241-AW-104	Tank Contents	241-AW-104	DN	NA	Saltcake	Solid	290 kgal	No	NA	NA
241-AW-105	Tank Contents	241-AW-105	DN/PD	1.16 Mgal	Supernate	Liquid	136 kgal	No	NA	NA
241-AW-105	Tank Contents	241-AW-105	DN/PD	NA	Saltcake	Solid	260 kgal	No	NA	NA
241-AW-106	Tank Contents	241-AW-106	DN	1.16 Mgal	Supernate	Liquid	308 kgal	No	NA	NA
241-AW-106	Tank Contents	241-AW-106	DN	NA	Saltcake	Solid	228 kgal	No	NA	NA
241-AW-101	Tank Headspace	241-AW-101	NA	NA	NA	Vapor	1057 m^3, no NH_3 present	No	NA	NA
241-AW-102	Tank Headspace	241-AW-102	NA	NA	NA	Vapor	4963 m^3, no NH_3 present	No	NA	NA
241-AW-103	Tank Headspace	241-AW-103	NA	NA	NA	Vapor	3377 m^3, no NH_3 present	No	NA	NA
241-AW-104	Tank Headspace	241-AW-104	NA	NA	NA	Vapor	1069 m^3, no NH_3 present	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AW-105	Tank Headspace	241-AW-105	NA	NA	NA	Vapor	3911 m^3, no NH_3 present	No	NA	NA
241-AW-106	Tank Headspace	241-AW-106	NA	NA	NA	Vapor	3290 m^3, no NH_3 present - see radionuclide concentrations Note 1	No	NA	NA
241-AW*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AW*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	Contaminated vehicle staging area present - no vehicles noted.
241-AW*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AW	Ventilation Filter Contents	Primary	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	Yes - disposal in accord w/ WHC-EP-0063-4 (9/93)	Yes	NA	HEPA filters monitored for DP drop/loading.
241-AW	Ventilation Filter Contents	Annulus	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	Yes - disposal in accord w/ WHC-EP-0063-4 (9/93)	Yes	NA	HEPA filters monitored for DP drop/loading.
241-AW	Ventilation Filter Contents	Breather	NA	NA	NA	NA	NA	NA	NA	NA
241-AW	Contamination In Ventilation System	De-entrainer	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AW	Contamination In Ventilation System	Seal loop	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AW	Contents of Pipeline and/or Source Tank During Transfer	None	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AW	Contents of Sump	NA	NA	NA	NA	NA	NA	NA	NA	There are no sumps in AW Farm.
241-AW-01B-06B	Contamination in Pit or Box	Annulus pump pits 01B-06B	Residual contamination	1.5 Kgal	NA	Residue	Unknown	No	6 pits	NA
241-AW-01B	Contamination in Pit or Box	Annulus pump pit 01B	Residual contamination	1.5 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-02B	Contamination in Pit or Box	Annulus pump pit 02B	Residual contamination	1.5 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-03B	Contamination in Pit or Box	Annulus pump pit 03B	Residual contamination	1.5 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-04B	Contamination in Pit or Box	Annulus pump pit 04B	Residual contamination	1.5 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-05B	Contamination in Pit or Box	Annulus pump pit 05B	Residual contamination	1.5 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-06B	Contamination in Pit or Box	Annulus pump pit 06B	Residual contamination	1.5 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-01A-06A	Contamination in Pit or Box	Central pump pits 01A-06A	Residual contamination	3.7 Kgal	NA	Residue	Unknown	No	6 pits	NA
241-AW-01A	Contamination in Pit or Box	Central pump pit 01A	Residual contamination	3.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-02A	Contamination in Pit or Box	Central pump pit 02A	Residual contamination	3.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-03A	Contamination in Pit or Box	Central pump pit 03A	Residual contamination	3.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-04A	Contamination in Pit or Box	Central pump pit 04A	Residual contamination	3.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-05A	Contamination in Pit or Box	Central pump pit 05A	Residual contamination	3.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-06A	Contamination in Pit or Box	Central pump pit 06A	Residual contamination	3.7 Kgal	NA	Residue	Unknown	No	1 pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AW-01C-06C	Contamination in Pit or Box	Leak detection pump pits 01C-06C	Residual contamination	1.7 Kgal	NA	Residue	Unknown	No	6 pits	NA
241-AW-01C	Contamination in Pit or Box	Leak detection pump pit 01C	Residual contamination	1.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-02C	Contamination in Pit or Box	Leak detection pump pit 02C	Residual contamination	1.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-03C	Contamination in Pit or Box	Leak detection pump pit 03C	Residual contamination	1.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-04C	Contamination in Pit or Box	Leak detection pump pit 04C	Residual contamination	1.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-05C	Contamination in Pit or Box	Leak detection pump pit 05C	Residual contamination	1.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-06C	Contamination in Pit or Box	Leak detection pump pit 06C	Residual contamination	1.7 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-02D	Contamination in Pit or Box	Drain pit 02D	Residual contamination	7.1 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-A	Contamination in Pit or Box	Valve pit AW-A	Residual contamination	4.4 Kgal	NA	Residue	Unknown	No	1 pits	NA
241-AW-B	Contamination in Pit or Box	Valve pit AW-B	Residual contamination	4.4 Kgal	NA	Residue	Unknown	No	1 pits	NA
241-AW-K1	Contamination in Pit or Box	Primary seal pot pit AW K1	Residual contamination	.06 Kgal	NA	Residue	Unknown	No	1 pit	NA
241-AW-K2	Contamination in Pit or Box	Annulus seal pot pit AW K2	Residual contamination	Unknown	NA	Residue	Unknown	No	1 pits	NA
241-AW-02E	Contamination in Pit or Box	Feed pump pit 02E	Residual contamination	3 Kgal	NA	Residue	Unknown	No	1 pits	NA
241-AW-VIP	Contamination in Pit or Box	Ventilation instrument pits VIP-1,2,3	Residual contamination	5.2 Kgal	NA	Residue	Unknown	No	3 pits	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AW-FP	Contamination in Pit or Box	Flush pit	Residual contamination	.8 Kgal	NA	Residue	Unknown	No	1 pit	NA
COB-AW-1-12	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-01	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-02	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-03	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-04	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-05	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-06	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-07	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-08	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-09	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
COB-AW-10	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-11	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
COB-AW-12	Contamination in Pit or Box	Clean out boxes AW 9, 10	Residual contamination	.047 Kgal	NA	Residue	Unknown	No	2 COBs	NA
241-AW*	SARA 313 Materials	Cylinder	90% argon / 10% methane	480 ft3	NA	Gas mixture	480 ft3	Yes	2 bottles	For PCM1B.
241-AW*	Other	Service building	Raw water	NA	NA	Residue	NA	No	NA	NA
241-AW*	Other	Change trailer	Low level waste	NA	SWPs, other low level waste	Solid	Low level	Yes	NA	Controlled by HPTs.
241-AW*	Other	Operations support facility 272-AW	See comment	See comment	See comment	See comment	See comment	See comment	See comment	For maintenance shop materials refer to the "Hazardous Materials Inventory Database," 1/10/96.
241-AW*	Other	Acid sewer manhole	See comment	See comment	See comment	See comment	See comment	See comment	See comment	The acid sewer manhole is located outside of the AW Farm. It is now isolated, and was used for access to the PUREX chemical sewer.
AW Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	6 - 55 gallon mixed waste drums (maximum)	Soil, tank contacted, HEPA filters, misc. RMW wastes	Solid	Low Level (less than class C)	Yes	6 - 55 gal. drums max capacity	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AX-101	Tank Contents	AX-101	DSSF	1.0 Mgal	Sludge Saltcake	Solid Solid	3 Kgal 745 Kgal - saltcake contains an estimated 298 Kgal of pumpable liquid.	No	NA	AX-101 is a watch list tank (hydrogen/flammable gas). AX-101 will be pumped.
241-AX-102	Tank Contents	AX-102	CC	1.0 Mgal	Supernate Sludge Saltcake	Liquid Solid Solid	3 Kgal 7 Kgal 29 Kgal	No	NA	AX-102 is a watch list tank (organics). Tank is interim stabilized, assumed leaker.
241-AX-103	Tank Contents	AX-103	CC	1.0 Mgal	Sludge Saltcake	Solid Solid	2 Kgal 110 Kgal	No	NA	AX-103 is a watch list tank (hydrogen/flammable gas). Tank is interim stabilized.
241-AX-104	Tank Contents	AX-104	NCPLX	1.0 Mgal	Sludge	Solid	7 Kgal	No	NA	Tank is interim stabilized, assumed leaker.
241-AX-101	Tank Headspace	AX-101	NA	NA	NA	Vapor	1953 m^3, total NH_3 67 g	NA	NA	NA
241-AX-102	Tank Headspace	AX-102	NA	NA	NA	Vapor	1953 m^3, total NH_3 120 g	NA	NA	NA
241-AX-103	Tank Headspace	AX-103	NA	NA	NA	Vapor	1953 m^3, total NH_3 140 g	NA	NA	NA
241-AX-104	Tank Headspace	AX-104	NA	NA	NA	Vapor	1953 m^3, no NH_3 present	NA	NA	NA
241-AX*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AX*	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AX*	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AX*	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AX*	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA
241-AX*	Ventilation Filter Contents	Breather	NA	1 R/hr at six inches	NA	Particulate	<100 mR/hr *	Yes, filters disposed of in accord w/ EP-0063, Rev 4 (9/93)	NA	* Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area [rad survey report 221830, 5/2/96] SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs. Filters are tested annually for efficiency and replace if they fail.
241-AX*	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	AX Farm has no ventilation system. It is served by Tank Farm A.
241-AX*	Contamination In Ventilation System	Seal loop	Silicon based oil	<1 gallon	NA	Liquid	Residual	No	1 per breather (total 4)	NA
241-AX*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	Refer to transfer line Table 7.
241-AX*	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AX*	Contamination in Pit or Box	Primary seal pot pit	Residual contamination	.1 K gal	NA	Residue	Unknown	No	1 seal pot pit	NA
241-AX*	Contamination in Pit or Box	Distributor pit	Residual contamination	2.5 K gal	NA	Residue	Unknown	No	1 distributor pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AX*	Contamination in Pit or Box	Leak detection pit (4)	Residual contamination	.9 K gal each	NA	Residue	Unknown	No	4 leak detection pits	NA
241-AX*	Contamination in Pit or Box	Dry wells	NA	NA	NA	NA	<100 mR/hr	No	29 dry wells	NA
241-AX*	Contamination in Pit or Box	Drain pit	Unknown	Unknown	NA	Unknown	Unknown	No	1 drain pit	NA
241-AX-151	Contamination in Pit or Box	Diverter station AX-151	Residual contamination	31.9 K gal	NA	Residue	Unknown	No	1 diverter station	NA
241-AX-152	Contamination in Pit or Box	Diverter station and catch Tank AX-152	Residual contamination	21.2 K gal	NA	Residue	Unknown	No	1 diverter station	NA
241-AX	Contamination in Pit or Box	Valve pit for diverter	Residual contamination	.6 K gal	NA	Residue	Unknown	No	1 valve pit	NA
241-AX-153	Contamination in Pit or Box	Isolation jumper pit AX-153	Residual contamination	1.5 K gal	NA	Residue	Unknown	No	1 isolation jumper pit	NA
241-AX-155	Contamination in Pit or Box	Diversion box AX-155	Residual contamination	3.3 K gal	NA	Residue	Unknown	No	1 diversion box	NA
241-AX-501	Contamination in Pit or Box	Valve pit AX-501	Residual contamination	1.1 K gal	NA	Residue	Unknown	No	1 valve pit	NA
241-AX-VP	Contamination in Pit or Box	Valve pit	Residual contamination	3.2 K gal	NA	Residue	Unknown	No	1 valve pit	NA
241-AX-A	Contamination in Pit or Box	Valve pit AX-A	Residual contamination	4.3 K gal each	NA	Residue	Unknown	No	1 valve pit	NA
241-AX-B	Contamination in Pit or Box	Valve pit AX-B	Residual contamination	4.3 K gal each	NA	Residue	Unknown	No	1 valve pit	NA
241-AX-SP	Contamination in Pit or Box	Service pit	Raw water	.62 K gal	NA	Liquid	NA	No	1 service pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AX-A	Contamination in Pit or Box	Flush pit (2)	Raw water	.82 K gal	NA	Liquid	NA	No	1 flush pit	NA
241-AX-B	Contamination in Pit or Box	Flush pit	Raw water	.82 K gal	NA	Liquid	NA	No	1 flush pit	NA
241-AX-COB	Contamination in Pit or Box	Cleanout boxes	Residual contamination	.07 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AX*	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
AX Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	Six 55 gal mixed waste drums	Soil, tank contacted, HEPA filters, misc. RMW wastes	Solid	Low level (less than class C)	Yes	Six 55 gal drums max capacity	Inventories removed when filled, transported to 209-E 90 day storage facility. This SAA serves A, AX, AY and AZ farms, and is located in AY Farm.
241-AY-101	Tank Contents	AY-101	DC	1.16 Mgal	Supernate Solid	Liquid Solid	850 Kgal 83 Kgal	No	NA	NA
241-AY-102	Tank Contents	AY-102	DN	1.16 M gal	Supernate Solid	Liquid Solid	694 Kgal 32 Kgal	No	NA	NA
241-AY-101	Tank Headspace	AY-101	NA	NA	NA	Vapor	1780 m^3, no NH_3 present	No	NA	NA
241-AY-102	Tank Headspace	AY-102	NA	NA	NA	Vapor	1572 m^3, no NH_3 present	No	NA	NA
241-AY*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AY*	Contamination on Vehicle	Construction equipment (trucks, crane)	Residual contamination	NA	NA	Residue	Unknown	Yes	Varies with construct activities	Construction for new ventilation facilities for AY and AZ Farms.
241-AY*	Contamination on Equipment or Tools	Construction tools	Residual contamination	NA	NA	Residue	Unknown	Yes	Varies with construct activities	Construction for new ventilation facilities for AY and AZ Farms.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AY*	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA
241-AY*	Ventilation Filter Contents	Annulus	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	200 mR/hr maximum WHC-SD-WM-EMP-031, Rev 2, summarizes the assay results of HEPA filters for stack 296-A-17.	Yes - disposed in accord w/ WHC-EP-0063-4 (9/93)	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufacturer's specs.
241-AY*	Ventilation Filter Contents	Breather	NA	NA	NA	NA	NA	NA	NA	NA
241-AY*	Contamination In Ventilation System	De-entrainer	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AY*	Contamination In Ventilation System	Seal loop	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AY*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	Refer to transfer line Table 7.
241-AY*	Contents of Sump or Encasement	Encasement: From 101-AY to 102-AY	Residual contamination	1.2 K gal	NA	Residue	Unknown	No	NA	Volume calculations represent available area in pipe encasements.
241-AY*	Contents of Sump or Encasement	Encasement: Between tanks to 241-AX-152 diversion box	Residual contamination	9.9 K gal	NA	Residue	Unknown	No	NA	Volume calculations represent available area in pipe encasements.
241-AY-01A	Contamination in Pit or Box	Pump pit 01A	Residual contamination	3.6 K gal	NA	Residue	Unknown	No	1 pump pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AY-01F	Contamination in Pit or Box	Annulus pumpout pit 01F	Residual contamination	1.6 K gal	NA	Residue	Unknown	No	1 pumpout pit	NA
241-AY-01B-E	Contamination in Pit or Box	Sluice pits 01B,C,D,E	Residual contamination	2.5 K gal each	NA	Residue	Unknown	No	4 sluice pits	NA
241-AY*	Contamination in Pit or Box	Leak detection pit	Residual contamination	3.1 K gal	NA	Residue	Unknown	No	1 leak det. pit includes: lk det well, lk det pit, rad det well, rad dry well	NA
241-AY*	Contamination in Pit or Box	Encasement leak detection pit	Residual contamination	3.1 K gal	NA	Residue	Unknown	No	1 enc pit includes: lk det pit, enc drain well, rad det well	Volume calculations represent available area in pipe encasements.
241-AY*	Contamination in Pit or Box	Encasement on N side of tank	Residual contamination	26.7 K gal	NA	Residue	Unknown	No	1 encasement	Volume calculations represent available area in pipe encasements.
241-AY-02A	Contamination in Pit or Box	Pump pit 02A	Residual contamination	3.6 K gal	NA	Residue	Unknown	No	1 pump pit	NA
241-AY*	Contamination in Pit or Box	Annulus pumpout pit	Residual contamination	9.6 K gal	NA	Residue	Unknown	No	1 pumpout pit	NA
241-AY-02B-E	Contamination in Pit or Box	Sluice pits 02B,C,D,E	Residual contamination	2.5 K gal each	NA	Residue	Unknown	No	4 sluice pits	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AY*	Contamination in Pit or Box	Leak detection pit	Residual contamination	3 K gal	NA	Residue	Unknown	No	1 leak det pit includes: lk det well, lk det pit, rad dry well, rad det well	NA
241-AY*	Contamination in Pit or Box	Encasement S side of tank	Residual contamination	.3 K gal	NA	Residue	Unknown	No	1 encasement	NA
241-AY-501	Contamination in Pit or Box	Condensate valve pit AY-501	Residual contamination	4 K gal	NA	Residue	Unknown	No	1 valve pit	NA
241-AY-151	Contamination in Pit or Box	Pumpout pit AY-151	Residual contamination	1.3 K gal	NA	Residue	Unknown	No	1 pumpout pit	NA
241-AY-152	Contamination in Pit or Box	Transfer box AY-152	Residual contamination	4.9 K gal	NA	Residue	Unknown	No	1 transfer box	NA
241-AY*	Contamination in Pit or Box	Raw water pits	Residual contamination	2 @ 1.2 K gal each; 8 @ .2 K gal each; 1 @ .6 K gal	NA	Residue	Unknown	No	11 Raw water pits	NA
241-AY*	Contamination in Pit or Box	Condensate drain valve pit	Residual contamination	.1 K gal	NA	Residue	Unknown	No	1 cond dr pit	NA
241-AY-1	Contamination in Pit or Box	Cleanout box AY-1	Residual contamination	.07 K gal	NA	Residue	Unknown	No	1 COB	NA
241-AY*	SARA 313 Materials	Outside change trailer (2)	10 % methane/ 90% argon	480 f3 / bottle	NA	Gas	NA	Yes	2 bottles each trailer	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AY*	SARA 313 Materials	See comment	NA	NA	NA	NA	NA	NA	NA	Major amount of construction materials for new vent modifications.
AY Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	6 - 55 gallon mixed waste drums (maximum)	Soil, tank contacted, HEPA filters, misc. RMW wastes	Solid	Low level (less than class C)	Yes	6- 55 gal drums max capacity	NA
241-AY	Other	Sheds (3)	Misc. low level waste	NA	SWPs	Solid	Low level	Yes	Approx. 3 bags per shed	NA
241-AZ-101	Tank Contents	AZ-101	Aging	1.16 Mgal	Supernate Solid	Liquid Solid	882 Kgal 35 Kgal	No	NA	NA
241-AZ-102	Tank Contents	AZ-102	Aging	1.16 Mgal	Supernate Solid	Liquid Solid	859 Kgal 95 Kgal	No	NA	NA
241-AZ-101	Tank Headspace	AZ-101	NA	NA	NA	Vapor	1826 m^3, no NH_3 present	No	NA	NA
241-AZ-102	Tank Headspace	AZ-102	NA	NA	NA	Vapor	1704 m^3, no NH_3 present	No	NA	NA
241-AZ*	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-AZ*	Contamination on Vehicle	Construction equipment (trucks, crane)	Residual contamination	NA	NA	Residue	Unknown	Yes	Varies with construct activities	Construction for new ventilation and recirculation facilities for AY and AZ.
241-AZ*	Contamination on Equipment or Tools	Construction tools	Residual contamination	NA	NA	Residue	Unknown	Yes	Varies with construct activities	Construction for new ventilation and recirculation facilities for AY and AZ Farms.
241-AZ*	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AZ*	Ventilation Filter Contents	Annulus	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	200 mR/hr maximum	Yes - disposed in accord w/ WHC-EP-0063-4 (9/93)	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufacturer's specs.
241-AZ*	Ventilation Filter Contents	Breather	NA	NA	NA	NA	NA	NA	NA	NA
241-AZ*	Contamination In Ventilation System	De-entrainer	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AZ*	Contamination In Ventilation System	Seal loop	Process condensate	NA	NA	Liquid	Residual	NA	NA	NA
241-AZ*	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	Refer to transfer line Table 7.
241-AZ*	Contents of Sump or Encasement	North encasement	Residual contamination	.12 K gal	NA	Residue	Unknown	No	NA	Volume calculations represent available area in pipe encasements.
241-AZ*	Contents of Sump or Encasement	South encasement	Residual contamination	5.1 K gal	NA	Residue	Unknown	No	NA	Volume calculations represent available area in pipe encasements.
241-AZ*	Contents of Sump or Encasement	West encasement to sluice transfer box	Residual contamination	6.8 K gal	NA	Residue	Unknown	No	NA	Volume calculations represent available area in pipe encasements.
241-AZ*	Contents of Sump or Encasement	Encasement between AZ-151 and AZ-152	Residual contamination	2 K gal	NA	Residue	Unknown	No	NA	Volume calculations represent available area in pipe encasements.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AZ*	Contents of Sump or Encasement	Sluice transfer box encasement	Residual contamination	4.8 K gal	NA	Residue	Unknown	No	NA	Volume calculations represent available area in pipe encasements.
241-AZ*	Contamination in Pit or Box	AZ-101								
241-AZ-01A	Contamination in Pit or Box	Pump pit 01A	Residual contamination	3.4 K gal	NA	Residue	Unknown	No	1 pump pit	NA
241-AZ-01F	Contamination in Pit or Box	Annulus pumpout pit 01F	Residual contamination	1.6 K gal	NA	Residue	Unknown	No	1 annulus pumpout pit	NA
241-AZ-01B-C	Contamination in Pit or Box	Sluice pits 01B,C	Residual contamination	2.9 K gal each	NA	Residue	Unknown	No	2 sluice pits	NA
241-AZ-01B	Contamination in Pit or Box	Sluice pit 01B	Residual contamination	2.9 K gal each	NA	Residue	Unknown	No	1 sluice pit	NA
241-AZ-01C	Contamination in Pit or Box	Sluice pit 01C	Residual contamination	2.9 K gal each	NA	Residue	Unknown	No	1 sluice pit	NA
241-AZ	Contamination in Pit or Box	Leak detection pit	Residual contamination	3 K gal	NA	Residue	Unknown	No	1 leak det. pit includes: lk det well, lk det pit, rad det well, rad dry well	NA
241-AZ	Contamination in Pit or Box	Raw water valve pit	Raw water	1.3 K gal	NA	Residue	No	No	1 raw water valve pit	NA
241-AZ-153	Contamination in Pit or Box	Vent valve pit	Residual contamination	.8 K gal	NA	Residue	Unknown	No	1 vent valve pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AZ	Contamination in Pit or Box	Sluice raw water pit	Raw water	.2 K gal	NA	Residue	No	No	1 sluice raw water valve pit	NA
241-AZ	Contamination in Pit or Box	AZ-102								
241-AZ-02A	Contamination in Pit or Box	Pump pit 02A	Residual contamination	3.4 K gal	NA	Residue	Unknown	No	1 pump pit	NA
241-AZ-02F	Contamination in Pit or Box	Annulus pumpout pit 02F	Residual contamination	1.6 K gal	NA	Residue	Unknown	No	1 pumpout pit	NA
241-AZ-02B-C	Contamination in Pit or Box	Sluice pits 02B,C	Residual contamination	2.8 K gal each	NA	Residue	Unknown	No	2 sluice pits	NA
241-AZ-02B	Contamination in Pit or Box	Sluice pit 02B	Residual contamination	2.8 K gal each	NA	Residue	Unknown	No	1 sluice pit	NA
241-AZ-02C	Contamination in Pit or Box	Sluice pit 02C	Residual contamination	2.8 K gal each	NA	Residue	Unknown	No	1 sluice pit	NA
241-AZ	Contamination in Pit or Box	Leak detection pit	Residual contamination	1.9 K gal	NA	Residue	Unknown	No	1 leak det pit includes: lk det well, lk det pit, rad dry well, rad det well	NA
241-AZ	Contamination in Pit or Box	Encasement leak detection pit	Residual contamination	2.8 K gal	NA	Residue	Unknown	No	1 encasement	NA
241-AZ	Contamination in Pit or Box	Raw water valve pit	Raw water	1.3 K gal	NA	Residue	No	No	1 raw water valve pit	NA
241-AZ-562	Contamination in Pit or Box	Vent valve pit	Residual contamination	.8 K gal	NA	Residue	Unknown	No	1 vent valve pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AZ	Contamination in Pit or Box	Sluice raw water pit	Raw water	.2 K gal	NA	Residue	No	No	1 sluice raw water valve pit	NA
241-AZ	Contamination in Pit or Box	Other pits								
COB-AZ-1-10	Contamination in Pit or Box	Cleanout boxes AZ1-10	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-1	Contamination in Pit or Box	Cleanout box AZ1	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-2	Contamination in Pit or Box	Cleanout box AZ2	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-3	Contamination in Pit or Box	Cleanout box AZ3	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-4	Contamination in Pit or Box	Cleanout box AZ4	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-5	Contamination in Pit or Box	Cleanout box AZ5	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-6	Contamination in Pit or Box	Cleanout box AZ6	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-7	Contamination in Pit or Box	Cleanout box AZ7	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-8	Contamination in Pit or Box	Cleanout box AZ8	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-9	Contamination in Pit or Box	Cleanout box AZ9	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-10	Contamination in Pit or Box	Cleanout box AZ10	Residual contamination	.06 K gal each	NA	Residue	Unknown	No	10 COBs	NA
241-AZ-161	Contamination in Pit or Box	Airlift circulator 601 caisson AZ-161	NA	8.9 K gal	NA	None	NA	NA	1 caisson	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-AZ-162	Contamination in Pit or Box	Airlift circulator 602 caisson AZ-162	NA	7.3 K gal	NA	None	NA	NA	1 caisson	NA
241-AZ-152	Contamination in Pit or Box	Sluice transfer box AZ-152	Residual contamination	7.5 K gal	NA	Residue	Unknown	No	1 sluice transfer box	NA
241-AZ-155	Contamination in Pit or Box	Contaminated equipment storage pit AZ-155	Residual contamination	53.7 K gal	NA	Residue	Unknown	No	1 storage pit	NA
241-AZ-151	Contamination in Pit or Box	Catch tank pit AZ-151	Residual contamination	2.9 K gal	NA	Residue	Unknown	No	1 catch tank pit	NA
241-AZ-154	Contamination in Pit or Box	Condensate pump pit AZ-154	Residual contamination	2.3 K gal	NA	Residue	Unknown	No	1 con. pump pit	NA
241-AZ*	Contamination in Pit or Box	Steam trap	Residual contamination	1.5 K gal	NA	Residue	Unknown	No	1 steam trap	Steam has been isolated to the facility.
241-AZ*	Contamination in Pit or Box	Condensate valve caisson	Residual contamination	.2 K gal	NA	Residue	Unknown	No	1 con. valve caisson	NA
241-AZ*	Contamination in Pit or Box	Steam trap and PRV station	Residual contamination	1.1 K gal	NA	Residue	Unknown	No	1 st. trap and prv sta	NA
216-A-39	Contamination in Pit or Box	Crib 216-A-39	Residual contamination	Unknown	NA	Residue	Unknown	No	1 crib	AN
241-AZ*	SARA 313 Materials	See comment	NA	NA	NA	NA	NA	NA	NA	Major amount of construction materials for new vent modifications.
241-AZ*	Other	Steel storage box	Unknown	NA	NA	Solid	Low level	Yes	1 small shed	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
216-W-LWC	Crib	216-W-LWC	NA	NA	NA	NA	NA	NA	NA	Crib received 1,200,000,000 liters of liquid process waste water from contaminated laundry.
216-Z-20	Crib	216-Z-20	NA	NA	NA	NA	NA	NA	NA	Crib received 3,800,000,000 liters of liquid cooling water, steam condensate, storm sewer, and drains from 234-5Z, 231-Z, 291-Z, 232-Z, 236-Z, and 2736-Z.
216-B-3-3	Ditch	216-B-3-3	NA	NA	NA	NA	NA	NA	NA	Ditch transported and percolated cooling water and chemical sewer drain from 221-B, 202-A 241-BY, and 244-CR Vault.
PFP Pond	Pond	PFP Pond	NA	NA	NA	NA	NA	NA	NA	This pond, also known as the tile field, is not in the Environmental Sites Database, it was not used for radiologically contaminated waste.
216-Z-21	Crib	216-Z-21	NA	NA	NA	NA	NA	NA	NA	This crib did not appear in the WIDS database. It is also called the 216-Z-21 seepage pond, it received steam condensate and cooling water from the PFP plant.
241-B-101	Tank Contents	B-101	NCPLX	530 kgal	Sludge	Solid	113 kgal	No	NA	Assumed leaker, interim stabilized 3/81 (documentation complete 7/91).
241-B-102	Tank Contents	B-102	NCPLX	530 kgal	Supernate Sludge Saltcake	Liquid Solid Solid	4 kgal 18 kgal 10 kgal	No	NA	Interim stabilized 8/85.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-B-103	Tank Contents	B-103	NCPLX	530 kgal	Sludge	Solid	59 kgal	No	NA	Assumed leaker, interim stabilized 2/85.
241-B-104	Tank Contents	B-104	NCPLX	530 kgal	Supernate Sludge Saltcake	Liquid Solid Solid	1 kgal 301 kgal 69 kgal	No	NA	Interim stabilized 6/85.
241-B-105	Tank Contents	B-105	NCPLX	530 kgal	Sludge Saltcake	Solid Solid	40 kgal 266 kgal	No	NA	Assumed leaker, interim stabilized 12/84.
241-B-106	Tank Contents	B-106	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 116 kgal	No	NA	Interim stabilized 3/85.
241-B-107	Tank Contents	B-107	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 164 kgal	No	NA	Assumed leaker, interim stabilized 12/84.
241-B-108	Tank Contents	B-108	NCPLX	530 kgal	Sludge	Solid	94 kgal	No	NA	Interim stabilized 5/85.
241-B-109	Tank Contents	B-109	NCPLX	530 kgal	Sludge	Solid	127 kgal	No	NA	Interim stabilized 4/85.
241-B-110	Tank Contents	B-110	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 245 kgal	No	NA	Assumed leaker, interim stabilized 12/84.
241-B-111	Tank Contents	B-111	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 236 kgal	No	NA	Assumed leaker, interim stabilized 6/85.
241-B-112	Tank Contents	B-112	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	3 kgal 30 kgal	No	NA	Assumed leaker, interim stabilized 5/85.
241-B-201	Tank Contents	B-201	NCPLX	55,000 gal	Supernate Sludge	Liquid Solid	1 kgal 28 kgal	No	NA	Assumed leaker, interim stabilized 8/81.
241-B-202	Tank Contents	B-202	NCPLX	55,000 gal	Sludge	Solid	27 kgal	No	NA	Interim stabilized 5/85.
241-B-203	Tank Contents	B-203	NCPLX	55,000 gal	Supernate Sludge	Liquid Solid	1 kgal 50 kgal	No	NA	Assumed leaker, interim stabilized 6/84.
241-B-204	Tank Contents	B-204	NCPLX	55,000 gal	Supernate Sludge	Liquid Solid	1 kgal 49 kgal	No	NA	Assumed leaker, interim stabilized 6/84.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-B-301B	Tank Contents	241-B-301B IMUST	pH = 8.5 T 4.77 x10-3 grams/gal PU <6.58 x10-8 grams/gal U 1.77 x 10-5 lbs, gal T 9.01 x 102 Cs137 1.14 x 104µCi/gal in supernate PU 6.58 x 10-7 g/gal in supernate	36,000 gal	Supernate Solid	Liquid Solids	590 gal 21,660 gal	No	NA	Isolated 1985.
241-B-302B	Tank Contents	241-B-302B IMUST	B plant waste	17,684 gal	Supernate Sludge	Liquid Solids	4240 gal 690 gal	No	NA	Located at the corner of Baltimore and 7th Street, isolated 1985.
241-B-101	Tank Headspace	B-101	NA	NA	NA	Vapor	2812 cubic meters, no NH_3 present	No	NA	NA
241-B-102	Tank Headspace	B-102	NA	NA	NA	Vapor	3118 cubic meters, no NH_3 present	No	NA	NA
241-B-103	Tank Headspace	B-103	NA	NA	NA	Vapor	3016 cubic meters, 20 grams of NH_3	No	NA	NA
241-B-104	Tank Headspace	B-104	NA	NA	NA	Vapor	1835 cubic meters, no NH_3 present	No	NA	NA
241-B-105	Tank Headspace	B-105	NA	NA	NA	Vapor	2081 cubic meters, no NH_3 present	No	NA	NA
241-B-106	Tank Headspace	B-106	NA	NA	NA	Vapor	2797 cubic meters, no NH_3 present	No	NA	NA
241-B-107	Tank Headspace	B-107	NA	NA	NA	Vapor	2615 cubic meters, no NH_3 present	No	NA	NA
241-B-108	Tank Headspace	B-108	NA	NA	NA	Vapor	2884 cubic meters, no NH_3 present	No	NA	NA
241-B-109	Tank Headspace	B-109	NA	NA	NA	Vapor	2759 cubic meters, no NH_3 present	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-B-110	Tank Headspace	B-110	NA	NA	NA	Vapor	2308 cubic meters, no NH_3 present	No	NA	NA
241-B-111	Tank Headspace	B-111	NA	NA	NA	Vapor	2342 cubic meters, no NH_3 present	No	NA	NA
241-B-112	Tank Headspace	B-112	NA	NA	NA	Vapor	3115 cubic meters, no NH_3 present	No	NA	NA
241-B-201	Tank Headspace	B-201	NA	NA	NA	Vapor	124 cubic meters, no NH_3 present	No	NA	NA
241-B-202	Tank Headspace	B-202	NA	NA	NA	Vapor	131 cubic meters, no NH_3 present	No	NA	NA
241-B-203	Tank Headspace	B-203	NA	NA	NA	Vapor	40 cubic meters, no NH_3 present	No	NA	NA
241-B-204	Tank Headspace	B-204	NA	NA	NA	Vapor	44 cubic meters, 2.2 grams NH_3 *	No	NA	*Maximum ppm values used from data obtained 1/93 to 2/96. Accuracy of ammonia measurements may deviate 25%.
241-B-301B	Tank Headspace	241-B-301B	NA	NA	NA	Vapor	13750 gal, unknown composition	No	NA	NA
241-B-302B	Tank Headspace	241-B-302B	NA	NA	NA	Vapor	12754 gal, unknown composition	No	NA	NA
241-B	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers in B Farm.
241-B	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles in B Farm.
241-B	Contamination on Equipment or Tools	Contaminated tools possibly abandoned in pits	Possibly contaminated tools	NA	NA	Solid	Unknown	No*	NA	*Tools in pits are not expected to be easily moved.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-B	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA
241-B	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA
241-B	Ventilation Filter Contents	Breathers	NA	1 R/hr at six inches**	NA	Particulate	<100 mR/hr*	Yes, filters disposed of in accord w/ EP-0063, Rev 4 (9/93)	NA	*Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area [rad survey report 221830, 5/2/96] **SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs. Filters are tested annually and replaced if they fail.
241-B	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	NA
241-B	Contamination In Ventilation System	Seal loops	Oil	< 1 gal	NA	Liquid	Residual	No	One per tank.	Seal loops associated with breather filters on all tanks.
241-B	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer pipeline Table 7.
241-B	Contents of Sump or Encasement	None*	NA	NA	NA	NA	NA	NA	NA	*No sumps present in B Farm; refer to transfer pipeline Table 7 for encasements.
241-B	Contamination in Pit or Box	Pits	Residual contamination	NA	NA	Residue	NA	No	NA	Pits are all isolated and inactive.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-B	Contamination in Pit or Box	Diversion boxes	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and inactive.
241-B-151	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and inactive.
241-B-152	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and inactive.
241-B-153	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and inactive.
241-B-154	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and inactive.
241-B-252	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and inactive.
242-B-151	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and inactive.
241-B	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
B Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	Six 55 gallon mixed waste drums (maximum)	Soil, paint waste, tank contacted, mask cartridges, HEPA filters, misc. mixed wastes possible	Solid	Low level (less than class C)	Yes	Six 55 gallon drums maximum capacity for each satellite accumulat enclosure	Inventories removed when filled; transported to 209-E 90 day storage facility.
216-B-55	Other	Crib 216-B-55	NA	NA	NA	NA	NA	NA	NA	This crib received 1,230,000,000 liters of steam condensate from 221-B. The waste is low salt and neutral/base. Currently inactive.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
216-B-62	Other	Crib 216-B-62	NA	NA	NA	NA	NA	NA	NA	This crib received 282,000,000 liters of Process condensate from 221-B Separations Facilities. Currently inactive.
216-B-63	Other	Ditch 216-B-63	NA	NA	NA	NA	NA	NA	NA	This ditch received 7,220,000,000 liters of effluent from floor drains and chemical sewer wastes from 221-B, 225-B, and 271-B . Currently inactive.
216-B-3	Other	Pond 216-B-3	NA	NA	NA	Liquid	NA	Yes	NA	Expansion ponds still active, monitored weekly for level and inlet flow. Not in the WIDS database because they do not receive contaminated waste. They receive clean liquid such as steam condensate and cooling water.
241-BX-101	Tank Contents	BX-101	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 42 kgal	No	NA	Assumed leaker Interim stabilized 9/78.
241-BX-102	Tank Contents	BX-102	NCPLX	530 kgal	Sludge	Solid	96 kgal	No	NA	Assumed leaker Interim stabilized 11/78.
241-BX-103	Tank Contents	BX-103	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	6 kgal 62 kgal	No	NA	Interim stabilized 11/83.
241-BX-104	Tank Contents	BX-104	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	3 kgal 96 kgal	No	NA	Interim stabilized 9/89.
241-BX-105	Tank Contents	BX-105	NCPLX	530 kgal	Supernate Sludge Saltcake	Liquid Solid Solid	5 kgal 43 kgal 3 kgal	No	NA	Interim stabilized 3/81 (documentation complete 9/86).
241-BX-106	Tank Contents	BX-106	NCPLX	530 kgal	Sludge	Solid	38 kgal	No	NA	Interim stabilized 8/95.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BX-107	Tank Contents	BX-107	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 344 kgal	No	NA	Interim stabilized 9/90.
241-BX-108	Tank Contents	BX-108	NCPLX	530 kgal	Sludge	Solid	26 kgal	No	NA	Assumed leaker Interim stabilized 7/79.
241-BX-109	Tank Contents	BX-109	NCPLX	530 kgal	Sludge	Solid	193 kgal	No	NA	Interim stabilized 9/90.
241-BX-110	Tank Contents	BX-110	NCPLX	530 kgal	Supernate Sludge Saltcake	Liquid Solid Solid	3 kgal 195 kgal 9 kgal	No	NA	Assumed leaker Interim stabilized 8/85.
241-BX-111	Tank Contents	BX-111	NCPLX	530 kgal	Supernate Sludge Saltcake	Liquid Solid Solid	1 kgal 52 kgal 109 kgal	No	NA	Assumed leaker Interim stabilized 3/95.
241-BX-112	Tank Contents	BX-112	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 164 kgal	No	NA	Interim stabilized 9/90.
244-BX	Tank Contents	244-BX DCRT	Saltwell pumping waste from BX, BY, and B farms	31 kgal	NA	Liquid Solid	16397 gal total, about 1200-3300 gal of sludge	No	NA	DCRT receives waste from B, BX, and BY farms.
241-BX-302A	Tank Contents	241-BX-302A IMUST	Drainage from diversion boxes BR-152, BX-153, BYR-152, and BXR-152 Sr90-solids 7190 µCi/gal Sr90-supernatant 719 µCi/gal Cs137-supernatant 358 µCi/gal PU - supernate 6.55 x 10-8 g/L	17684 gal	NA	Solid	835 gal	No	NA	Isolated 1985, supernatant composition refers to samples taken when there was supernatant in the tank.
241-BX-302B	Tank Contents	241-BX-302B IMUST	drainage from BX-154 diversion box	11389 gal	Supernate Solids	Liquid Solid	94 gal 950 gal	No	NA	Isolated 1985.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BX-302C	Tank Contents	241-BX-302C IMUST	Drainage from BX-155 diversion box	11378 gal	Supernate Solids	Liquid Solid	635 gal 228 gal	No	NA	Isolated 1985.
241-BXR-001	Tank Contents	244-BXR-001 IMUST	Metal waste slurry Sr90-solids 348220 µCi/gal Sr90-supernatant 34822 µCi/gal Cs137-supernatant 38229 µCi/gal	50,000 gal	Supernate Solids	Liquid Solid	7215 gal	No	NA	Interim stabilized 1985, supernatant composition refers to samples taken when there was supernatant in the tank .
241-BXR-002	Tank Contents	244-BXR-002 IMUST	Slurry from 244-BXR-001 mixed w/nitric acid Sr90-solids 38270 µCi/gal Sr90-supernatant 3827 µCi/gal Cs137-supernatant 1964 µCi/gal	15,000 gal	Supernate Solids	Liquid Solid	380 gal 1805 gal	No	NA	Interim stabilized 1985.
241-BXR-003	Tank Contents	244-BXR-003 IMUST	Slurry from 244-BXR-001 mixed w/nitric acid Sr90-solids 3174480 µCi/gal Sr90-supernatant 317448 µCi/gal Cs137-supernatant 22824 µCi/gal	15,000 gal	Supernate Solids	Liquid Solid	356 gal 1449 gal	No	NA	Interim stabilized 1985.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BXR-011	Tank Contents	244-BXR-011 IMUST	Acid solutions from 244-BXR-002 and 244-BXR-003 Sr90-solids 183673 µCi/gal Sr90-supernatant 18367 µCi/gal Cs137-solids 72795 µCi/gal Cs137-supernatant 727950 µCi/gal PU -solids 3.78 x 10-7 g/g @ 0.564 g/mL	50,000 gal	Supernate Solids	Liquid Solid	98 gal 7020 gal	No	NA	Interim stabilized 1985.
241-BX-101	Tank Headspace	BX-101	NA	NA	NA	Vapor	3077 cubic meters, no NH_3 present	No	NA	NA
241-BX-102	Tank Headspace	BX-102	NA	NA	NA	Vapor	2876 cubic meters, no NH_3 present	No	NA	NA
241-BX-103	Tank Headspace	BX-103	NA	NA	NA	Vapor	2982 cubic meters, no NH_3 present	No	NA	NA
241-BX-104	Tank Headspace	BX-104	NA	NA	NA	Vapor	2876 cubic meters, 520 g NH_3	No	NA	NA
241-BX-105	Tank Headspace	BX-105	NA	NA	NA	Vapor	3046 cubic meters, no NH_3 present	No	NA	NA
241-BX-106	Tank Headspace	BX-106	NA	NA	NA	Vapor	3065 cubic meters, no NH_3 present	No	NA	NA
241-BX-107	Tank Headspace	BX-107	NA	NA	NA	Vapor	1934 cubic meters, no NH_3 present	No	NA	NA
241-BX-108	Tank Headspace	BX-108	NA	NA	NA	Vapor	3141 cubic meters, no NH_3 present	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BX-109	Tank Headspace	BX-109	NA	NA	NA	Vapor	2509 cubic meters, no NH_3 present	No	NA	NA
241-BX-110	Tank Headspace	BX-110	NA	NA	NA	Vapor	2456 cubic meters, no NH_3 present	No	NA	NA
241-BX-111	Tank Headspace	BX-111	NA	NA	NA	Vapor	2626 cubic meters, no NH_3 present	No	NA	NA
241-BX-112	Tank Headspace	BX-112	NA	NA	NA	Vapor	2615 cubic meters, no NH_3 present	No	NA	NA
244-BX	Tank Headspace	244-BX DCRT	NA	NA	NA	Vapor	Unknown	No	NA	No data on tank headspace available.
241-BX-302A	Tank Headspace	241-BX-302A IMUST	NA	NA	NA	Vapor	16849 gal unknown composition	No	NA	No data on tank headspace composition available.
241-BX-302B	Tank Headspace	241-BX-302B IMUST	NA	NA	NA	Vapor	10345 gal unknown composition	No	NA	No data on tank headspace composition available.
241-BX-302C	Tank Headspace	241-BX-302C IMUST	NA	NA	NA	Vapor	10515 gal unknown composition	No	NA	No data on tank headspace composition available.
241-BX-001	Tank Headspace	244-BXR-001 IMUST	NA	NA	NA	Vapor	42785 gal unknown composition	No	NA	No data on tank headspace composition available.
241-BX-002	Tank Headspace	244-BXR-002 IMUST	NA	NA	NA	Vapor	12815 gal unknown composition	No	NA	No data on tank headspace composition available.
241-BX-003	Tank Headspace	244-BXR-003 IMUST	NA	NA	NA	Vapor	13195 gal unknown composition	No	NA	No data on tank headspace composition available.
241-BXR-011	Tank Headspace	244-BXR-011 IMUST	NA	NA	NA	Vapor	42882 gal unknown composition	No	NA	No data on tank headspace composition available.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BX	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tanker in BX Farm.
241-BX	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles stored near BX Farm.
241-BX	Contamination on Equipment or Tools	Abandoned tools possibly in tank pits	Possibly contaminated tools	NA	NA	Solid	Unknown	No *	NA	*Tools not expected to be easily removed from pits.
241-BX	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA
241-BX	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA
241-BX	Ventilation Filter Contents	Breather	NA	1 R/hr at six inches**	NA	Particulate	<100 mR/hr*	Yes, filters disposed of in accord w/ EP-0063, Rev 4 (9/93)	NA	*Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area [rad survey report 221830, 5/2/96] **SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs. Filters are tested annually for efficiency and replaced if they fail.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BX	Ventilation Filter Contents	Filter on vent system for DCRT 244-BX	NA	1 R/hr at six inches**	NA	Particulate	<100 mR/hr*	Yes	NA	*Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area [rad survey report 221830, 5/2/96] **SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs. Filters are tested annually for efficiency and replaced if they fail.
241-BX	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No de-entrainer.
241-BX	Contamination In Ventilation System	Seal loops for breathers	Oil	< 1 gal	NA	Liquid	Residual	No	One per tank.	Seal loops associated with breather filters on all tanks.
241-BX	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-BX	Contents of Sump or Encasement	DCRT vault**	NA	41,000 gal*	NA	NA	NA	No	NA	*Volume of vault = (44' x 16' x 13'7") - volume of the tank DCRT is used as saltwell receiver. **Vault serves as "encasement" for the DCRT.
241-BX	Contamination in Pit or Box	Pump, sluice, heel, and condenser pits	Residual contamination	NA	NA	Residue	NA	No	NA	All pump, sluice, heel, and condenser pits are weather covered in BX Farm.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BX	Contamination in Pit or Box	Raw water service pit	Water	1450 gal (7' diameter x 5')	NA	Liquid	NA	No	NA	Service pit provides raw water to BX and BY Farms for saltwell pumping.
241-BX	Contamination in Pit or Box	Saltwell pumping pits	Residual contamination	1050 gal (6' diameter x 5') on BX-107 and BX-109 and 740 gal (5' diameter x 5') on BX-110, BX-111, and BX-112	NA	Residue	NA	No	NA	*Saltwell pump pits Not isolated on tanks BX-107, 109-112 only.
244-BX	Contamination in Pit or Box	244-BX DCRT pump pit	Residual contamination	23,000 gal (19' x 17' x 9'-6")	NA	Residue	NA	No	NA	NA
244-BX	Contamination in Pit or Box	244-BX DCRT filter pit	Residual contamination	13,300 gal (11' x 17' x 9'-6")	NA	Residue	NA	No	NA	Filters discussed separately.
244-BX	Contamination in Pit or Box	244-BX DCRT instrument pit	Residual contamination	800 gal (4' diameter x 8'-4")	NA	Residue	NA	No	NA	NA
241-BXR-151	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes in BX Farm are all isolated and inactive.
241-BXR-152	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes in BX Farm are all isolated and inactive.
241-BXR-153	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes in BX Farm are all isolated and inactive.
241-BX	SARA 313 Materials	Gas bottles for PCM1B	90% argon / 10% methane	480 cubic feet	NA	Gas	480 cubic ft	Yes	2 bottles	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
BX Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	Six 55 gallon mixed waste drums (maximum)	Soil, paint waste, tank contacted, mask cartridges, HEPA filters, misc. mixed wastes possible	Solid	Low level (less than class C)	Yes	Six 55 gallon drums maximum capacity for each satellite accumulat enclosure	Inventories removed when filled; transported to 209-E 90 day storage facility.
241-BX	Other	Large tank of phosphoric acid west of BX-112	Phosphoric acid	1000 gallons estimated	NA	Liquid	100 gallon heel / unknown	Yes*	1 tank	Tank scheduled for removal by WHC Operations.
241-BY-101	Tank Contents	BY-101	NCPLX	758,000	Sludge Saltcake	Solid Solid	109 kgal 278 kgal	No	NA	Interim stabilized 5/84.
241-BY-102	Tank Contents	BY-102	NCPLX	758,000	Saltcake	Solid	277 kgal	No	NA	Interim stabilized 4/95.
241-BY-103	Tank Contents	BY-103	NCPLX	758,000	Sludge Saltcake	Solid Solid	5 kgal 395 kgal	No	NA	Assumed leaker, BY-103 is being pumped.
241-BY-104	Tank Contents	BY-104	NCPLX	758,000	Sludge Saltcake	Solid Solid	40 kgal 366 kgal	No	NA	Interim stabilized 1/85.
241-BY-105	Tank Contents	BY-105	NCPLX	758,000	Sludge Saltcake	Solid Solid	44 kgal 459 kgal	No	NA	Assumed leaker BY-105 has had cement added. It may be pumped further in the future.
241-BY-106	Tank Contents	BY-106	NCPLX	758,000	Sludge Saltcake	Solid Solid	95 kgal 547 kgal	No	NA	Assumed leaker BY-106 is being pumped.
241-BY-107	Tank Contents	BY-107	NCPLX	758,000	Sludge Saltcake	Solid Solid	60 kgal 206 kgal	No	NA	Assumed leaker, interim stabilized 7/79.
241-BY-108	Tank Contents	BY-108	NCPLX	758,000	Sludge Saltcake	Solid Solid	154 kgal 74 kgal	No	NA	Assumed leaker, interim stabilized 2/85.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BY-109	Tank Contents	BY-109	NCPLX	758,000	Sludge Saltcake	Solid Solid	83 kgal 340 kgal	No	NA	BY-109 is being pumped.
241-BY-110	Tank Contents	BY-110	NCPLX	758,000	Sludge Saltcake	Solid Solid	103 kgal 295 kgal	No	NA	Interim stabilized 1/85.
241-BY-111	Tank Contents	BY-111	NCPLX	758,000	Sludge Saltcake	Solid Solid	21 kgal 438 kgal	No	NA	Interim stabilized 1/85.
241-BY-112	Tank Contents	BY-112	NCPLX	758,000	Sludge Saltcake	Solid Solid	5 kgal 286 kgal	No	NA	Interim stabilized 6/84.
216-BY-201	Tank Contents	216-BY-201 IMUST	See comments	Unknown	Unknown	Unknown	Unknown	No	NA	This tank received waste from 241-BY Farm and the Tri-butyl Phosphate Waste Line. Leaked waste to the ground in 1955.
241-BY-101	Tank Headspace	BY-101	NA	NA	NA	Vapor	2517 cubic meters, no NH_3 present	No	NA	NA
241-BY-102	Tank Headspace	BY-102	NA	NA	NA	Vapor	2933 cubic meters, no NH_3 present	No	NA	NA
241-BY-103	Tank Headspace	BY-103	NA	NA	NA	Vapor	2467 cubic meters, 49 g NH_3	No	NA	Tank is being pumped; headspace will change.
241-BY-104	Tank Headspace	BY-104	NA	NA	NA	Vapor	2445 cubic meters, 470 g NH_3	No	NA	NA
241-BY-105	Tank Headspace	BY-105	NA	NA	NA	Vapor	2078 cubic meters, 69 / 71 g NH_3	No	NA	Tank may be pumped in the future; headspace will change.
241-BY-106	Tank Headspace	BY-106	NA	NA	NA	Vapor	1551 cubic meters, 88 g NH_3	No	NA	Tank is being pumped; headspace will change.
241-BY-107	Tank Headspace	BY-107	NA	NA	NA	Vapor	2975 cubic meters, 2200 g NH_3	No	NA	NA
241-BY-108	Tank Headspace	BY-108	NA	NA	NA	Vapor	3118 cubic meters, 2500 / 830 g NH_3	No	NA	NA
241-BY-109	Tank Headspace	BY-109	NA	NA	NA	Vapor	2380 cubic meters, no NH_3 present	No	NA	Tank is being pumped; headspace will change.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BY-110	Tank Headspace	BY-110	NA	NA	NA	Vapor	2475 cubic meters, 740 / 510 g NH_3	No	NA	NA
241-BY-111	Tank Headspace	BY-111	NA	NA	NA	Vapor	2244 cubic meters, 100 g NH_3	No	NA	NA
241-BY-112	Tank Headspace	BY-112	NA	NA	NA	Vapor	2880 cubic meters, 140 g NH_3	No	NA	NA
216-BY-201	Tank Headspace	216-BY-201	Unknown	NA	Unknown	Vapor	Unknown	No	NA	No data available.
241-BY	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers in BY Farm.
241-BY	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles stored near BY Farm.
241-BY	Contamination on Equipment or Tools	Asbestos covered evaporator near BY-101, radioactively contaminated	Contaminated equipment	NA	NA	Solid	Unknown	Yes	NA	Commonly called "the big pink thing".
241-BY	Contamination on Equipment or Tools	Several 30' long, 4-5' diameter caissons w/contaminated equipment inside (above ground)	Contaminated equipment	NA	NA	Solid	Unknown	Yes	NA	NA
241-BY	Contamination on Equipment or Tools	Abandoned contaminated tools possibly in pits	Contaminated tools	NA	NA	Solids	Unknown	No*	NA	*Tools not expected to be easily removed from pits
241-BY	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA
241-BY	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BY	Ventilation Filter Contents	Breather	NA	1 R/hr at six inches**	NA	Particulate	<100 mR/hr on all tanks except possibly BY-101, 102, 105, and 109 which are on the West Tank Farm Shift Office High Radiation Area Key Assignment List (Not sure if this means the breather filters, No exact rad numbers provided - No response from reference 14 to these questions)	Yes, Disposed of in accord w/ EP-0063, Rev 4 (9/93)	NA	**SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs. Filter efficiency is tested annually and filters are replaced if they fail.
241-BY	Contamination In Ventilation System	De-entrainer	NA	NA	NA	NA	NA	NA	NA	No de-entrainer.
241-BY	Contamination In Ventilation System	Seal loops for breathers	oil	<1 gal	NA	Liquid	Residual	No	One per tank	Seal loops associated with breather filters on all tanks.
241-BY	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-BY	Contents of Sump or Encasement	NA	NA	NA	NA	NA	NA	NA	NA	No known sumps with material inventory in BY Farm. See transfer line Table 7 for discussion of encasements.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-BY	Contamination in Pit or Box	Saltwell pump pits	Residual contamination	6000 gal (14.5' x 11' x 5') for tanks BY-102, 103, 105, 106 6400 gal (17' x 11' x 4'-7") for BY-109	NA	Residue	NA	No	NA	Pump pits (saltwell pumping) are active (not weather covered) on tanks BY-102, 103, 105, 106, and 109.
241-BY	Contamination in Pit or Box	All other pits in BY Farm	Residual contamination	NA	NA	Residue	NA	No	NA	All pits except pump pits noted above are weather covered
241-BYR-152	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and weather covered.
241-BYR-153	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and weather covered.
241-BYR-154	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and weather covered.
241-BYR-155	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	Diversion boxes are all isolated and weather covered.
241-BY	SARA 313 Materials	Gas bottles for SHMS*	Hydrogen / nitrogen mixture	480 cubic feet	NA	Gas	480 cubic feet	Yes	3 bottles per tank*	*Only on tanks BY-103, BY-106, and BY-109.
241-BY	Other	None	NA	NA	NA	NA	NA	NA	NA	
241-C-101	Tank Contents	C-101	NCPLX	530 kgal	Sludge	Solid	88 kgal	No	NA	Assumed leaker, interim stabilized 11/83.
241-C-102	Tank Contents	C-102	DC	530 kgal	Sludge	Solid	316 kgal	No	NA	Interim stabilized 9/95.
241-C-103	Tank Contents	C-103	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	133 kgal 62 kgal	No	NA	C-103 will be pumped in the future.
241-C-104	Tank Contents	C-104	CC	530 kgal	Sludge	Solid	295 kgal	No	NA	Interim stabilized 9/89.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-C-105	Tank Contents	C-105	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	2 kgal 132 kgal	No	NA	Interim stabilized 10/95.
241-C-106	Tank Contents	C-106	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	32 kgal 197 kgal	No	NA	C-106 will be sluiced in the future. Treated cooling water (pH 9-10) is added to tank, about 6000 gallons/month.
241-C-107	Tank Contents	C-107	DC	530 kgal	Sludge	Solid	237 kgal	No	NA	Interim stabilized 8/95.
241-C-108	Tank Contents	C-108	NCPLX	530 kgal	Sludge	Solid	66 kgal	No	NA	Interim stabilized 3/84.
241-C-109	Tank Contents	C-109	NCPLX	530 kgal	Supernate Sludge	Liquid Solid	4 kgal 62 kgal	No	NA	Interim stabilized 11/83.
241-C-110	Tank Contents	C-110	DC	530 kgal	Supernate Sludge	Liquid Solid	1 kgal 177 kgal	No	NA	Assumed leaker, interim stabilized 5/95.
241-C-111	Tank Contents	C-111	NCPLX	530 kgal	Sludge	Solid	57 kgal	No	NA	Assumed leaker, interim stabilized 3/84.
241-C-112	Tank Contents	C-112	NCPLX	530 kgal	Sludge	Solid	104 kgal	No	NA	Interim stabilized 9/90.
241-C-201	Tank Contents	C-201	NCPLX	55 kgal	Sludge	Solid	2 kgal	No	NA	Assumed leaker, interim stabilized 3/82.
241-C-202	Tank Contents	C-202	EMPTY	55 kgal	Sludge	Solid	1 kgal	No	NA	Assumed leaker, interim stabilized 8/81.
241-C-203	Tank Contents	C-203	NCPLX	55 kgal	Sludge	Solid	5 kgal	No	NA	Assumed leaker, interim stabilized 3/82.
241-C-204	Tank Contents	C-204	NCPLX	55 kgal	Sludge	Solid	3 kgal	No	NA	Assumed leaker, interim stabilized 9/82.
244-CR	Tank Contents	CR vault tank 001	Unknown	50 kgal	Unknown	Unknown	Unknown	No	NA	Inactive. No data on tank contents obtained.
244-CR	Tank Contents	CR vault tank 002	Unknown	15 kgal	Unknown	Unknown	Unknown	No	NA	Inactive. No data on tank contents obtained.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
244-CR	Tank Contents	CR vault tank 003	Saltwell waste from C farm (C-102, C-107, C-110	15 kgal	NA	Liquid Solid	4653 gal total	No	NA	This is the only CR Vault tank still in use. Amount of solids in tank unknown.
244-CR	Tank Contents	CR vault tank 011	Unknown	50 kgal	Unknown	Unknown	Unknown	No	NA	Inactive. No data on tank contents obtained. Transfer from Hot Semi Works to tank recorded around 1978.
241-C-301C	Tank Contents	241-C-301C IMUST	pH 9.3, T 6.09 x 102, PU <6.58 g/gal, U 5.0 x 10-4 lbs/gal, T 1.7 x 103 µCi/gal, Cs134 1.47 x 102 µCi/gal Cs137-super 2.55 x 104 µCi/gal Sr90-Solids 17000 µCi/gal Sr90-super. 1700 µCi/gal Pu-super. 6.58 x 10-7 g/gal	36 kgal	Supernate Sludge	Liquid Solid	1470 gal 9016 gal	No	NA	Isolated.
241-C-101	Tank Headspace	C-101	NA	NA	NA	Vapor	2906 cubic meters, 220 g NH_3	No	NA	NA
241-C-102	Tank Headspace	C-102	NA	NA	NA	Vapor	2043 cubic meters, 286 g NH_3	No	NA	NA
241-C-103	Tank Headspace	C-103	NA	NA	NA	Vapor	2501 cubic meters, 540 g NH_3*	No	NA	Tank C-103 will be pumped in the future; headspace will change. *Insufficient data to correct for temperature. A temperature of 11C assumed where no data exists.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-C-104	Tank Headspace	C-104	NA	NA	NA	Vapor	2123 cubic meters, 70 g NH_3	No	NA	NA
241-C-105	Tank Headspace	C-105	NA	NA	NA	Vapor	2728 cubic meters, 5.2 g NH_3	No	NA	NA
241-C-106	Tank Headspace	C-106	NA	NA	NA	Vapor	2373 cubic meters, 4.5 g NH_3	No	NA	Tank C-106 will be sluiced in the future; headspace will change.
241-C-107	Tank Headspace	C-107	NA	NA	NA	Vapor	2342 cubic meters, 150 g NH_3	No	NA	NA
241-C-108	Tank Headspace	C-108	NA	NA	NA	Vapor	2990 cubic meters, 6 g NH_3	No	NA	NA
241-C-109	Tank Headspace	C-109	NA	NA	NA	Vapor	3005 cubic meters, 23 g NH_3	No	NA	NA
241-C-110	Tank Headspace	C-110	NA	NA	NA	Vapor	2570 cubic meters, 240 g NH_3	No	NA	NA
241-C-111	Tank Headspace	C-111	NA	NA	NA	Vapor	3024 cubic meters, 130 g NH_3	No	NA	NA
241-C-112	Tank Headspace	C-112	NA	NA	NA	Vapor	2846 cubic meters, 48 g NH_3	No	NA	NA
241-C-201	Tank Headspace	C-201	NA	NA	NA	Vapor	226 cubic meters, no NH_3 present	No	NA	NA
241-C-202	Tank Headspace	C-202	NA	NA	NA	Vapor	230 cubic meters, no NH_3 present	No	NA	NA
241-C-203	Tank Headspace	C-203	NA	NA	NA	Vapor	215 cubic meters, no NH_3 present	No	NA	NA
241-C-204	Tank Headspace	C-204	NA	NA	NA	Vapor	222 cubic meters, no NH_3 present	No	NA	NA
244-CR	Tank Headspace	CR vault tank 001	NA	NA	NA	NA	NA	NA	NA	No headspace data available.
244-CR	Tank Headspace	CR vault tank 002	NA	NA	NA	NA	NA	NA	NA	No headspace data available.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
244-CR	Tank Headspace	CR vault tank 003	NA	NA	NA	NA	NA	NA	NA	No headspace data available. This is the only CR vault tank currently in use.
244-CR	Tank Headspace	CR vault tank 011	NA	NA	NA	NA	NA	NA	NA	No headspace data available.
241-C-301C	Tank Headspace	241-C-301C IMUST	NA	NA	NA	Vapor	22514 gal, unknown composition	No	NA	No headspace data available.
241-C	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers in C Farm.
241-C	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles stored in C Farm.
241-C	Contamination on Equipment or Tools	Contaminated tools or jumpers possibly abandoned in pits	Contaminated tools, jumpers	NA	NA	Solid	Unknown	No*	NA	*Tools are not expected to be easily moved from pits.
241-C	Contamination on Equipment or Tools	Contaminated equipment stored near C-301C IMUST	Contaminated equipment	NA	NA	Solid	Unknown	Yes	NA	Boxes and drums with contaminated materials

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-C	Ventilation Filter Contents	Primary - C-105/C-106 exhaust system	NA	1 R/hr at six inches**	NA	Particulate	<100 mR/hr*, 70 mR/hr on top of C-105 inlet filter [rad survey report 221830, 5/2/96]	Yes, filters disposed of in accord w/ EP-0063, Rev 4 (9/93)	NA	*Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area (except C-105 inlet filter) [rad survey report 221830, 5/2/96] **SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs.
241-C	Ventilation Filter Contents	Annulus exhaust	NA	NA	NA	NA	NA	NA	NA	NA
241-C	Ventilation Filter Contents	Breathers	NA	1 R/hr at six inches**	NA	Particulate	<100 mR/hr*	Yes, filters disposed of in accord w/ EP-0063, Rev 4 (9/93)	NA	*Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area [rad survey report 221830, 5/2/96] **SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to SSTs. Filter efficiency is tested annually and filters are replaced if they fail.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
244-CR	Ventilation Filter Contents	244-CR vault vent system filters	NA	1 R/hr at six inches**	NA	Particulate	Unknown	Yes, filters disposed of in accord w/ EP-0063, Rev 4 (9/93)	NA	**SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this limit applies to CR vault. Filter efficiency is tested annually and filters are replaced if they fail.
241-C	Contamination In Ventilation System	De-entrainer	Process condensate	NA	NA	Liquid	Residual	No	NA	For the C-105/C-106 exhaust system.
241-C	Contamination In Ventilation System	Seal loops	Condensate	<1 gal	NA	Liquid	Residual	No	One per tank, except C-105 and C-106	Seal loops on breather filters for all tanks except C-105 and C-106.
241-C	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line study.
244-CR	Contents of Sump or Encasement	CR vault space (including sump)	Residual contamination, standing liquid possible	About 74,000 gal (2 large vaults) and about 30,000 gal (2 smaller vaults)*	NA	Residue and possibly liquid	Unknown	No	4 vaults	*Capacity of vaults = volume of vault - volume of tank in vault. Large vaults are 22' x 26' x 29', small vaults are 16' x 20' x 19'. Each vault also has a small sump, 2' x 3' x 1', standing liquid in sumps possible.
244-CR	Contents of Sump or Encasement	CR vault filter pit sump	Residual contamination	About 30 gal (2'-10" square x 6" deep)	NA	Residue	NA	No	1	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-C	Contamination in Pit or Box	Inactive pits*	Residual contamination	NA	NA	Residue	NA	No	NA	*All pits except those noted below are isolated and inactive.
241-C	Contamination in Pit or Box	Pump pits*	Residual contamination	10,000 gal (11' x 14'-6" x 8'-8"	NA	Residue	NA	No	NA	*Pump pits not isolated on C-102, C-103, C-105, and C-106. Isolated on Tanks C-104 and C-101. See saltwell pump pits for C-107 through C-112.
241-C	Contamination in Pit or Box	Heel pits*	Residual contamination	2000 gal (9' x 6' x 4'-10")	NA	Residue	NA	No	NA	*Isolated on Tanks C-101 and C-104. C-105 is weather covered. Only expected to be used on C-103 (for saltwell pumping) and possibly C-106 in the future.
241-C	Contamination in Pit or Box	Saltwell pump pits*	Residual contamination	1000 gal (6' dia x 5' deep)	NA	Residue	NA	No	NA	*Only potentially active (not weather covered) on C-107, 110, and 112 (see heel pits above). C-110 and C-112 not expected to be used.
241-C	Contamination in Pit or Box	Sluice pit*	Residual contamination	4000 gal (9' x 8'-6" x 7')	NA	Residue	NA	No	NA	*Potentially active on C-106, which will be sluiced.
241-C	Contamination in Pit or Box	Valve pit 241-C	Residual contamination	5600 gal (10' dia x 9'-6")	NA	Residue	NA	No	NA	May be used in the future for pumping C-103.
241-C	Contamination in Pit or Box	Raw water service pit	Raw water	NA	NA	Liquid	NA	No	NA	Service pit only has raw water in it. No longer in use.
244-CR	Contamination in Pit or Box	CR vault pump pits (one each above CR-011 and CR-001)	Residual contamination	30,000 gal (26' x 8' x 19'-4")	NA	Residue	NA	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
244-CR	Contamination in Pit or Box	CR vault pump pit (one above CR-002 and CR-003)	Residual contamination	48,600 gal (42' x 8' x 19'-4")	NA	Residue	NA	No	NA	NA
244-CR	Contamination in Pit or Box	CR vault filter pit	Residual contamination	9500 gal (11'-8" x 11'-10" x 9'-2")	NA	Residue	NA	No	NA	NA
244-CR	Contamination in Pit or Box	CR vault access pits	Residual contamination	One at 1400 gal (7'-8" x 5' x 5'), one at 1500 gal (7'10" x 5' x 5'), and two at 800 (6'10" x 3' x 5')	NA	Residue	NA	No	NA	1400 gal pit associated with CR-011, 1500 gal pit associated with CR-001, smaller pits associated with CR-002 and CR-003.
241-C	Contamination in Pit or Box	Diversion boxes	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-C-151	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-C-152	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-C-153	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-C-154	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-C-252	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-CR-151	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-CR-152	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.
241-CR-153	Contamination in Pit or Box	Diversion box	Residual contamination	NA	NA	Residue	NA	No	NA	All diversion boxes are isolated and inactive.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-C	SARA 313 Materials	Gas bottles for PCM1B	90% argon / 10% methane	480 cubic feet	NA	Gas	480 cubic ft	Yes	2 bottles	NA
C Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	Six 55 gallon mixed waste drums (maximum)	Soil, paint waste, tank contacted, mask cartridges, HEPA filters, misc. mixed wastes possible	Solid	Low level (less than class C)	Yes	Six 55 gallon drums maximum capacity for each satellite accumu-lation enclosure	Inventories removed when filled; transported to 209-E 90 day storage facility.
241-C	Other	Gas bottles*	Acetylene*	480 cubic feet	NA	Gas	480 cubic feet	Yes	2 bottles	*Two gas bottles of unknown contents were located within a construction area near C-106 (assumed to be acetylene for welding).
241-S-101	Tank Contents	241-S-101	NCPLX	758 Kgal	Supernate Sludge Saltcake	Liquid Solid Solid	12 Kgal 244 Kgal 171 Kgal	No	NA	Scheduled completion of interim stabilization 8/30/97.
241-S-102	Tank Contents	241-S-102	DSSF	758 Kgal	Sludge Saltcake	Solid Solid	4 Kgal 545 Kgal	No	NA	Scheduled completion of interim stabilization 1/31/99.
241-S-103	Tank Contents	241-S-103	DSSF	758 Kgal	Supernate Sludge Saltcake	Liquid Solid Solid	17 Kgal 10 Kgal 221 Kgal	No	NA	Scheduled completion of interim stabilization 8/31/98.
241-S-104	Tank Contents	241-S-104	NCPLX	758 Kgal	Supernate Sludge	Liquid Solid	1 Kgal 293 Kgal	No	NA	Assumed leaker Interim stabilized 12/84.
241-S-105	Tank Contents	241-S-105	NCPLX	758 Kgal	Sludge Saltcake	Solid Solid	2 Kgal 454 Kgal	No	NA	Interim stabilized 9/88.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-S-106	Tank Contents	241-S-106	NCPLX	758 Kgal	Supernate Sludge Saltcake	Liquid Solid Solid	4 Kgal 28 Kgal 447 Kgal	No	NA	Scheduled completion of interim stabilization 11/30/98.
241-S-107	Tank Contents	241-S-107	NCPLX	758 Kgal	Supernate Sludge Saltcake	Liquid Solid Solid	14 Kgal 293 Kgal 69 Kgal	No	NA	Scheduled completion of interim stabilization 4/30/99.
241-S-108	Tank Contents	241-S-108	NCPLX	758 Kgal	Sludge Saltcake	Solid Solid	4 Kgal 600 Kgal	No	NA	Scheduled completion of interim stabilization 2/28/97.
241-S-109	Tank Contents	241-S-109	NCPLX	758 Kgal	Sludge Saltcake	Solid Solid	13 Kgal 555 Kgal	No	NA	Scheduled completion of interim stabilization 2/28/98.
241-S-110	Tank Contents	241-S-110	NCPLX	758 Kgal	Sludge Saltcake	Solid Solid	131 Kgal 259 Kgal	No	NA	Scheduled completion of interim stabilization 2/28/97.
241-S-111	Tank Contents	241-S-111	NCPLX	758 Kgal	Supernate Sludge Saltcake	Liquid Solid Solid	10 Kgal 139 Kgal 447 Kgal	No	NA	Scheduled completion of interim stabilization 9/30/98.
241-S-112	Tank Contents	241-S-112	NCPLX	758 Kgal	Sludge Saltcake	Solid Solid	5 Kgal 518 Kgal	No	NA	Scheduled completion of interim stabilization 1/31/98.
244-S	Tank Contents	DCRT 244-S	See comments	87,720 Kgal **	See comments	See comments	Unknown	No	NA	* Waste from West Area Tank Farms, PFP, T-Plant, and 222-S labs . ** 108 Kgal vault volume less 20,280 tank volume.
241-S-304	Tank Contents	Catch tank 241-S-304	No data	6300 gal	No data	No data	2379 gal	No	NA	NA
240-S-302	Tank Contents	IMUST 240-S-302	No data	17684 gal	No data	No data	2276 gallons total waste	No	NA	Tank level monitored weekly for level.
240-S-302A	Tank Contents	IMUST 241-S-302A	No data	17684 gal	No data	No data	5130 gallons total waste	No	NA	Tank monitored by a leak detector-FIC level gauge.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
240-S-302B	Tank Contents	IMUST 241-S-302B	NA	14314 gal	0.00	NA	0 gal	No	NA	NA
216-S-25	Tank Contents	Crib 216-S-25	NA	NA	NA	NA	NA	NA	NA	This crib receive 288,000,000 liters of process steam condensate from 242-S and 216-U-1 and 2 .
216-S-26	Tank Contents	Crib 216-S-26	NA	NA	NA	NA	NA	NA	NA	This crib received 164,000,000 liters of steam condensate, byproduct radioactive wastes, and sink wastes from 222-S.
241-S-101	Tank Headspace	241-S-101	NA	NA	NA	Vapor	2365 m^3, 1200 g NH_3	No	NA	NA
241-S-102	Tank Headspace	241-S-102	NA	NA	NA	Vapor	1903 m^3, 590 / 960 g NH_3	No	NA	NA
241-S-103	Tank Headspace	241-S-103	NA	NA	NA	Vapor	3043 m^3, no NH_3 present	No	NA	NA
241-S-104	Tank Headspace	241-S-104	NA	NA	NA	Vapor	2869 m^3, no NH_3 present	No	NA	NA
241-S-105	Tank Headspace	241-S-105	NA	NA	NA	Vapor	2255 m^3, no NH_3 present	No	NA	NA
241-S-106	Tank Headspace	241-S-106	NA	NA	NA	Vapor	2168 m^3, no NH_3 present	No	NA	NA
241-S-107	Tank Headspace	241-S-107	NA	NA	NA	Vapor	2558 m^3, 370 g NH_3	No	NA	NA
241-S-108	Tank Headspace	241-S-108	NA	NA	NA	Vapor	1695 m^3, no NH_3 present	No	NA	NA
241-S-109	Tank Headspace	241-S-109	NA	NA	NA	Vapor	1831 m^3, no NH_3 present	No	NA	NA
241-S-110	Tank Headspace	241-S-110	NA	NA	NA	Vapor	2505 m^3, 270 g NH_3	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-S-111	Tank Headspace	241-S-111	NA	NA	NA	Vapor	1726 m^3, 160 g NH_3	No	NA	NA
241-S-112	Tank Headspace	241-S-112	NA	NA	NA	Vapor	2002 m^3, no NH_3 present	No	NA	NA
244-S	Tank Headspace	DCRT 244-S	NA	NA	NA	Vapor	Unknown	No	NA	NA
241-S-304	Tank Headspace	Catch tank 241-S-304	NA	No data	NA	Vapor	Unknown	No	NA	No data on tank headspace composition available.
240-S-302	Tank Headspace	IMUST 240-S-302	NA	NA	NA	Vapor	17684 gal	No	NA	No data on tank headspace composition available.
241-S-302A	Tank Headspace	IMUST 241-S-302A	NA	NA	NA	Vapor	17684 gal	No	NA	No data on tank headspace composition available.
241-S-302B	Tank Headspace	IMUST 241-S-302B	NA	NA	NA	Vapor	14314 gal	No	NA	No data on tank headspace composition available.
241-S	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-S	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	NA
241-S	Contamination on Equipment or Tools	Old ventilation system	Residual	NA	NA	Residue	NA	Yes	NA	* Shared ventilation system is being dismantled. Sections are bagged and stored in conex boxes on the east side of the farm.
241-S	Contamination on Equipment or Tools	Cover blocks	Residual	NA	NA	Residue	NA	Yes	NA	* Cover blocks for tanks being saltwell pumped are stored on east side of the farm.
241-S	Contamination on Equipment or Tools	Bone yard	NA	NA	NA	NA	NA	Yes	NA	* Storage area for equipment on east side of the farm.
241-S	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-S	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA
241-S	Ventilation Filter Contents	Breather	NA	1 R/h at 6 inches	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0063-4	NA	Filter efficiency is tested annually and replaced if they fail.
241-S	Contamination In Ventilation System	De-entrainers	NA	NA	NA	NA	NA	NA	NA	NA
241-S	Contamination In Ventilation System	Seal loop	Oil and condensate	1 cup	NA	Liquid	Residual	No	1 per tank	Seal loops associated with breather filters on tanks.
241-S	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-S	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	No known sumps with material inventory in S Farm. See transfer line Table 7 for discussion of encasements.
241-S	Contamination in Pit or Box	Cleanout boxes COB 1 through 18, COB 51-1 and 52-1	Unknown	73 gal	NA	Unknown	Unknown	No	20 boxes	NA
241-S	Contamination in Pit or Box	Valve pits 241-S-A, B, C, D	Residual	3142 gal	NA	Residue	Unknown	No	4 pits	NA
241-S-A	Contamination in Pit or Box	Valve pit 241-S-A	Residual	3142 gal	NA	Residue	Unknown	No	1 pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-S-B	Contamination in Pit or Box	Valve pit 241-S-B	Residual	3142 gal	NA	Residue	Unknown	No	1 pit	NA
241-S-C	Contamination in Pit or Box	Valve pit 241-S-C	Residual	3142 gal	NA	Residue	Unknown	No	1 pit	NA
241-S-D	Contamination in Pit or Box	Valve pit 241-S-D	Residual	3142 gal	NA	Residue	Unknown	No	1 pit	NA
241-S-151	Contamination in Pit or Box	Diversion box 241-S-151	Residual	33510 gal	NA	Residue	Unknown	No	1 pit	NA
241-S-152	Contamination in Pit or Box	Diversion box 241-S-152	Residual	NA	NA	Residue	Unknown	No	1 pit	NA
241-S-01A	Contamination in Pit or Box	Pump pits 241-S-01A, 03A, 06A, 07A, 08A, 09A, 10A, 11A, 12A	Residual	2723 gal	NA	Residue	Unknown	No	9 pits	NA
241-S-02B	Contamination in Pit or Box	Distributor pit 241-S-02B	Residual	681 gal	NA	Residue	Unknown	No	1 pit	NA
241-S	Contamination in Pit or Box	Other pits	Residual	NA	NA	Residue	Unknown	No	NA	All other pits are weather covered.
241-S	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA
241-S-VSU	Other	Vertical storage units	NA	NA	Solid	Unknown *	Yes *	NA	* Riser plug and valve handle storage. Also may have misc tools.	NA
241-S	Other	Flammable storage cabinet	Paint	NA	NA	NA	NA	Yes	NA	Spray paint stored in flammable storage cabinet in bone yard.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-S	Other	Propane bottles	Propane	2 bottles	NA	Gas	NA	Yes	2 bottles	Propane for small space heater near green house on NE side of farm.
241-S	Other	Trailer	Liquid nitrogen propane	2 tanks	NA	Gas	NA	Yes	2 tanks	Trailer parked on outside of fence on west side of farm. Hose is routed to sample truck inside farm.
S Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed wastes	6 - 55 gal mixed waste drums (maximum)	NA	Solid	Low level (less than class C).	Yes	6 - 55 gal drums max capacity for each satellite enclosure.	S-Farm SAA covers S, SX, and SY farms. Inventories removed when filled, transported to 209-E 90 day storage facility.
241-SX-101	Tank Contents	241-SX-101	DC	1 million gal	Supernate Sludge Saltcake	Liquid Solid Solid	1 Kgal 112 Kgal 343 Kgal	No	NA	Scheduled completion of interim stabilization 3/31/99.
241-SX-102	Tank Contents	241-SX-102	DSSF	1 million gal	Sludge Saltcake	Solid Solid	117 Kgal 426 Kgal	No	NA	Scheduled completion of interim stabilization 9/30/98.
241-SX-103	Tank Contents	241-SX-103	NCPLX	1 million gal	Supernate Sludge Saltcake	Liquid Solid Solid	1 Kgal 115 Kgal 536 Kgal	No	NA	Scheduled completion of interim stabilization 2/28/99.
241-SX-104	Tank Contents	241-SX-104	DSSF	1 million gal	Sludge Saltcake	Solid Solid	136 Kgal 478 Kgal	No	NA	Assumed leaker, scheduled completion of interim stabilization 1/31/99.
241-SX-105	Tank Contents	241-SX-105	DSSF	1 million gal	Sludge Saltcake	Solid Solid	73 Kgal 610 Kgal	No	NA	Scheduled completion of interim stabilization 1/31/99.
241-SX-106	Tank Contents	241-SX-106	NCPLX	1 million gal	Supernate Sludge Saltcake	Liquid Solid Solid	61 Kgal 12 Kgal 465 Kgal	No	NA	Scheduled completion of interim stabilization 4/30/99.
241-SX-107	Tank Contents	241-SX-107	NCPLX	1 million gal	Sludge	Solid	104 Kgal	No	NA	Assumed leaker.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SX-108	Tank Contents	241-SX-108	NCPLX	1 million gal	Sludge	Solid	87 Kgal	No	NA	Assumed leaker.
241-SX-109	Tank Contents	241-SX-109	NCPLX	1 million gal	Saltcake	Solid	244 Kgal	No	NA	Assumed leaker.
241-SX-110	Tank Contents	241-SX-110	NCPLX	1 million gal	Sludge	Solid	62 Kgal	No	NA	Assumed leaker.
241-SX-111	Tank Contents	241-SX-111	NCPLX	1 million gal	Sludge	Solid	125 Kgal	No	NA	Assumed leaker, interim stabilized 7/79.
241-SX-112	Tank Contents	241-SX-112	NCPLX	1 million gal	Sludge	Solid	92 Kgal	No	NA	Assumed leaker, interim stabilized 7/79.
241-SX-113	Tank Contents	241-SX-113	NCPLX	1 million gal	Sludge	Solid	26 Kgal	No	NA	Assumed leaker, interim stabilized 11/78.
241-SX-114	Tank Contents	241-SX-114	NCPLX	1 million gal	Sludge	Solid	181 Kgal	No	NA	Assumed leaker, interim stabilized 7/79.
241-SX-115	Tank Contents	241-SX-115	NCPLX	1 million gal	Sludge	Solid	12 Kgal	No	NA	Assumed leaker, interim stabilized 9/78.
241-SX-302	Tank Contents	IMUST 241-SX-302	CPLX, DSSF, NCPLX	17684 gal	NA	Solid Supernate	1050 gal 305 gal	No	NA	Isolated.
241-SX-101	Tank Headspace	241-SX-101	NA	NA	NA	Vapor	3105 m^3, 9 g NH_3 present	No	NA	NA
241-SX-102	Tank Headspace	241-SX-102	NA	NA	NA	Vapor	2776 m^3, 33 g NH_3 present	No	NA	NA
241-SX-103	Tank Headspace	241-SX-103	NA	NA	NA	Vapor	2364 m^3, 140 g NH_3 present	No	NA	NA
241-SX-104	Tank Headspace	241-SX-104	NA	NA	NA	Vapor	2507 m^3, no NH_3 present	No	NA	NA
241-SX-105	Tank Headspace	241-SX-105	NA	NA	NA	Vapor	2246 m^3, no NH_3 present	No	NA	NA
241-SX-106	Tank Headspace	241-SX-106	NA	NA	NA	Vapor	2795 m^3, 390 g NH_3 present	No	NA	NA
241-SX-107	Tank Headspace	241-SX-107	NA	NA	NA	Vapor	4438 m^3, no NH_3 present	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SX-108	Tank Headspace	241-SX-108	NA	NA	NA	Vapor	4502 m^3, no NH_3 present	No	NA	NA
241-SX-109	Tank Headspace	241-SX-109	NA	NA	NA	Vapor	3908 m^3, no NH_3 present	No	NA	NA
241-SX-110	Tank Headspace	241-SX-110	NA	NA	NA	Vapor	4597 m^3, no NH_3 present	No	NA	NA
241-SX-111	Tank Headspace	241-SX-111	NA	NA	NA	Vapor	4358 m^3, no NH_3 present	No	NA	NA
241-SX-112	Tank Headspace	241-SX-112	NA	NA	NA	Vapor	4483 m^3, no NH_3 present	No	NA	NA
241-SX-113	Tank Headspace	241-SX-113	NA	NA	NA	Vapor	4733 m^3, no NH_3 present	No	NA	NA
241-SX-114	Tank Headspace	241-SX-114	NA	NA	NA	Vapor	4146 m^3, no NH_3 present	No	NA	NA
241-SX-115	Tank Headspace	241-SX-115	NA	NA	NA	Vapor	4786 m^3, no NH_3 present	No	NA	NA
241-SX-302	Tank Headspace	IMUST 241-SX-302	NA	NA	NA	Vapor	16329 gal	No	NA	No data on tank headspace composition available.
241-SX	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-SX	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	NA
241-SX	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	NA
241-SX	Ventilation Filter Contents	Primary	NA	1 R/h at 6 inches	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0063-4	NA	NA
241-SX	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SX	Ventilation Filter Contents	Breather	NA	1 R/h at 6 inches	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0063-4	NA	Filter efficiency is tested annually and replaced if they fail.
241-SX	Contamination In Ventilation System	De-entrainers	NA	NA	NA	NA	NA	NA	NA	NA
241-SX.	Contamination In Ventilation System	Seal loop	Oil and condensate	1 cup	NA	Liquid	Residual	No	One per tank	Seal loops associated with breather filters on all tanks.
241-SX	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-SX	Contents of Sump or Encasement	NA	NA	NA	NA	NA	NA	NA	NA	No known sumps with material inventory in SX Farm. See transfer line Table 7 for discussion of encasements.
241-SX-01A	Contamination in Pit or Box	Pump pit 241-SX-01A	Residual	2245 gal	NA	Residue	NA	No	1 pit	NA
241-SX-04A	Contamination in Pit or Box	Pump pit 241-SX-04A	Residual	2245 gal	NA	Residue	NA	No	1 pit	NA
241-SX-06A	Contamination in Pit or Box	Pump pit 241-SX-06A	Residual	2245 gal	NA	Residue	NA	No	1 pit	NA
241-SX-05A	Contamination in Pit or Box	Pump pit 241-SX-05A	Residual	992 gal	NA	Residue	NA	No	1 pit	NA
241-SX-103B	Contamination in Pit or Box	Distributor pit 241-SX-103B	Residual	3042 gal	NA	Residue	NA	No	1 pit	NA
241-SX-105B	Contamination in Pit or Box	Distributor pit 241-SX-105B	Residual	4031 gal	NA	Residue	NA	No	1 pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SX-A	Contamination in Pit or Box	Valve box 241-SX-A	Residual	3142 gal	NA	Residue	NA	No	1 box	NA
241-SX-B	Contamination in Pit or Box	Valve box 241-SX-B	Residual	3142 gal	NA	Residue	NA	No	1 box	NA
241-SX-151	Contamination in Pit or Box	Diversion box 241-SX-151	Residual	NA	NA	Residue	NA	No	1 box	* Both diversion boxes are weather covered.
241-SX-152	Contamination in Pit or Box	Diversion box 241-SX-152	Residual	NA	NA	Residue	NA	No	1 box	* Both diversion boxes are weather covered.
241-SX	Contamination in Pit or Box	Other pits and boxes	Residual	NA	NA	Residue	NA	No	NA	All other pits in SX Farm are weather covered.
241-SX	SARA 313 Materials	Gas bottles for PCM1B	90% argon / 10% methane	480 cubic feet	NA	Gas	480 cubic feet	Yes	2 bottles	NA
241-SX	Other	Material storage	Miscellaneous equipment storage	NA	NA	Solid	NA	Yes	NA	* North of change trailer outside of west fence.
241-SY-101	Tank Contents	241-SY-101	CC	1.16 M gal	NA	Bulk	1109 Kgal	No	NA	NA
241-SY-102	Tank Contents	241-SY-102	DN/PT	1.16 M gal	NA	Liquid Solid	310 Kgal 71 Kgal	No	NA	NA
241-SY-103	Tank Contents	241-SY-103	CC	1.16 M gal	NA	Liquid Solid	382 Kgal 362 Kgal	No	NA	NA
241-SY-101	Tank Headspace	241-SY-101	NA	NA	NA	Vapor	1125 m^3, see comment for NH_3	No	NA	* For SY Tank Farm Stack, the head space volumes were combined to calculate the total amount of ammonia.
241-SY-102	Tank Headspace	241-SY-102	NA	NA	NA	Vapor	3885 m^3, see comment for NH_3	No	NA	* For SY Tank Farm Stack, the head space volumes were combined to calculate the total amount of ammonia.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SY-103	Tank Headspace	241-SY-103	NA	NA	NA	Vapor	2507 m^3, see comment for NH_3	No	NA	* For SY Tank Farm Stack, the head space volumes were combined to calculate the total amount of ammonia.
241-SY	Tank Headspace	SY stack	NA	NA	NA	Vapor	7517 m^3, 640 g NH_3	No	NA	* For SY Tank Farm Stack, the head space volumes were combined to calculate the total amount of ammonia.
241-SY	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-SY	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	NA
241-SY	Contamination on Equipment or Tools	101-SY mixer	Tank waste	NA	NA	NA	NA	NA	NA	Mixer for tank 101-SY. Shielding is provided on east side of the SY Farm for change out.
241-SY	Ventilation Filter Contents	Primary	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	* Need surface rad measurements	Yes - disposal in accord w/ WHC-EP-0064-4	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufacturers specs.
241-SY	Ventilation Filter Contents	Annulus	NA	200 mR/hr maximum for all HEPA filters	NA	Particulate	* Need surface rad measurements	Yes - disposal in accord w/ WHC-EP-0064-4	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufacturers specs.
241-SY	Ventilation Filter Contents	Inlet breather	NA	1 R/h at 6 inches	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0064-4	NA	HEPA filters monitored for DP drop/loading in accordance w/ manufacturers specs.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SY	Contamination In Ventilation System	De-entrainers	Condensate	NA	NA	Liquid	NA	NA	NA	NA
241-SY	Contamination In Ventilation System	Seal loop	Condensate	NA	NA	Liquid	NA	NA	NA	Drains to SY-102 drain pit.
241-SY	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-SY	Contents of Sump or Encasement	NA	NA	NA	NA	NA	NA	NA	NA	No known sumps with material inventory in SY-Farm. See transfer line Table 7 for discussion of encasements.
241-SY-01A	Contamination in Pit or Box	Pump pit 241-SY-01A	Residual	2374 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-03A	Contamination in Pit or Box	Pump pit 241-SY-03A	Residual	2374 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-02A	Contamination in Pit or Box	Pump pit 241-SY-02A	Residual	2513 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-01B	Contamination in Pit or Box	Annulus pump pit 241-SY-01B	Residual	1231 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-02B	Contamination in Pit or Box	Annulus pump pit 241-SY-02B	Residual	1231 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-03B	Contamination in Pit or Box	Annulus pump pit 241-SY-03B	Residual	1231 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-01C	Contamination in Pit or Box	Leak detection pit 241-SY-01C	Residual	1356 gal	NA	Residue	Unknown	No	1 pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SY-02C	Contamination in Pit or Box	Leak detection pit 241-SY-02C	Residual	1356 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-03C	Contamination in Pit or Box	Leak detection pit 241-SY-03C	Residual	1356 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-02D	Contamination in Pit or Box	Drain pit 241-SY-02D	Residual	1459 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-02E	Contamination in Pit or Box	Feed pump pit 241-SY-02E	Residual	2474 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-A	Contamination in Pit or Box	Valve pits 241-SY-A	Residual	4413 gal	NA	Residue	Unknown	No	1 pit	NA
241-SY-B	Contamination in Pit or Box	Valve pits 241-SY-B	Residual	4413 gal	NA	Residue	Unknown	No	1 pit	NA
COB-SY-1-6	Contamination in Pit or Box	Clean out boxes COB-SY-1 through SY-6	Residual	181 gal	NA	Residue	Unknown	No	6 boxes	NA
241-SY-1	Contamination in Pit or Box	Clean out box COB-SY-1	Residual	181 gal	NA	Residue	Unknown	No	1 box	NA
241-SY-2	Contamination in Pit or Box	Clean out box COB-SY-2	Residual	181 gal	NA	Residue	Unknown	No	1 box	NA
241-SY-3	Contamination in Pit or Box	Clean out box COB-SY-3	Residual	181 gal	NA	Residue	Unknown	No	1 box	NA
241-SY-4	Contamination in Pit or Box	Clean out box COB-SY-4	Residual	181 gal	NA	Residue	Unknown	No	1 box	NA
241-SY-5	Contamination in Pit or Box	Clean out box COB-SY-5	Residual	181 gal	NA	Residue	Unknown	No	1 box	NA
241-SY-6	Contamination in Pit or Box	Clean out box COB-SY-6	Residual	181 gal	NA	Residue	Unknown	No	1 box	NA
241-SY	SARA 313 Materials	PCM1B gas bottles	90% argon / 10% methane	480 cubic feet	NA	Gas	480 cubic feet	Yes	2 bottles	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-SY	Other	Liquid nitrogen	Nitrogen	~1500 gal	NA	Gas	Unknown	No	1 large tank	North side of SY Farm.
241-SY	Other	Diesel generator	Diesel fuel	NA	NA	Liquid	Unknown	Yes	1 generator	North side of 241-SY-271 instrument building.
241-SY	Other	Hydrogen bottles	.01%H2, 99.99% air 5.0% H2, 95.0% air	480 cubic feet	NA	Gas	480 cubic feet	Yes	2 bottles per SHMS cabinet *	* 2 SHMS on Tank 101-SY and 1 on Tank 103-SY. Calibration bottles for instrumentation.
241-T-101	Tank Contents	241-T-101	NCPLX	530 Kgal	Supernate Sludge	Liquid Solid	1 Kgal 101 Kgal	No	NA	Assumed leaker, interim stabilized 4/93.
241-T-102	Tank Contents	241-T-102	NCPLX	530 Kgal	Supernate Sludge	Liquid Solid	13 Kgal 19 Kgal	No	NA	Interim stabilized 3/81 under old criteria, must meet new criteria.
241-T-103	Tank Contents	241-T-103	NCPLX	530 Kgal	Supernate Sludge	Liquid Solid	4 Kgal 23 Kgal	No	NA	Assumed leaker, interim stabilized 11/83.
241-T-104	Tank Contents	241-T-104	NCPLX	530 Kgal	Supernate Sludge	Liquid Solid	3 Kgal 442 Kgal	No	NA	Scheduled completion of interim stabilization 7/31/96.
241-T-105	Tank Contents	241-T-105	NCPLX	530 Kgal	Sludge	Solid	98 Kgal	No	NA	Interim stabilized 6/87.
241-T-106	Tank Contents	241-T-106	NCPLX	530 Kgal	Supernate Sludge	Liquid Solid	2 Kgal 19 Kgal	No	NA	Assumed leaker, interim stabilized 8/81.
241-T-107	Tank Contents	241-T-107	NCPLX	530 Kgal	Sludge	Solid	173 Kgal	No	NA	Assumed leaker, scheduled completion of interim stabilization 4/30/96.
241-T-108	Tank Contents	241-T-108	NCPLX	530 Kgal	Sludge	Solid	44 Kgal	No	NA	Assumed leaker, interim stabilized 11/78.
241-T-109	Tank Contents	241-T-109	NCPLX	530 Kgal	Sludge	Solid	58 Kgal	No	NA	Assumed leaker, interim stabilized 12/84.
241-T-110	Tank Contents	241-T-110	NCPLX	530 Kgal	Supernate Sludge	Liquid Solid	3 Kgal 376 Kgal	No	NA	Scheduled completion of interim stabilization 2/28/97.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-T-111	Tank Contents	241-T-111	NCPLX	530 Kgal	Sludge	Solid	446 Kgal	No	NA	Assumed leaker, interim stabilized 12/94.
241-T-112	Tank Contents	241-T-112	NCPLX	530 Kgal	Supernate Sludge	Liquid Solid	7 Kgal 60 Kgal	No	NA	Interim stabilized 3/81 under old criteria, must meet new criteria.
241-T-201	Tank Contents	241-T-201	NCPLX	55 Kgal	Supernate Sludge	Liquid Solid	1 Kgal 28 Kgal	No	NA	NA
241-T-202	Tank Contents	241-T-202	NCPLX	55 Kgal	Sludge	Solid	21 Kgal	No	NA	NA
241-T-203	Tank Contents	241-T-203	NCPLX	55 Kgal	Sludge	Solid	35 Kgal	No	NA	NA
241-T-204	Tank Contents	241-T-204	NCPLX	55 Kgal	Sludge	Solid	38 Kgal	No	NA	NA
241-T-301	Tank Contents	IMUST 241-T-301	Supernate 6.58E-07 g/gal PU 1600 µCi/gal Cs137 304 µCi/gal Sr90 solids 3040 µCi/gal Sr90	36000 gal	NA	Solid Supernate	21658 gal 588 gal	No	NA	NA
242-T-135	Tank Contents	IMUST 242-T-135	No data	Unknown	No data	NA	NA	NA	NA	NA
241-T-101	Tank Headspace	241-T-101	NA	NA	NA	Vapor	2853 m^3, no NH_3 present	No	NA	NA
241-T-102	Tank Headspace	241-T-102	NA	NA	NA	Vapor	3118 m^3, no NH_3 present	No	NA	NA
241-T-103	Tank Headspace	241-T-103	NA	NA	NA	Vapor	3137 m^3, no NH_3 present	No	NA	NA
241-T-104	Tank Headspace	241-T-104	NA	NA	NA	Vapor	1555 m^3, no NH_3 present	No	NA	NA
241-T-105	Tank Headspace	241-T-105	NA	NA	NA	Vapor	2869 m^3, no NH_3 present	No	NA	NA
241-T-106	Tank Headspace	241-T-106	NA	NA	NA	Vapor	3160 m^3, no NH_3 present	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-T-107	Tank Headspace	241-T-107	NA	NA	NA	Vapor	2585 m^3, 250/190 g	No	NA	NA
241-T-108	Tank Headspace	241-T-108	NA	NA	NA	Vapor	3073 m^3, no NH_3 present	No	NA	NA
241-T-109	Tank Headspace	241-T-109	NA	NA	NA	Vapor	3020 m^3, no NH_3 present	No	NA	NA
241-T-110	Tank Headspace	241-T-110	NA	NA	NA	Vapor	1805 m^3, 60 g NH_3	No	NA	NA
241-T-111	Tank Headspace	241-T-111	NA	NA	NA	Vapor	1551 m^3, 260 g NH_3	No	NA	NA
241-T-112	Tank Headspace	241-T-112	NA	NA	NA	Vapor	2986 m^3, 120 g NH_3	No	NA	NA
241-T-201	Tank Headspace	241-T-201	NA	NA	NA	Vapor	124 m^3, no NH_3 present	No	NA	NA
241-T-202	Tank Headspace	241-T-202	NA	NA	NA	Vapor	154 m^3, no NH_3 present	No	NA	NA
241-T-203	Tank Headspace	241-T-203	NA	NA	NA	Vapor	101 m^3, no NH_3 present	No	NA	NA
241-T-204	Tank Headspace	241-T-204	NA	NA	NA	Vapor	90 m^3, no NH_3 present	No	NA	NA
241-T-301	Tank Headspace	IMUST 241-T-301	NA	NA	NA	Vapor	13754 gal	No	NA	No data on tank headspace composition available.
241-T-135	Tank Headspace	IMUST 242-T-135	NA	No data	NA	NA	NA	NA	NA	NA
241-T	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-T	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	NA
241-T	Contamination on Equipment or Tools	Hand tools	NA	NA	NA	NA	NA	Yes	NA	Hand tools stored next to Satellite Accumulation Area for in-farm usage.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-T	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA
241-T	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA
241-T	Ventilation Filter Contents	Breather	NA	1 R/h at 6 inches	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0063-4	NA	Filter efficiency is tested annually and replaced if they fail.
241-T	Contamination In Ventilation System	De-entrainers	NA	NA	NA	NA	NA	NA	NA	NA
241-T	Contamination In Ventilation System	Seal loop	Oil and condensate	1 cup	NA	Liquid	NA	NA	NA	Seal loops associated with breather filters on all tanks.
241-T	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-T	Contents of Sump or Encasement	NA	NA	NA	NA	NA	NA	NA	NA	No known sumps with material inventory in T Farm.
241-T-04A	Contamination in Pit or Box	Pump pit 241-T-104	Residual	1057 gal	NA	Residue	Unknown	No	1 pit	NA
241-T-05A	Contamination in Pit or Box	Pump pit 241-T-105	Residual	1057 gal	NA	Residue	Unknown	No	1 pit	NA
241-T-07A	Contamination in Pit or Box	Pump pit 241-T-107	Residual	1057 gal	NA	Residue	Unknown	No	1 pit	NA
241-T-09A	Contamination in Pit or Box	Pump pit 241-T-109	Residual	1057 gal	NA	Residue	Unknown	No	1 pit	NA
241-T-10A	Contamination in Pit or Box	Pump pit 241-T-110	Residual	1057 gal	NA	Residue	Unknown	No	1 pit	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-T-11A	Contamination in Pit or Box	Pump pit 241-T-111	Residual	1057 gal	NA	Residue	Unknown	No	1 pit	NA
241-T-01B	Contamination in Pit or Box	Heel pit 241-T-01B	Residual	6860 gal	NA	Residue	Unknown	No	1 pit	NA
241-T-DIV	Contamination in Pit or Box	Diversion box 240-T-151, 152,153,252, TR-152,153	Residual	NA	NA	Residue	Unknown	No	6 boxes	All are weather covered.
240-T-151	Contamination in Pit or Box	Diversion box 240-T-151	Residual	NA	NA	Residue	Unknown	No	1 box	All are weather covered.
240-T-152	Contamination in Pit or Box	Diversion box 240-T-152	Residual	NA	NA	Residue	Unknown	No	1 box	All are weather covered.
240-T-153	Contamination in Pit or Box	Diversion box 240-T-153	Residual	NA	NA	Residue	Unknown	No	1 box	All are weather covered.
240-T-252	Contamination in Pit or Box	Diversion box 240-T-252	Residual	NA	NA	Residue	Unknown	No	1 box	All are weather covered.
240-TR-152	Contamination in Pit or Box	Diversion box 240-TR-152	Residual	NA	NA	Residue	Unknown	No	1 box	All are weather covered.
240-TR-153	Contamination in Pit or Box	Diversion box 240-TR-153	Residual	NA	NA	Residue	Unknown	No	1 box	All are weather covered.
241-T	SARA 313 Materials	Gas bottles for PCM1B	90% argon / 10% methane	480 cubic feet	NA	Vapor	480 cubic feet per bottle	Yes	2 bottles	Located outside change trailer.
241-T	Other	Conex storage	NA	NA	NA	NA	NA	NA	1 conex box	* Temporary storage (conex) located southwest of T-112.
T Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed waste	6 - 55 gal drums maximum storage	NA	NA	NA	NA	None	* Located south of conex storage.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-T	Other	Gas generator	NA	NA	NA	NA	NA	NA	1 generator	* Gasoline powered generator located southwest of T-112 along the south fence.
241-T	Other	Tool storage	NA	NA	NA	NA	NA	NA	1 tool storage box	* Located next to SAA.
241-T	Other	Contaminated burial boxes	NA	NA	NA	NA	NA	NA	2 boxes	* Located south of hazard storage.
241-T	Other	Building	NA	NA	NA	NA	NA	NA	NA	* Small pink building Northwest of Tank T-102. Assumed asbestos.
216-T-1	Other	Ditch 216-T-1	NA	NA	NA	NA	NA	NA	NA	This ditch received 178,000,000 liters of cooling water waste, decon. waste, and sodium hydroxide wash water solution from 221-T, 271-T, and Sodium-Air Water Reaction Emergency Air Cleaning Development - HEDL.
216-T-4-2	Other	Ditch 216-T-4-2	NA	NA	NA	NA	NA	NA	NA	This ditch received steam condensate and condenser cooling water form 242-T and 221-T.
216-T-7	Other	Crib 216-T-7	NA	NA	NA	NA	NA	NA	NA	Received waste from 221-T, and 224-T buildings. The waste is high salt and neutral/basic.
216-T-32	Other	Crib 216-T-32	NA	NA	NA	NA	NA	NA	NA	Received waste from the 224-T building via the 201-T tank. The waste is high salt and neutral/basic.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TX-101	Tank Contents	241-TX-101	NCPLX	758 K gal	Supernate Sludge	Liquid Solid	3 Kgal 84 Kgal	No	NA	Interim stabilized 2/84.
241-TX-102	Tank Contents	241-TX-102	NCPLX	758 K gal	Saltcake	Solid	217 Kgal	No	NA	Interim stabilized 4/83.
241-TX-103	Tank Contents	241-TX-103	NCPLX	758 K gal	Sludge	Solid	157 Kgal	No	NA	Interim stabilized 8/83.
241-TX-104	Tank Contents	241-TX-104	NCPLX	758 K gal	Supernate Saltcake	Liquid Solid	1 Kgal 64 Kgal	No	NA	Interim stabilized 9/79.
241-TX-105	Tank Contents	241-TX-105	NCPLX	758 K gal	Saltcake	Solid	609 Kgal	No	NA	Assumed leaker, interim stabilized 4/83.
241-TX-106	Tank Contents	241-TX-106	NCPLX	758 K gal	Saltcake	Solid	453 Kgal	No	NA	Interim stabilized 6/83.
241-TX-107	Tank Contents	241-TX-107	NCPLX	758 K gal	Supernate Saltcake	Liquid Solid	1 Kgal 35 Kgal	No	NA	Assumed leaker, interim stabilized 10/79.
241-TX-108	Tank Contents	241-TX-108	NCPLX	758 K gal	Saltcake	Solid	134 Kgal	No	NA	Interim stabilized 3/83.
241-TX-109	Tank Contents	241-TX-109	NCPLX	758 K gal	Saltcake	Solid	384 Kgal	No	NA	Interim stabilized 4/83.
241-TX-110	Tank Contents	241-TX-110	NCPLX	758 K gal	Saltcake	Solid	462 Kgal	No	NA	Assumed leaker, interim stabilized 4/83.
241-TX-111	Tank Contents	241-TX-111	NCPLX	758 K gal	Saltcake	Solid	370 Kgal	No	NA	Interim stabilized 4/83.
241-TX-112	Tank Contents	241-TX-112	NCPLX	758 K gal	Saltcake	Solid	649 Kgal	No	NA	Interim stabilized 4/83.
241-TX-113	Tank Contents	241-TX-113	NCPLX	758 K gal	Saltcake	Solid	607 Kgal	No	NA	Assumed leaker, interim stabilized 4/83.
241-TX-114	Tank Contents	241-TX-114	NCPLX	758 K gal	Saltcake	Solid	535 Kgal	No	NA	Assumed leaker, interim stabilized 4/83.
241-TX-115	Tank Contents	241-TX-115	NCPLX	758 K gal	Saltcake	Solid	640 Kgal	No	NA	Assumed leaker, interim stabilized 9/83.
241-TX-116	Tank Contents	241-TX-116	NCPLX	758 K gal	Saltcake	Solid	631 Kgal	No	NA	Assumed leaker, interim stabilized 4/83.
241-TX-117	Tank Contents	241-TX-117	NCPLX	758 K gal	Saltcake	Solid	626 Kgal	No	NA	Assumed leaker, interim stabilized 3/83.
241-TX-118	Tank Contents	241-TX-118	NCPLX	758 K gal	Saltcake	Solid	347 Kgal	No	NA	Interim stabilized 4/83.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TX-302A	Tank Contents	241-TX-302A IMUST	Cs 137 Supernate 48µCi/gal	17684	NA	Solids Supernate	2450 gal 30 gal	No	NA	NA
241-TX-302B(R)	Tank Contents	241-TX-302B(R) IMUST	NA	12000	NA	No data	0 gal	No	NA	NA
241-TX-302B	Tank Contents	241-TX-302B IMUST	NA	17684	NA	No data	1320 gal	No	NA	NA
241-TX-302X	Tank Contents	241-TX-302X IMUST	NA	14314	NA	Solids Supernate	108 gal 245 gal	No	NA	NA
241-TX-001	Tank Contents	244-TX-001 IMUST	Cs 137 supernate 16995µCi/gal	50000	NA	Solids Supernate	2291 gal 49 gal	No	NA	NA
241-TX-002	Tank Contents	244-TX-002 IMUST	Cs 137 supernate 83270µCi/gal PU supernate 0.72 µg/L	15000	NA	Solids	2945 gal	No	NA	NA
241-TX-003	Tank Contents	244-TX-003 IMUST	NA	15000	NA	Solids	6460 gal	No	NA	NA
242-TA-R1	Tank Contents	242-TA-R1 IMUST	No data *	No data	NA	No data	No data	No	NA	* Waste is noted as being very hot radiologically.
241-TX-302C	Tank Contents	241-TX-302C Catch Tank	No data *	14556 gal	NA	No data	5040 gal	No	NA	* Waste from 241-TX-154 diversion box.
241-TX-101	Tank Headspace	241-TX-101	NA	NA	NA	Vapor	3652 m^3	No	NA	NA
241-TX-102	Tank Headspace	241-TX-102	NA	NA	NA	Vapor	3160 m^3	No	NA	NA
241-TX-103	Tank Headspace	241-TX-103	NA	NA	NA	Vapor	3387 m^3	No	NA	NA
241-TX-104	Tank Headspace	241-TX-104	NA	NA	NA	Vapor	3735 m^3	No	NA	NA
241-TX-105	Tank Headspace	241-TX-105	NA	NA	NA	Vapor	1676 m^3, 25 g NH_3	No	NA	NA
241-TX-106	Tank Headspace	241-TX-106	NA	NA	NA	Vapor	2267 m^3	No	NA	NA
241-TX-107	Tank Headspace	241-TX-107	NA	NA	NA	Vapor	3845 m^3, 560 g NH_3	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TX-108	Tank Headspace	241-TX-108	NA	NA	NA	Vapor	3474 m^3	No	NA	NA
241-TX-109	Tank Headspace	241-TX-109	NA	NA	NA	Vapor	2528 m^3, 1080 g NH_3	No	NA	NA
241-TX-110	Tank Headspace	241-TX-110	NA	NA	NA	Vapor	2233 m^3	No	NA	NA
241-TX-111	Tank Headspace	241-TX-111	NA	NA	NA	Vapor	2581 m^3, 72 g NH_3	No	NA	NA
241-TX-112	Tank Headspace	241-TX-112	NA	NA	NA	Vapor	1525 m^3	No	NA	NA
241-TX-113	Tank Headspace	241-TX-113	NA	NA	NA	Vapor	1684 m^3	No	NA	NA
241-TX-114	Tank Headspace	241-TX-114	NA	NA	NA	Vapor	1956 m^3	No	NA	NA
241-TX-115	Tank Headspace	241-TX-115	NA	NA	NA	Vapor	1559 m^3	No	NA	NA
241-TX-116	Tank Headspace	241-TX-116	NA	NA	NA	Vapor	1593 m^3	No	NA	NA
241-TX-117	Tank Headspace	241-TX-117	NA	NA	NA	Vapor	1612 m^3	No	NA	NA
241-TX-118	Tank Headspace	241-TX-118	NA	NA	NA	Vapor	2668 m^3, 67 g NH_3	No	NA	NA
241-TX-302A	Tank Headspace	241-TX-302A IMUST	NA	NA	NA	Vapor	15204 gal *	No	NA	* No data on tank headspace composition available.
241-TX-302B(R)	Tank Headspace	241-TX-302B(R) IMUST	NA	NA	NA	Vapor	12000 gal *	No	NA	* No data on tank headspace composition available.
241-TX-302B	Tank Headspace	241-TX-302B IMUST	NA	NA	NA	Vapor	1 7684 gal *	No	NA	* No data on tank headspace composition available.
241-TX-302X	Tank Headspace	241-TX-302X IMUST	NA	NA	NA	Vapor	13961 gal	No	NA	* No data on tank headspace composition available.
241-TX-001	Tank Headspace	244-TX-001 IMUST	NA	NA	NA	Vapor	47660 gal *	No	NA	* No data on tank headspace composition available.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TX-002	Tank Headspace	244-TX-002 IMUST	NA	NA	NA	Vapor	12055 gal *	No	NA	* No data on tank headspace composition available.
241-TX-003	Tank Headspace	244-TX-003 IMUST	NA	NA	NA	Vapor	8540 gal *	No	NA	* No data on tank headspace composition available.
242-TA-R1	Tank Headspace	242-TA-R1 IMUST	NA	NA	NA	Vapor	Unknown	No	NA	* No data on tank headspace composition available.
241-TX-302C	Tank Headspace	241-TX-302C Catch tank	NA	NA	NA	Vapor	Unknown	No	NA	* No data on tank headspace composition available.
241-TX	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-TX	Contamination on Vehicle	Garbage truck	NA	NA	NA	NA	NA	Yes	NA	Garbage truck located south of change trailer outside of fence in contaminated vehicle parking area.
241-TX	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	Tool crib located in Tx Farm contained misc small tools, no contamination detected on rad survey.
241-TX	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA
241-TX	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA
241-TX	Ventilation Filter Contents	Breather	NA	1 R/h at 6 inches	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0063-4	NA	Filter efficiency is tested annually and replaced if they fail.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TX	Ventilation Filter Contents	Filter on vent system for DCRT 244-TX	NA	1 R/h at 6 inches	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0063-4	NA	Filter efficiency is tested annually and are replaced if they fail.
241-TX	Contamination In Ventilation System	De-entrainers	NA	NA	NA	NA	NA	NA	NA	NA
241-TX	Contamination In Ventilation System	Seal loop	Oil and condensate	1 cup	NA	Liquid	Residual	NA	NA	Seal loops associated with breather filters on tanks.
241-TX	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
244-TX	Contents of Sump or Encasement	244-TX DCRT vault	NA	54,000 gal. *	NA	NA	NA	NA	NA	* Volume of vault = 85,000 gal - tank volume (31,000 gal).
241-TX	Contamination in Pit or Box	Pump pits	Residual	NA	NA	Residue	NA	No	NA	All pump pits in TX Farm are weather covered and inactive .
241-TX	Contamination in Pit or Box	Sluice pits	Residual	NA	NA	Residue	NA	No	NA	All sluice pits in TX Farm are weather covered and inactive.
241-TX	Contamination in Pit or Box	Heel pit	Residual	NA	NA	Residue	NA	No	NA	241-TX-112 Heel pit is weather covered and inactive.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TXR-151-3	Contamination in Pit or Box	Diversion boxes * 241-TXR-151, 241-TXR-152, 241-TXR-153, 241-TX-153, 241-TX-155, 242-T-151	Residual	NA	NA	Residue	NA	No	NA	* All listed diversion boxes are weather covered.
241-TXR-151	Contamination in Pit or Box	Diversion box 241-TXR-151	Residual	NA	NA	Residue	NA	No	NA	* All listed diversion boxes are weather covered.
241-TXR-152	Contamination in Pit or Box	Diversion box 241-TXR-152	Residual	NA	NA	Residue	NA	No	NA	* All listed diversion boxes are weather covered.
241-TXR-153	Contamination in Pit or Box	Diversion box 241-TXR-153	Residual	NA	NA	Residue	NA	No	NA	* All listed diversion boxes are weather covered.
241-TX-153	Contamination in Pit or Box	Diversion box 241-TX-153	Residual	NA	NA	Residue	NA	No	NA	* All listed diversion boxes are weather covered.
241-TX-155	Contamination in Pit or Box	Diversion box 241-TX-155	Residual	NA	NA	Residue	NA	No	NA	* All listed diversion boxes are weather covered.
241-T-151	Contamination in Pit or Box	Diversion box 241-T-151	Residual	NA	NA	Residue	NA	No	NA	* All listed diversion boxes are weather covered.
241-TX-152	Contamination in Pit or Box	241-TX-152	Residual	2082 gal	NA	Residue	NA	No	NA	NA
241-TX-154	Contamination in Pit or Box	241-TX-154	Residual	24,832 gal *	NA	Residue	NA	No	NA	* Includes diversion box, pipe pit, and jumper storage.
241-TX	SARA 313 Materials	Gas bottles for PCM1B *	90% argon / 10% methane	480 cubic feet	NA	Gas	480 cubic feet	Yes	2 bottles	* Outside the TX-Farm change trailer.
241-TX	Other	Water tanks w/gas powered pump	Water	~2500 gal	NA	Liquid	Unknown	Yes	2 tanks	* Stored on outside of west fence, south of change trailer.
241-TX	Other	Herbicide	Herbicide	~25 bags	NA	Solid	Unknown	Yes	~ 25 bags	* Herbicide on pallet wrapped in plastic.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
TX Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed wastes	6 -55 gal mixed waste drums (maximum)	NA	Solid	Low level (less than class C)	Yes	6 - 55 gal drums max capacity for each satellite enclosure	Inventories removed when filled, transported to 209-E 90 day storage facility.
241-TX	Other	Liquid nitrogen	Liquid nitrogen	2 bottles	NA	Vapor	NA	Yes	2 bottles	Stored outside west fence labeled "Rust Geotech."
241-TY-101	Tank Contents	241-TY-101	NCPLX	758 Kgal	Sludge	Solid	118 Kgal	No	NA	Assumed leaker, interim stabilized 4/84.
241-TY-102	Tank Contents	241-TY-102	NCPLX	758 Kgal	Saltcake	Solid	64 Kgal	No	NA	Tank sound, interim stabilized 9/79
241-TY-103	Tank Contents	241-TY-103	NCPLX	758 Kgal	Sludge	Solid	162 Kgal	No	NA	Assumed leaker, interim stabilized 2/83.
241-TY-104	Tank Contents	241-TY-104	NCPLX	758 Kgal	Supernate Sludge	Liquid Solid	43 Kgal	No	NA	Assumed leaker, interim stabilized 11/83.
241-TY-105	Tank Contents	241-TY-105	NCPLX	758 Kgal	Sludge	Solid	231 Kgal	No	NA	Assumed leaker, interim stabilized 2/83.
241-TY-106	Tank Contents	241-TY-106	NCPLX	758 Kgal	Sludge	Solid	17 Kgal	No	NA	Assumed leaker, interim stabilized 11/78.
241-TY-302A	Tank Contents	241-TY-302A (IMUST)	NA	17,684 gal	Sludge	Solid	450 gal	No	NA	No data available for material composition.
241-TY-302B	Tank Contents	241-TY-302B (IMUST)	NA	14,314 gal	NA	NA	0 gal	No	NA	No data available for material composition.
216-TY-201	Tank Contents	216-TY-201 (IMUST)	NA	19,200 gal	No data	No data	No data	No data	NA	Concrete tank received waste from TY-Farm and transferred it to the 216-T cribs.
241-TY-101	Tank Headspace	241-TY-101	NA	NA	NA	Vapor	3535 m^3, 12 mg/m^3 NH_3 present.	No	NA	Tank TY-101 has tank vapor space sampling probe installed (temporary).

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TY-102	Tank Headspace	241-TY-102	NA	NA	NA	Vapor	3739 m^3, no NH_3 present	No	NA	Tank TY-102 scheduled to have tank vapor space sampling probe installed.
241-TY-103	Tank Headspace	241-TY-103	NA	NA	NA	Vapor	3368 m^3, 37 mg/m^3 NH_3 present	No	NA	Tank TY-103 has tank vapor space sampling probe installed (temporary).
241-TY-104	Tank Headspace	241-TY-104	NA	NA	NA	Vapor	3807 m^3, 46 mg/m^3 NH_3 present	No	NA	Tank TY-104 has tank vapor space sampling probe installed (temporary).
241-TY-105	Tank Headspace	241-TY-105	NA	NA	NA	Vapor	3107 m^3, no NH_3 present	No	NA	NA
241-TY-106	Tank Headspace	241-TY-106	NA	NA	NA	Vapor	3917 m^3, no NH_3 present	No	NA	NA
241-TY-302A	Tank Headspace	241-TY-302A (IMUST)	NA	NA	NA	Vapor	17,234 gal	No	NA	NA
241-TY-302B	Tank Headspace	241-TY-302B (IMUST)	NA	NA	NA	Vapor	14,314 gal	No	NA	NA
216-TY-201	Tank Headspace	216-TY-201 (IMUST)	NA	NA	NA	Vapor	19,200 gal	No	NA	NA
241-TY	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers in TY farm.
241-TY	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	NA
241-TY	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No stored equipment in Ty farm.
241-TY	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	TY farm has only SST's with passive ventilation.
241-TY	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	TY farm has only SST's, no annulus.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-TY	Ventilation Filter Contents	Breather	Residual	1 R/h at 6 inches	NA	Particulate	NA	Yes-disposal in accord w/ WHC-EP-0063-4 (9/93)	1 per tank	HEPA breather filters located on each tank.
241-TY	Contamination In Ventilation System	De-entrainers	NA	NA	NA	NA	NA	No	NA	No de-entrainers in Ty Farm.
241-TY	Contamination In Ventilation System	Seal loop	Residual	~1 cup (breather filter loop)	NA	Liquid (oil)	NA	No	~1 cup oil in breather filter seal loop	Same for all TY Tanks 101-106.
241-TY	Contents of Pipeline and/or Source Tank During Transfer	None	NA	NA	NA	NA	NA	No	NA	Refer to transfer line Table 7.
241-TY	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	No	NA	No sumps/encasements in TY farm.
241-TY	Contamination in Pit or Box	All pits	NA	NA	NA	NA	Residual	No	NA	All pits in TY-Farm are weather covered.
241-TY	Contamination in Pit or Box	Valve box	NA	NA	NA	NA	Residual	No	NA	Valve box located between 241-TY-105/106, used for waste routing within TY Farm, below grade.
241-TY	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	No SARA 313 materials listed for the TY farm.
241-TY	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-U-101	Tank Contents	241-U-101	NCPLX	530 K gal	Supernate Sludge	Liquid Solid	3 Kgal 22 Kgal	No	NA	Assumed leaker, interim stabilized 9/79.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-U-102	Tank Contents	241-U-102	NCPLX	530 K gal	Supernate Sludge Saltcake	Liquid Solid Solid	18 Kgal 43 Kgal 313 Kgal	No	NA	Scheduled completion of interim stabilization 10/31/98.
241-U-103	Tank Contents	241-U-103	NCPLX	530 K gal	Supernate Sludge Saltcake	Liquid Solid Solid	13 Kgal 32 Kgal 423 Kgal	No	NA	Scheduled completion of interim stabilization/31/98.
241-U-104	Tank Contents	241-U-104	NCPLX	530 K gal	Sludge	Solid	122 Kgal	No	NA	Assumed leaker, interim stabilized 10/78.
241-U-105	Tank Contents	241-U-105	NCPLX	530 K gal	Supernate Sludge Saltcake	Liquid Solid Solid	37 Kgal 32 Kgal 349 Kgal	No	NA	Scheduled completion of interim stabilization 12/98/31.
241-U-106	Tank Contents	241-U-106	NCPLX	530 K gal	Supernate Sludge Saltcake	Liquid Solid Solid	15 Kgal 26 Kgal 185 Kgal	No	NA	Scheduled completion of interim stabilization 6/30/98.
241-U-107	Tank Contents	241-U-107	DSSF	530 K gal	Supernate Sludge Saltcake	Liquid Solid Solid	31 Kgal 15 Kgal 360 Kgal	No	NA	Scheduled completion of interim stabilization 1/31/99.
241-U-108	Tank Contents	241-U-108	NCPLX	530 K gal	Supernate Sludge Saltcake	Liquid Solid Solid	24 Kgal 29 Kgal 415 Kgal	No	NA	Scheduled completion of interim stabilization 12/31/98.
241-U-109	Tank Contents	241-U-109	NCPLX	530 K gal	Supernate Sludge Saltcake	Liquid Solid Solid	19 Kgal 48 Kgal 396 Kgal	No	NA	Scheduled completion of interim stabilization 12/31/98.
241-U-110	Tank Contents	241-U-110	NCPLX	530 K gal	Sludge	Solid	186 Kgal	No	NA	Assumed leaker, interim stabilized 12/84 under old criteria, must meet new criteria.
241-U-111	Tank Contents	241-U-111	DSSF	530 K gal	Sludge Saltcake	Solid Solid	26 Kgal 303 Kgal	No	NA	Scheduled completion of interim stabilization 8/31/98.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-U-112	Tank Contents	241-U-112	NCPLX	530 K gal	Supernate Sludge	Liquid Solid	4 Kgal 45 Kgal	No	NA	Assumed leaker, interim stabilized 9/79 under old criteria, must meet new criteria.
241-U-201	Tank Contents	241-U-201	NCPLX	55 Kgal	Supernate Sludge	Liquid Solid	1 Kgal 4 Kgal	No	NA	NA
241-U-202	Tank Contents	241-U-202	NCPLX	55 Kgal	Supernate Sludge	Liquid Solid	1 Kgal 4 Kgal	No	NA	NA
241-U-203	Tank Contents	241-U-203	NCPLX	55 Kgal	Supernate Sludge	Liquid Solid	1 Kgal 2 Kgal	No	NA	NA
241-U-204	Tank Contents	241-U-204	NCPLX	55 Kgal	Supernate Sludge	Liquid Solid	1 Kgal 2 Kgal	No	NA	NA
244-U	Tank Contents	244-U DCRT	NA	26000 gal	NA	NA	NA	NA	NA	244-U DCRT has not been used.
241-U-301B	Tank Contents	Catch Tank 241-U-301-B	Residual	36400 gal	No data	No data	7820 gal	No	NA	Waste from diversion boxes U-151 and U-152.
241-UX-302A	Tank Contents	Catch Tank 241-UX-302-A	Residual	17700 gal	No data	No data	2432 gal	No	NA	Waste from diversion box UX-154.
241-U-101	Tank Headspace	241-U-101	NA	NA	NA	Vapor	3145 m^3, 220 g NH_3	No	NA	NA
241-U-102	Tank Headspace	241-U-102	NA	NA	NA	Vapor	1824 m^3, no NH_3 present	No	NA	NA
241-U-103	Tank Headspace	241-U-103	NA	NA	NA	Vapor	1468 m^3, 810 g NH_3	No	NA	NA
241-U-104	Tank Headspace	241-U-104	NA	NA	NA	Vapor	2778 m^3, no NH_3 present	No	NA	NA
241-U-105	Tank Headspace	241-U-105	NA	NA	NA	Vapor	1657 m^3, 410/830 g NH_3	No	NA	NA
241-U-106	Tank Headspace	241-U-106	NA	NA	NA	Vapor	2384 m^3, 1800/920 g NH_3	No	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-U-107	Tank Headspace	241-U-107	NA	NA	NA	Vapor	1703 m^3, 580/980 g NH_3	No	NA	NA
241-U-108	Tank Headspace	241-U-108	NA	NA	NA	Vapor	1468 m^3, no NH_3 present	No	NA	NA
241-U-109	Tank Headspace	241-U-109	NA	NA	NA	Vapor	1487 m^3, 440 g NH_3	No	NA	NA
241-U-110	Tank Headspace	241-U-110	NA	NA	NA	Vapor	2535 m^3, no NH_3 present	No	NA	NA
241-U-111	Tank Headspace	241-U-111	NA	NA	NA	Vapor	1994 m^3, 1000/100 g NH_3	No	NA	NA
241-U-112	Tank Headspace	241-U-112	NA	NA	NA	Vapor	3054 m^3, no NH_3 present	No	NA	NA
241-U-201	Tank Headspace	241-U-201	NA	NA	NA	Vapor	215 m^3, no NH_3 present	No	NA	NA
241-U-202	Tank Headspace	241-U-202	NA	NA	NA	Vapor	215 m^3, no NH_3 present	No	NA	NA
241-U-203	Tank Headspace	241-U-203	NA	NA	NA	Vapor	222 m^3, 15 g NH_3	No	NA	NA
241-U-204	Tank Headspace	241-U-204	NA	NA	NA	Vapor	222 m^3, 0.024 g NH_3	No	NA	NA
244-U	Tank Headspace	244-U DCRT	NA	NA	NA	NA	26000 gal	No	NA	244-U DCRT has not been used.
241-U-301B	Tank Headspace	Catch Tank 241-U-301-B	NA	No data	NA	Vapor	No data available	No	NA	NA
241-UX-302A	Tank Headspace	Catch Tank 241-UX-302-A	NA	NA	NA	Vapor	15268 gal	No	NA	NA
241-U	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	NA
241-U	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-U	Contamination on Equipment or Tools	Tools abandoned in vertical storage units	Contaminated tools	NA	NA	Solids	Unknown	No *	NA	* Tools to be disposed of.
241-U	Contamination on Equipment or Tools	Hand tool	Tools	NA	NA	Solids	Unknown	Yes *	NA	* Hand tools stored next to Satellite Accumulation Area for in-farm usage.
241-U	Ventilation Filter Contents	Primary	NA	NA	NA	NA	NA	NA	NA	NA
241-U	Ventilation Filter Contents	Annulus	NA	NA	NA	NA	NA	NA	NA	NA
241-U	Ventilation Filter Contents	Breather	NA	1 R/h at 6 inches.	NA	Particulate	NA	Yes - disposal in accord w/ WHC-EP-0063-4	NA	Filter efficiency is tested annually and replaced if they fail.
241-U	Contamination In Ventilation System	De-entrainers	NA	NA	NA	NA	NA	NA	NA	NA
241-U	Contamination In Ventilation System	Seal loop	Oil and condensate	1 cup	NA	Liquid	Residual	NA	NA	Seal loops associated with breather filters on tanks.
241-U	Contents of Pipeline and/or Source Tank During Transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer line Table 7.
241-U	Contents of Sump or Encasement	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-U-01A-09A	Contamination in Pit or Box	Pump pits U 01A thru 09A	Residual	6820 gal	NA	Residue	Unknown	No	9 pits	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-U-01A	Contamination in Pit or Box	Pump pit U 01A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-02A	Contamination in Pit or Box	Pump pit U 02A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-03A	Contamination in Pit or Box	Pump pit U 03A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-04A	Contamination in Pit or Box	Pump pit U 04A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-05A	Contamination in Pit or Box	Pump pit U 05A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-06A	Contamination in Pit or Box	Pump pit U 06A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-07A	Contamination in Pit or Box	Pump pit U 07A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-08A	Contamination in Pit or Box	Pump pit U 08A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-09A	Contamination in Pit or Box	Pump pit U 09A	Residual	6820 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-10A	Contamination in Pit or Box	Pump pit U 10A	Residual	2020 gal	NA	Residue	Unknown	No	1 pit	NA
241-U-11A	Contamination in Pit or Box	Pump pit U 11A	Residual	2020 gal	NA	Residue	Unknown	No	1 pit	NA
241-UR-02B-09B	Contamination in Pit or Box	Distributor pits UR 02B thru 09B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Tank U-101 distributor pit is weather covered. Cover plate in place; volumes were calculated with normal cover blocks.
241-UR-02B	Contamination in Pit or Box	Distributor pit UR 02B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-UR-03B	Contamination in Pit or Box	Distributor pit UR 03B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.
241-UR-04B	Contamination in Pit or Box	Distributor pit UR 04B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.
241-UR-05B	Contamination in Pit or Box	Distributor pit UR 05B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.
241-UR-06B	Contamination in Pit or Box	Distributor pit UR 06B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.
241-UR-07B	Contamination in Pit or Box	Distributor pit UR 07B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.
241-UR-08B	Contamination in Pit or Box	Distributor pit UR 08B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.
241-UR-09B	Contamination in Pit or Box	Distributor pit UR 09B	Residual	224 gal	NA	Residue	Unknown	No	1 pit *	* Cover plate in place, volumes were calculated with normal cover blocks.
241-UR-10B	Contamination in Pit or Box	Distributor pit UR 10B	Residual	176 gal	NA	Residue	Unknown	NA	1 pit	NA
241-UR-11B	Contamination in Pit or Box	Distributor pit UR 11B	Residual	176 gal	NA	Residue	Unknown	NA	1 pit	NA
241-U	Contamination in Pit or Box	Sluice pits	Residual	NA	NA	Residue	Unknown	NA	9 pits	All distributor pits in U-Farm are weather covered.
241-U	Contamination in Pit or Box	Condenser pits	Residual	NA	NA	Residue	Unknown	NA	14 pits	All condenser pits in U-Farm are weather covered.
241-U	Contamination in Pit or Box	Saltwell Pit	Residual	NA	NA	Residue	Unknown	NA	1 pit	Tank U-112 only, weather covered.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-U-PIT	Contamination in Pit or Box	Valve pits 241-U-A, B, C, D	Residual	3142 gal	NA	Residue	Unknown	NA	4 pits	NA
241-U-A	Contamination in Pit or Box	Valve pit 241-U-A	Residual	3142 gal	NA	Residue	Unknown	NA	1 pit	NA
241-U-B	Contamination in Pit or Box	Valve pit 241-U-B	Residual	3142 gal	NA	Residue	Unknown	NA	1 pit	NA
241-U-C	Contamination in Pit or Box	Valve pit 241-U-C	Residual	3142 gal	NA	Residue	Unknown	NA	1 pit	NA
241-U-D	Contamination in Pit or Box	Valve pit 241-U-D	Residual	3142 gal	NA	Residue	Unknown	NA	1 pit	NA
241-U-151	Contamination in Pit or Box	Diversion box 241-U-151	Residual	7554 gal	NA	Residue	Unknown	NA	1 box	NA
241-U-152	Contamination in Pit or Box	Diversion box 241-U-152	Residual	11331 gal	NA	Residue	Unknown	NA	1 box	NA
241-U-154	Contamination in Pit or Box	Diversion box 241-U-154	Residual	31296 gal	NA	Residue	Unknown	NA	1 box *	* Includes jumper storage, nozzle pit, and pipe pit.
241-U-DIV	Contamination in Pit or Box	Diversion boxes 241-U-153, 241-U-252, 241-UR-151, 241-UR-152, 241-UR-153, 241-UR-154	Residual	NA	NA	Residue	Unknown	NA	6 boxes	All are weather covered.
241-U-153	Contamination in Pit or Box	Diversion box 241-U-153	Residual	NA	NA	Residue	Unknown	NA	1 box	All are weather covered.
241-U-252	Contamination in Pit or Box	Diversion box 241-U-252	Residual	NA	NA	Residue	Unknown	NA	1 box	All are weather covered.
241-UR-151	Contamination in Pit or Box	Diversion box 241-UR-151	Residual	NA	NA	Residue	Unknown	NA	1 box	All are weather covered.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-UR-152	Contamination in Pit or Box	Diversion box 241-UR-152	Residual	NA	NA	Residue	Unknown	NA	1 box	All are weather covered.
241-UR-153	Contamination in Pit or Box	Diversion box 241-UR-153	Residual	NA	NA	Residue	Unknown	NA	1 box	All are weather covered.
241-UR-154	Contamination in Pit or Box	Diversion box 241-UR-154	Residual	NA	NA	Residue	Unknown	NA	1 box	All are weather covered.
COB U25	Contamination in Pit or Box	Clean out boxes COB U25 thru U34	Residual	26 gal	NA	Residue	Unknown	NA	7 boxes	NA
COB U26	Contamination in Pit or Box	Clean out box COB U26	Residual	26 gal	NA	Residue	Unknown	NA	1 box	NA
COB U27	Contamination in Pit or Box	Clean out box COB U27	Residual	26 gal	NA	Residue	Unknown	NA	1 box	NA
COB U28	Contamination in Pit or Box	Clean out box COB U28	Residual	26 gal	NA	Residue	Unknown	NA	1 box	NA
COB U29	Contamination in Pit or Box	Clean out box COB U29	Residual	26 gal	NA	Residue	Unknown	NA	1 box	NA
241-U	SARA 313 Materials	Gas bottles for PCM1B	90% argon / 10% methane	480 cubic feet	NA	Gas	480 cubic feet	Yes	2 bottles	NA
241-U	SARA 313 Materials	Flammable storage cabinet	Spray paint	NA	NA	Aerosol	NA	Yes	Misc spray paint	NA
241-U	Other	Liquid nitrogen for sampling activities	Liquid nitrogen	Large trailer mounted tank	NA	Gas	Unknown	Yes	1 Tank	Tank and trailer located outside the south fence of U-Farm.
241-U	Other	Propane tank	Propane	3 ft. dia. X 6 ft. tank on trailer	NA	Gas	Unknown	Yes	1 Tank	Located on same trailer as liquid nitrogen.
241-U	Other	Propane tank	Propane	4 ft. dia X 6 ft. tank on ground	NA	Gas	Unknown	Yes	1 Tank	Located on ground next to nitrogen trailer.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
216-U-12	Other	Crib 216-U-12	NA	NA	NA	NA	NA	NA	NA	This crib received 150,000,000 liters of stack drainage, process condensate, and contaminated water from the 291-U-1 stack, 224-U, 244-WR vault, and 244-U.
216-U-17	Other	Crib 216-U-17	NA	NA	NA	NA	NA	NA	NA	This crib received 2,110,000 liters of neutralized process condensate from the UO3 plant.
216-U-14	Other	Ditch 216-U-14	NA	NA	NA	NA	NA	NA	NA	This ditch received waste from 284-W powerhouse, 2723-W, 2724-W laundry building, 221-U chemical sewer, 224-U cooling water, 241-U-110 condenser tank cooling water, 242-S evaporator condensate and cooling water, 207-U basin, and additional waste from 221-U, 224-U and 271-U. A 1966 release consisted of ~3000 liters of 50% reprocessed nitric acid. The total release consisted of ~225,000 lb of corrosion solution (pH less than 2.0) and 100 lb of uranium.
U Satellite Accumulation Area	Other	Satellite accumulation area	RCRA mixed wastes	6 - 55 gal mixed waste drums (maximum)	NA	Solid	Low level (less than class C)	Yes	6 - 55 gal drums max capacity for each satellite enclosure	Inventories removed when filled, transported to 209-E 90 day storage facility.

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-EW-151	Contamination in Pit or Box	Access pit	Residual contamination	1900 gal (5' x 7'-10" x 6'-6")	NA	Residue	NA	No	NA	NA
241-EW-151	Contamination in Pit or Box	Catch tank pit	Residual contamination	4240 gal (8'6" x 8' x 8'4")	NA	Residue	NA	No	NA	NA
241-EW-151	Contamination in Pit or Box	Nozzle/pump pit	Residual contamination	1300 gal (8' x 6' x 3'8")	NA	Residue	NA	No	NA	NA
241-EW-151	Contamination in Ventilation System	De-entrainers	NA	NA	NA	NA	NA	NA	NA	No de-entrainer, passive ventilation only.
241-EW-151	Contamination in Ventilation System	Seal loop	Process condensate	NA	NA	Liquid	Residual	No	one	Seal loop associated with catch tank breather filter assembly.
241-EW-151	Contamination on Equipment or Tools	None	NA	NA	NA	NA	NA	NA	NA	No contaminated tools stored near vent station.
241-EW-151	Contamination on Vehicle	None	NA	NA	NA	NA	NA	NA	NA	No contaminated vehicles stored with catch station.
241-EW-151	Contents of Pipeline and/or source tank during transfer	NA	NA	NA	NA	NA	NA	NA	NA	See transfer pipeline Table 7.
241-EW-151	Contents of Sump or Encasement	None	NA	NA	NA	NA	NA	NA	NA	See catch tank pit below.
241-EW-151	Other	None	NA	NA	NA	NA	NA	NA	NA	NA
241-EW-151	Rail or Truck Tanker Contents	None	NA	NA	NA	NA	NA	NA	NA	No rail or truck tankers associated with vent station.
241-EW-151	SARA 313 Materials	None	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments
241-EW-151	Tank Contents	241-EW-151 catch tank within vent station	rainwater	800 gal	NA	Liquid	351 gal	No	NA	Catch tank serves the vent station for the cross site transfer line. Tank was about to be pumped during walkdown.
241-EW-151	Tank Headspace	241-EW-151 catch tank	NA	449 gal (capacity-contents)	NA	NA	NA	NA	NA	No data available. Tank was about to be pumped.
241-EW-151	Ventilation Filter Contents	Breather filter	Residual contamination	1 R/hr at six inches**	NA	Residue	Unknown*	Yes	NA	*Breather filter for catch tank. Catch tank currently thought to contain rainwater.

Table references to WHC-EP-0064-4 should be directed to the correct reference which is WHC-EP-0063-4 (see below).

The information in this table was taken from WHC-SD-WM-HIE-007, 1996, *Tank Waste Remediation System FSAR Hazard Identification Facility Configuration Verification Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

*Refer to comment items in the same data row.

**Refer to comment items in the same data row.

OSD-T-151-00008, 1994, *Operating Specifications for the 204-AR Waste Unloading Facility*, Rev. E-2, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0063-4, 1993, *Hanford Site Solid Waste Acceptance Criteria*, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0182, 1995, *Waste Tank Summary Report for Month Ending December 31, 1995*, Rev. 93, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0861, 1995, *Status Report for Inactive Miscellaneous Underground Storage Tanks at Hanford Site 200 Areas*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-EMP-031, 1996, *Tank Farm Stack NESHAP Designation Determinations*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-EV-040, 1990, *Double-Shell Tank Ancillary Equipment - Secondary Containment Evaluation*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-PD-046, 1995, *Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tanks Program Plan*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-006, 1994, *204-AR Unloading Facility Accelerated Safety Analysis*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

"See next sheet for list of terms used in this table."

Table A-2. Material at Risk Table. (124 sheets)

Field Name	MAR-Subject	MAR-Description	MAR-Classification	Capacity	Material Type	Physical Form	Volume or Activity	Transient	Quantity	Comments

Bld. = building.
CC = concentrated complexant.
COB = cleanout box.
con. = condensate.
cond dr = condensate drain.
CP = concentrated phosphate (waste).
CPLX = complexed waste.
DC = dilute complexed waste.
DCRT = double-contained receiver tank.
D. E. = diatomaceous earth.
DN = dilute noncomplexed waste.
DOT = U.S. Department of Transportation.
DP = differential pressure.
DSS = double-shell slurry.
DSSF = double-shell slurry feed.
DST = double-shell tank.
enc = enclosure.
FFTF = Fast Flux Test Facility.
FIC = Food Instrument Corporation.
HEDL = Hanford Engineering Development Laboratory.
HEPA = high-efficiency particulate air (filter).
HPT = health physics technician.
ID = identification.
IMUST = inactive miscellaneous underground storage tank.
LANL = Los Alamos National Laboratory.
lk det = leak detector.
M = million/molar.
MAR = material at risk.
misc = miscellaneous.
N = north.
NA = not applicable.
NCAW = neutralized current acid waste.
NCPLX = noncomplexed waste.
NE = northeast.
NHW = neutralized high-level waste.
PCM1B = personal contamination monitor 1B.
PD = PUREX decladding.
PFP = Plutonium Finishing Plant.
ppm = parts per million.
PRV = pressure relief valve.
prv sta = pressure relief valve station.
PUREX = Plutonium Uranium Extraction (Facility).
RCRA = *Resource Conservation and Recovery Act of 1976.*
RMW = radioactive mixed waste.
RW = raw water.
SAA = satellite accumulation area.
SAR = safety analysis report.
SARA = *Superfund Amendments and Reauthorization Act of 1986.*
SE = southeast.
SW = southwest.
SHMS = Standard Hydrogen Monitoring System.
SST = single-shell tank.
st. = steam.
SWP = special work procedure (refers to protective clothing worn in radiation zone).
TK = tank.
TWRS = Tank Waste Remediation System.
VIP = ventilation instrument pit.
WHC = Westinghouse Hanford Company.
WIDS = Waste Information Data System.

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-A-101	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-A-102	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-A-103	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-A-104	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-A-105	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-A-106	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-AN-101	Double shell tank	Active	Annulus has filtered inlet, K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AN-102	Double shell tank	Active	Annulus has filtered inlet, K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AN-103	Double shell tank	Active	Annulus has filtered inlet, K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AN-104	Double shell tank	Active	Annulus has filtered inlet, K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-AN-105	Double shell tank	Active	Annulus has filtered inlet, K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AN-106	Double shell tank	Active	Annulus has filtered inlet, K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AN-107	Double shell tank	Active	Annulus has filtered inlet, K1 primary tank ventilation system, K2 annulus ventilation system	Yes		No		No	
241-AP-101	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AP-102	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AP-103	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AP-104	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AP-105	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AP-106	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-AP-107	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AP-108	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AW-101	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AW-102	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	Yes		No		No	
241-AW-103	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AW-104	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AW-105	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AW-106	Double shell tank	Active	K1 primary tank ventilation system, K2 annulus ventilation system	No		No		No	
241-AX-101	Single shell tank	Passive	One breather filter with one seal loop	No	The ALC is still in the tank. There are flanged covers on the risers.	No		No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-AX-102	Single shell tank	Passive	One breather filter with one seal loop	No	The ALC is still in the tank. There are flanged covers on the risers.	No		No	
241-AX-103	Single shell tank	Passive	One breather filter with one seal loop	No	The ALC is still in the tank. There are flanged covers on the risers.	No		No	
241-AX-104	Single shell tank	Passive	One breather filter with one seal loop	No	The ALC is still in the tank. There are flanged covers on the risers.	No		No	
241-AY-101	Double shell tank	Active	Tank farm A primary ventilation system			No	Steam coils in tank, steam to facility is blanked off	No	
241-AY-102	Double shell tank	Active	Tank farm A primary ventilation system			No	Steam coils in tank, steam to facility is blanked off	No	
241-AZ-101	Double shell tank	Active	Tank farm A primary ventilation system	Yes		No	Steam coils in tank, steam to facility is blanked off	No	Two new mixer pumps are being installed in AZ-101 for sludge washing (Project W-151).
241-AZ-102	Double shell tank	Active	Tank farm A primary ventilation system	Yes		No	Steam coils in tank, steam to facility is blanked off	No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-B-101	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-102	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-103	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-104	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-105	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-106	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-107	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-108	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-109	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-110	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-111	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-112	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-201	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-202	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-B-203	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-B-204	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to B Tank Farm	No	
241-BX-101	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-102	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-103	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-104	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-105	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-106	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-107	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-108	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-109	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-110	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-111	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BX-112	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BX Tank Farm	No	
241-BY-101	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-BY-102	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BY Tank Farm	No	
241-BY-103	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	
241-BY-104	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BY Tank Farm	No	
241-BY-105	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	
241-BY-106	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	
241-BY-107	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	
241-BY-108	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	
241-BY-109	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BY Tank Farm	No	
241-BY-110	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	
241-BY-111	Single shell tank	Passive	One breather filter with one seal loop	No	Present, not presently operable	No	No steam to BY Tank Farm	No	
241-BY-112	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to BY Tank Farm	No	
241-C-101	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-C-102	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-103	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-104	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-105	Single shell tank	Active	Exhauster	No		No	No steam to C Tank Farm	No	
241-C-106	Single shell tank	Active	Exhauster	No		No	No steam to C Tank Farm	No	
241-C-107	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-108	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-109	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-110	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-111	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-112	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-201	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-202	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-203	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	
241-C-204	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to C Tank Farm	No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-S-101	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-102	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-103	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-104	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-105	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-106	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-107	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-108	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-109	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-110	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-111	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-S-112	Single shell tank	Passive	One breather filter with one seal loop	No		No	No steam to S Tank Farm	No	
241-SX-101	Single shell tank	Active	Vented through a shared underground piping system to SX-109	No		No	No steam to SX Tank Farm	No	
241-SX-102	Single shell tank	Active	Vented through a shared underground piping system to SX-109	No		No	No steam to SX Tank Farm	No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-SX-103	Single shell tank	Active	Vented through a shared underground piping system to SX-109	No		No	No steam to SX Tank Farm	No	
241-SX-104	Single shell tank	Active	Vented through a shared underground piping system to SX-109	No		No	No steam to SX Tank Farm	No	
241-SX-105	Single shell tank	Active	Vented through a shared underground piping system to SX-109	No		No	No steam to SX Tank Farm	No	
241-SX-106	Single shell tank	Active	Vented through a shared underground piping system to SX-109	No		No	No steam to SX Tank Farm	No	
241-SX-107	Single shell tank	Active	Vented to an above ground shared system	No		No	No steam to SX Tank Farm	No	
241-SX-108	Single shell tank	Active	Vented to an above ground shared system	No		No	No steam to SX Tank Farm	No	
241-SX-109	Single shell tank	Active	Vented to an above ground shared system	No		No	No steam to SX Tank Farm	No	
241-SX-110	Single shell tank	Active	Vented to an above ground shared system	No		No	No steam to SX Tank Farm	No	
241-SX-111	Single shell tank	Active	Vented to an above ground shared system	No		No	No steam to SX Tank Farm	No	
241-SX-112	Single shell tank	Active	Vented to an above ground shared system	No		No	No steam to SX Tank Farm	No	
241-SX-113	Single shell tank	Passive		No		No	No steam to SX Tank Farm	No	
241-SX-114	Single shell tank	Active	Vented to an above ground shared system	No		No	No steam to SX Tank Farm	No	
241-SX-115	Single shell tank	Passive		No		No	No steam to SX Tank Farm	No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-SY-101	Double shell tank	Active	Shared ventilation system	No		No	No steam to SY Tank Farm	Yes	
241-SY-102	Double shell tank	Active	Shared ventilation system	No		No	No steam to SY Tank Farm	No	
241-SY-103	Double shell tank	Active	Shared ventilation system	No		No	No steam to SY Tank Farm	No	
241-T-101	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-102	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-103	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-104	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-105	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-106	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-107	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-108	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-109	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-110	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-111	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-112	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-T-201	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-202	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-203	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-T-204	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-101	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-102	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-103	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-104	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-105	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-106	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-107	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-108	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-109	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-110	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-111	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-TX-112	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-113	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-114	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-115	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-116	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-117	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TX-118	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TY-101	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TY-102	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TY-103	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TY-104	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TY-105	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-TY-106	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-101	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-102	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	

Table A-3. Tank Waste Remediation System Facility Configurations. (14 sheets)

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-U-103	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-104	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-105	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-106	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-107	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-108	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-109	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-110	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-111	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-112	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-201	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-202	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-203	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	
241-U-204	Single shell tank	Passive	One breather filter with one seal loop	No		No		No	

ALC= air lift circulator.

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
				Separable Phase	TOC in liquids (>10 g/L)	TOC in solids >4.5 wt (dry basis)	Heat generation rate >26,000 BTU				
Legend Boxes->		Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does potential exist? Provide reference.	Does potential exist? Provide reference.	Does potential exist? Provide reference.
A FARM											
241-A-101	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-A-102	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Jo, 1995 WHC-SD-WM-DP-136, Rev. 0	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-A-103	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-A-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-A-105	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Hodgson 1995 74A30-95-018	Unknown or currently undocumented	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-A-106	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
AN FARM											
241-AN-101	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AN-102	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Yes, Esch, 1996, WHC-SD-WM-DP-165, Rev. 0	Yes, Esch, 1996, WHC-SD-WM-DP-165, Rev. 0	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-AN-103	Double shell tank	Facility Group 1 GRE - Yes Large Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AN-104	Double shell tank	Facility Group 1 GRE - Yes Large Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Yes, (Slurry) SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AN-105	Double shell tank	Facility Group 1 GRE - Yes Large Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Yes, (Slurry) SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AN-106	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-AN-107	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Yes, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
AP FARM											
241-AP-101	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Data not available	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AP-102	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Data not available	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AP-103	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Data not available	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-AP-104	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Data not available	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AP-105	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AP-106	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Data not available	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AP-107	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Data not available	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-AP-108	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Data not available	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
AW FARM											
241-AW-101	Double shell tank	Facility Group 1 GRE - Yes Large Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AW-102	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AW-103	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-AW-104	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AW-105	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AW-106	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
AX FARM											
241-AX-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-AX-102	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Yes, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-AX-103	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-AX-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No; SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
AY FARM											
241-AY-101	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Brevick, 1995, WHC-SD-ER-350, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-AY-102	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Brevick, 1995, WHC-SD-ER-350, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev.0
AZ FARM											
241-AZ-101	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	Yes, Brevick, 1995, WHC-SD-ER-350, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-AZ-102	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	Yes, Brevick, 1995, WHC-SD-ER-350, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
B FARM											
241-B-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Schreiber, 1995, WHC-SD-WM-DP-139 Rev. 0	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-B-102	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Winters, 1995, WHC-SD-WM-ER-405	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-103	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	N/A	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Jo, 1995 WHC-SD-WM-DP-137	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-105	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-106	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Conner, 1995, WHC-SD-WM-DP-140	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-B-107	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-109	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-111	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Remund et. al PNL-10099	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-B-112	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Dougherty 1995 WHC-SD-WM-ER-366	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-201	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-202	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-203	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Jo, 1996 WHC-SD-WM-DP-169 Rev.0	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-B-204	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Sasaki 1995, WHC-SD-WM-DP-160	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
BX FARM											
241-BX-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Schreiber 1995, WHC-SD-WM-ER-408	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-102	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-103	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Bell 1995 WHC-SD-WM-DP-135	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, HU 1996 WHC-SD-WM-DP-171	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-105	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Hall 1995 WHC-SD-WM-ER-406	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-BX-106	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Rollison 1995 8E480-95-018 R. 1.	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-BX-107	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Raphael 1994 WHC-EP-0739	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	N/A	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-109	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Sutey 1993 7C242-93-029	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-BX-111	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Sutey 1993 7C242-93-029	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BX-112	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
BY FARM											
241-BY-101	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-102	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Edington 1991 28110-PCL91-048	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-103	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Kelly 1995 WHC-SD-WM-DP-104 R. 1	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-BY-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-105	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Esch 1995 8E480 95-020	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-106	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Bell 1995 WHC-SD-WM-DP-103 R. 0A	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-107	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Baldwin 1995 WHC-SD-WM-ER-533	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-BY-109	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Schreiber 1995 WHC-SD-WM-DP-153	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-111	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-BY-112	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
C FARM											
241-C-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-C-102	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-C-103	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Bell 1995 WHC-SD-WM-DP-099	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-C-104	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-105	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-C-106	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-C-107	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Bell 1995 WHC-SD-WM-ER-474	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-109	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Sasaki 1995 WHC-SD-WM-ER-402	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Simpson 1994 WHC-SD-WM-ER-367	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-111	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Simpson 1995 WHC-SD-WM-ER-475	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-C-112	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-201	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	Yes, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-202	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	Yes, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-203	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-C-204	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Data not available	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
S FARM											
241-S-101	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-102	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-103	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Simpson 1994 WHC-SD-WM-ER-370	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-S-105	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-S-106	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-107	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Raphael 1995 WHC-SD-WM-DP-156	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-109	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Webb, 1996, WHC-SD-WM- - SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-S-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-111	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-S-112	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
SX FARM											
241-SX-101	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Weiss 1990 12712-PCL90-043	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-SX-102	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-SX-103	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-SX-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Weiss 1988 12221-PCL88-147 R.1	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-SX-105	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-SX-106	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-SX-107	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocument-ed	Unknown or currently undocument-ed	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-SX-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	N/A	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-SX-109	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocument-ed	Unknown or currently undocument-ed	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-SX-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	N/A	Unknown or currently undocument-ed	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-SX-111	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocument-ed	Unknown or currently undocument-ed	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-SX-112	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocument-ed	Unknown or currently undocument-ed	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmul a 1994 WHC-EP-0772
241-SX-113	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	N/A	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmul a 1994 WHC-EP-0772
241-SX-114	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmul a 1994 WHC-EP-0772
241-SX-115	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	N/A	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmul a 1994 WHC-EP-0772
SY FARM											
241-SY-101	Double shell tank	GRE - Yes Large Spontaneous Large Induced Steady State - Yes LA-UR-92-3196, Rev. 14	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	No, (Bulk) SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-SY-102	Double shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0
241-SY-103	Double shell tank	Facility Group 1 GRE - Yes Large Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No (but potential for Tank Bump), Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev.
T FARM											
241-T-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-T-102	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, PNL-10101	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-T-103	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-T-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-372	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-T-105	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-369	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-T-106	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-DP-143	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-T-107	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-382	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-T-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-DP-141	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-T-109	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-T-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-T-111	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	Yes, WHC-SD-WM-ER-540 WL: 2/94	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-T-112	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-T-201	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-T-202	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-T-203	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-T-204	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
TX FARM											
241-TX-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-TX-102	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-TX-103	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-TX-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-TX-105	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No Analysis WL: 1/91	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TX-106	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-TX-107	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TX-108	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-TX-109	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-TX-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TX-111	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-TX-112	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-TX-113	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TX-114	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TX-115	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TX-116	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-TX-117	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TX-118	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No Analysis WL: 1/91	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
TY FARM											
241-TY-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Per, Interview with Kevin Hull	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TY-102	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Per, Interview with Kevin Hull	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-TY-103	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Per, Interview with Kevin Hull	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-TY-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-DP-101 WL: 5/94	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Per, Interview with Kevin Hull	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TY-105	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Per, Interview with Kevin Hull	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-TY-106	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-482	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Per, Interview with Kevin Hull	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
U FARM											
241-U-101	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-U-102	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-U-103	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No Analysis WL: 5/94	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-U-104	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-U-105	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No Analysis WL: 5/94	Yes, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-U-106	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No Analysis WL: 1/91	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-U-107	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No Analysis WL: 1/91	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-U-108	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-U-109	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-U-110	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-EP-0643	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker
241-U-111	Single shell tank	Facility Group 2 GRE - Yes Small Spontaneous Large Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, Anal WL: 3/93	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994 WHC-EP-0772
241-U-112	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No evidence in non-Watchlist tank, assumed to be No	Unknown or currently undocumented	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Assumed Leaker

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
241-U-201	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-483	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-U-202	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-484	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-U-203	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-485	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
241-U-204	Single shell tank	Facility Group 3 GRE - Yes Small Induced Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	No, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, WHC-SD-WM-ER-486	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, Anantatmula 1994 WHC-EP-0772
MISCELLANEOUS											
244-A	DCRT	Facility Group Non-GRE GRE - No Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Unknown or currently undocumented	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Unknown or currently undocumented

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
244-BX	DCRT	Facility Group Non-GRE GRE - No Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Unknown or currently undocumented	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Unknown or currently undocume nted
244-CR	Vault	TK-CR-001, 002, 003 FG 3 GRE - Yes Small Induced SS- Yes TK-011 Non-GRE GRE - No SS - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Unknown or currently undocumented	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Unknown or currently undocume nted
244-S	DCRT	Facility Group Non-GRE GRE - No Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Unknown or currently undocumented	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Could overflow due to syphoning from 102-SY, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Unknown or currently undocume nted
244-TX	DCRT	Facility Group Non-GRE GRE - No Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	Unknown or currently undocumented	Unknown or currently undocumented	Unknown or currently undocumented	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Per, Interview with Kevin Hull	No, Bratzel 1996, WHC-SD-WM-TI-725	Unknown or currently undocume nted

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
244-U	DCRT	Facility Group Non-GRE GRE - No Steady State - Yes HNF-SD-WM-SAR-067, App K	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	NA	NA	Unknown or currently undocumented	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Unknown or currently un-documented

Table references to WHC-SD-ER-350 should be directed to the correct reference which is WHC-SD-WM-ER-350 (see below).

Edrington, R.S., 1991, *BY and C Tank Farm Supernate Sample Analyses [Revision of 16220-PCL90-117]* (internal memo 28110-PCL91-048 to R.K. Tranbarger, June 3), Westinghouse Hanford Company, Richland, Washington.

Esch, R.A., 1995, *Results for 241-BY-105 Grab Samples* (internal memo 8E480-95-020 to J.M. Jones, April 6), Westinghouse Hanford Company, Richland, Washington.

HNF-SD-WM-SAR-067, App K , *Tank Waste Remediation System Final Safety Analysis Report*, Fluor Daniel Hanford, Inc., Richland, Washington.

Hodgson, K.M., 1995, *Sampling of Waste in Tank 241-A-105* (internal memo 74A30-95-018 to N.W. Kirch, August 28), Westinghouse Hanford Company, Richland, Washington.

Huckaby, J.L., 1996, *Technical Basis for Orgscrn Spreadsheet* (PNNL Letter OT:073096 to J. E. Meacham, Westinghouse Hanford Company, July 30), Pacific Northwest National Laboratory, Richland, Washington.

LA-UR-92-3196, 1995, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, Rev. 14, Los Alamos National Laboratory.

PNL-10099, 1994, *Tank Characterization Report for Single-Shell Tank B-111*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington.

PNL-10101, 1994, *Tank Characterization Report for Single-Shell Tank T-102*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington.

Rollison, M.D., 1995, *Results for 241-BX-106 Grab Samples* (internal memo 8E480-95-018 to J.M. Jones, April 4), Westinghouse Hanford Company, Richland, Washington.

Sutey, M.J., 1993, *Waste Compatibility Assessment of Tank 241-AN-101 with Tanks 241-BX-110 and 241-BX-111* (internal memo 7C242-93-029 to S.D. Godfrey, August 3), Westinghouse Hanford Company, Richland, Washington.

Weiss, R.L., 1988, *Analysis of Tank 241-SX-104 Samples* (internal memo 12221-PCL88-147, Rev. 1, to K.G. Carothers, August 15), Westinghouse Hanford Company, Richland, Washington.

Weiss, R.L., 1990, *Analysis of Liquid Sample from Tank 241-SX-101* (internal memo 12712-PCL90-043 to V.C. Boyles, February 22), Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0643, 1993, *Tank Characterization Report for Single-Shell Tank 241-U-110*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0739, 1994, *Tank Characterization Report for Single-Shell Tank 241-BX-107*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0772, 1994, *Characterization of the Corrosion Behavior of the Carbon Steel Liner in Hanford Site Single Shell Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-099, 1995, *Final Report for Tank 241-C-103, Push Mode Sample Cores 63 and 66*, Rev 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-101, 1995, *216-Day Safety Screen Results and Final Report for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009*, Rev. 0-A, Westinghouse Hanford Company, Richland, Washington.

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity

WHC-SD-WM-DP-103, 1995, *Final Report for Tank 241-BY-106, Push Mode Sample Cores 64, 65, and 121*, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-104, 1995, *Final Report for Tank 241-BY-104, Auger Sample 95-AUG-012 and 95-AUG-013*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-135, 1995, *45-Day Safety Screening Results for Tank 241-BX-103, Push Mode, Cores 86 and 87*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-136, 1995, *45-Day Safety Screening Results and Final Report for Tank 241-A-102, Auger Sample 95-Aug-033*, Rev 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-137, 1995, *45-Day Safety Screening Results for Tank 241-B-104, Push Mode, Cores 88 and 89*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-139, 1995, *45-Day Safety Screening Results for Tank 241-B-101, Push Mode, Cores 90 and 91*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-140, 1995, *45-Day Safety Screening Results for Tank 241-B-106, Push Mode, Cores 93 and 94*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-141, 1995, *90-Day Safety Screening Results and Final Report for Tank 241-T-108, Auger Samples 95-AUG-035 and 95-AUG-037*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-143, 1995, *90-Day Safety Screening Results and Final Report for Tank 241-T-106, Auger Samples 95-AUG-038 and 95-AUG-039*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-153, 1995, *Final Report for Tank 241-BY-110, Rotary Mode Cores 92, 95, 101,103,106, 107, 109, 96 & 113*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-156, 1995, *Final Report for Tank 241-S-107, Push Mode Cores 105, 110 and 111*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-160, 1995, *45-Day Safety Screening Results for Tank 241-B-204, Push Mode Cores 112 and 114*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-165, 1996, *45-Day Safety Screening Results for Tank 241-AN-102, Grab Samples 2AN-95-1 Through 2AN-95-6 and 102-AN-1 Through 102-AN-4*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-169, 1996, *45-Day Safety Screening Results for Tank 241-B-203, Push Mode Cores 115, 120 and 122*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-DP-171, 1996, *Final Report for Tank 241-BX-104, Push Mode Cores 126 and 127*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-350, 1995, *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 Areas*, Rev. 0, ICF Kaiser Hanford Company, Richland, Washington.

WHC-SD-WM-ER-366, 1995, *Tank Characterization Report for Double-Shell Tank 241-SY-102*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-367, 1994, *Tank Characterization Report for Single-Shell Tank 241C110*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-369, 1994, *Tank Characterization Report for Single-Shell Tank 241-T-105*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-370, 1994, *Tank Characterization Report for Single Shell Tank 241-S-104*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-372, 1994, *Tank Characterization Report for Single-Shell Tank 241-T-104*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table A-4. TWRS Tank Unique Phenomena. (42 Sheets)

Field Name	Type	Flammable Gas	Ferrocyanide (Historical Record)	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity

WHC-SD-WM-ER-382, 1994, *Tank Characterization Report for Single-Shell Tank 241-T-107*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-402, 1995, *Tank Characterization Report for Single-Shell Tank 241-C-109*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-405, 1995, *Tank Characterization Report for Single-Shell Tank 241-B-102*, Rev 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-406, 1995, *Tank Characterization Report for Single-Shell Tank 241-BX-105*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-408, 1995, *Tank Characterization Report for Single-Shell Tank 241-BX-101*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-474, 1995, *Tank Characterization Report for Single-Shell Tank 241-C-107*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-475, 1995, *Tank Characterization Report for Single-Shell Tank 241-C-111*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-482, 1995, *Tank Characterization Report for Single-Shell Tank 241-TY-106*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-483, 1995, *Tank Characterization Report for Single-Shell Tank 241-U-201*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-484, 1995, *Tank Characterization Report for Single-Shell Tank 241-U-202*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-485, 1995, *Tank Characterization Report for Single-Shell Tank 241-U-203*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-486, 1995, *Tank Characterization Report for Single-Shell Tank 241-U-204*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-533, 1995, *Tank Characterization Report for Single-Shell Tank 241-BY-108*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-ER-540, 1996, *Tank 241-T-111 Characterization Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-HIE-007, 1996, *Tank Waste Remediation System FSAR Hazards Identification/Facility Configuration Verification Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SARR-010, 1995, *Heat Removal Characteristics of Waste Storage Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SARR-033, 1996, *Safety Criteria for Organic Watch List Tanks at the Hanford Site*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-SARR-038, 1996, *Assessment of the Potential for Ferrocyanide Propagating Reaction Accidents*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-TI-725, 1996, *Tank Farm Nuclear Criticality Review*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
WHC-SD-WM-TI-759, 1996, *Hazard Evaluation for the Tank Waste Remediation System Final Safety Analysis Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Btu = British thermal unit.
FG = facility group.
GRE = gas release event.
PHA = preliminary hazard analysis.
PNNL = Pacific Northwest National Laboratory.
TOC = total organic carbon.
SAIC = Science Applications International Corporation.
SS = steady state.
WL = watchlist.

Table A-5-A. TWRS Facility Hazard Identification. (4 Sheets)

Facility 241-A-Tank Farm	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
A TANK FARM		NA	NA	NA	NA	NA	NA	5	6	2, 3	NA	11	NA	NA	NA
241-A-101	SST	2	6,7,8	15	11,13,14	NA	NA	NA	4	NA	NA	NA	NA	NA	A-101 is a watchlist tank (hydrogen/flammable gas, organics).
241-A-102	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-103	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	Recommended to be added as a watchlist tank (hydrogen/flammable gas).
241-A-104	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-105	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-106	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-151	Diversion box (outside farm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-A-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-A-COBs	Cleanout boxes (11)	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-501	Water sluicing bldg	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	2,10	NA	3	NA
241-A-701	Compressor building (outside fence)	NA	NA	NA	4,5	NA	NA	1,2,3,5	1,2,4,5, 9,10,16	2,3,4	6	10,13	6	6	Outside of building: underground fuel storage tank, and inst. air receiver
241-A-101	Pump pit B (6)(1)	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	(1) Pits are inactive and weather enclosed with polyurethane foam.
241-A-101(3), 105(2), 106(1)	Sluice pits (1)	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA

Table A-5-A. TWRS Facility Hazard Identification. (4 Sheets)

Facility 241-A-Tank Farm	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes —>		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-A-01H	Distributor pit(1)	NA	NA	NA	NA	NA	NA	NA	4(2)	NA	NA	NA	NA	NA	(2) Pit leak detector not in service
241-A-401	Condenser bldg	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	Bldg. covered with taped covers, with penetrations in covers. Tumbleweed buildup on North side of building. This building is secured and controlled by HPTs. No hazards are assumed to exist.
241-A-401	Diverter Caisson	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-702	Ventilation facility	NA	NA	NA	NA	NA	NA	1,2,3,5	4,10, 11,16	2,4	NA	NA	NA	NA	NA
241-A-271	Control room	NA	NA	NA	NA	NA	NA	3,5	4,5,10(3)	2,4	NA	10	NA	NA	(3) 2 Substations outside of control room
241-A-350	Drainage lift station & catch tank	NA	NA	NA	NA	NA	NA	5	4,9,10	2,3	NA	11	NA	NA	NA
	ALC flush buildings (3)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Leak detection lateral for tanks 103, 105, 106	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-A&B	Valve pits	NA	NA	NA	NA	NA	NA	NA	4	NA	5(4)	NA	NA	3(5)	(4) Crane parked next to valve pit (5) Heat traces in pit
	Old portable exhauster near 105-A	NA	NA	NA	NA	NA	NA	1,3,5	4,10	2,4	NA	NA	NA	NA	NA

Table A-5-A. TWRS Facility Hazard Identification. (4 Sheets)

Facility 241-A-Tank Farm	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
*Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-A-831	Old Ventilation stack bldg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	241-A-831 bldg inactive.
241-A-CT-400	Cooling towers (outside fence)	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
	Pump station for cooling towers	NA	NA	NA	NA	NA	NA	5	4,9,10	2,3	NA	10	NA	NA	
	"Lift" station pumping station	NA	NA	NA	NA	NA	NA	5	4,9,10	2,3	NA	NA	NA	NA	NA
	Hazardous storage shed (outside fence)	NA	NA	NA	17(7)	NA	NA	3,5	4,10	2,4	NA	NA	NA	NA	(7) Sign indicated flammable materials, did not open shed to verify
A-08, F-561	Raw water valve pit, valve pit, crib sampling station	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	10	NA	NA	NA
	Old ion exchanger	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive
216-A-28	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-A-30	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-A-36A	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-A-36B	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-A-37-1	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-A-45	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-5-A. TWRS Facility Hazard Identification. (4 Sheets)

Facility 241-A-Tank Farm	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
A-417	Catch tank	2[8]	NA	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	[8] Assume potentially the same as tank waste.
244A	Lift station (DCRT)	2	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-153	Diversion box	2	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-A-302A	Catch tank	2	NA	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-A-302B	Catch tank	2	NA	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-A-501	Valve pit	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F-562	Valve pit	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AX-80	Service pit	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F-505	Diverter caisson	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AX-152	Valve pit	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-A-431	Ventilation building	[9]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	[9] Did not look into this building, it is locked up and Inactive
	Fuel storage tank	[10]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	[10] Contents and serviceability of this tank unknown.

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

ALC = airlift circulator.
COB = cleanout box.
DCRT = double-contained receiver tank.
HPT = health physics technician.
NA = not applicable.
Rxtns = reactions.
SST = single-shell tank.

Table A-5-AN. TWRS Facility Hazard Identification. (3 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
AN TANK FARM		NA	NA	NA	NA	NA	NA	5	6	2, 3	NA	11	NA	NA	NA
241-AN-101	DST	2	6,7,8	15	11(1)	NA	NA	2(3),3	4,6,9,10,14	3		11,15	NA	NA	(1) Hydrogen not above LFL
241-AN-102	DST	2	6,7,8	15	11(1)	NA	NA	2(3), 5,3	4,6,9,10,14	3		11,15	NA	NA	(2) Ammonia (3) Pump bearings
241-AN-103	DST	2	6,7,8	15	11(1), 14(2)	NA	NA	2(3),3, 7(5)	4,6,9,10,14,10(6)	2,3		11,15	NA	NA	AN-103 is a watchlist tank (hydrogen/ flammable gas). (4) Mixer pump motor (caustic addition)
241-AN-104	DST	2	6,7,8	15	11(1), 14(2)	NA	NA	2(3),3, 7(5)	4,6,9,10,14,10(6)	2,3		11,15	NA	NA	AN-104 is a watch list tank (hydrogen/ flammable gas). (5) Sealed camera units in the dome space (6) Camera motor
241-AN-105	DST	2	6,7,8	15	11(1), 14(2)	NA	NA	2(3), 3,7(5)	4,6,9,10,14,10(6)	2,3		11,15	NA	NA	AN-105 is a watch list tank (hydrogen/ flammable gas). (7) Mixer pump motor
241-AN-106	DST	2 ,4	6,7,8	15	11(1)	NA	NA	2(3),3	4,6,9,10,14	3		11,15	NA	NA	NA
241-AN-107	DST	2	6,7,8	15	11(1), 14(2)	NA	NA	2(3), 3,7(5)	4,6,9,10,14,10(6)	2,3		11,15	NA	NA	NA
COB-AN-1	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
COB-AN-2	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
COB-AN-3	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
COB-AN-4	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
COB-AN-5	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
COB-AN-6	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
COB-AN-7	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA

Table A-5-AN. TWRS Facility Hazard Identification. (3 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes ->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
COB-AN-8	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
COB-AN-9	Cleanout box	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AN-273	Compressor building	NA	NA	NA	NA	NA	NA	1,2,3, 5	4,7,8,9, 10,11,14	2,3,4	5	7,13	2,6	1,3	NA
241-AN-01D	Condensate receiver pit	NA	NA	NA	NA	NA	NA	NA	4	NA	5	3	NA	NA	NA
241-AN	Flush pit	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AN-271	Instrument building	NA	NA	NA	NA	NA	NA	2,3,5	3,4,5, 6,7,8, 11,14, 16(8)	2,4	NA	NA	NA	3	(8) 480 V. considered high voltage
	Service pit	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	10	NA	3	NA
241-AN-A	Valve pit	NA	NA	NA	NA	NA	NA	NA	4	NA	5	3,10	NA	NA	NA
241-AN-B	Valve pit	NA	NA	NA	NA	NA	NA	NA	4	NA	5	3,10	NA	NA	NA
	Satellite accumulation area	1, 2, 4	NA	NA	2, 10, 17 (tank contact wastes)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Annulus pits (7)	NA	NA	NA	NA	NA	NA	2,5	4	2,3	5	3	NA	NA	NA
	Leak detector pits (7)	NA	NA	NA	NA	NA	NA	2,5	4	2,3	5	3	NA	NA	NA
	Central pump pits (7)	NA	NA	NA	NA	NA	NA	2,5	4	2,3	5	3	NA	NA	NA
241-AN-01E	Supernate receiver pit (1)	NA	NA	NA	NA	NA	NA	NA	4	NA	5	3	NA	NA	NA
	Ventilation pits (4)	NA	NA	NA	NA	NA	NA	NA	4	NA	5	3	NA	NA	NA
241-AN-274	Caustic addition control building	2	NA	NA	NA	NA	NA	2,4	4,9,10, 11	2,3	NA	NA	NA	3(9)	(9) Heat trace

Table A-5-AN. TWRS Facility Hazard Identification. (3 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
	Ventilation pad	NA	6,7	NA	11,14	NA	NA	1,2,3,4,5	4,6,10, 11,16	2,4	NA	NA	NA	3	NA
	Change trailer	NA	NA	NA	NA	NA	NA	NA	4,8,11	NA	NA	NA	5	3	NA

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

COB = cleanout box.
DST = double-shell tank.
LFL = Lower Flammability Limit.
NA = not applicable.
Rxtns = reactions.

Table A-5-AP. TWRS Facility Hazard Identification. (2 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
AP TANK FARM		NA	NA	NA	NA	NA	NA	5	6	2, 3	NA	11	NA	NA	NA
241-AP-101	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP-102	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP-103	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP-104	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP-105	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP-106	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP-107	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP-108	DST	2	6, 7, 8	15	4, 11, 14	5*	NA	5	9, 14	3	NA	NA	NA	NA	*Tank waste
241-AP	Valve pit	2	NA	15	NA	NA	NA	5	14	NA	NA	NA	NA	NA	NA
COB-AP-07D	Clean out box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO COBs in AP Farm
COB-AP-07E	Clean out box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO COBs in AP Farm
COB-AP-07F	Clean out box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO COBs in AP Farm
241-AP	Flush pit	NA	NA	NA	NA	NA	NA	NA	14	NA	NA	NA	NA	NA	leak detection in sump
241-AP-273	Service Bldg.	NA	NA	NA	NA	NA	NA	NA	11, 14	NA	NA	NA	NA	3	Space heater in service Bld.
241-AP-02D	Feed pump pit	2	NA	15	NA	NA	NA	5	9, 14	3	NA	NA	NA	NA	NA
241-AP-07D	Mixer pump pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	07D pit empty
241-AP-07E	Mixer pump pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	07E pit empty
241-AP-07F	Mixer pump pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	07F pit empty
241-AP-271	Instrument building	NA	NA	NA	NA	NA	NA	NA	4, 3, 16, 5, 6, 7 , 8, 11, 14	NA	NA	NA	5	3	NA

Table A-5-AP. TWRS Facility Hazard Identification. (2 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-AP-701	Compressor building	NA	NA	NA	4, 5, 10	NA	NA	1, 2, 3, 5	4, 6, 8, 10, 11, 14, 16	2, 4	NA	NA	6, 8	3, 6	Small flammable storage cabinet located in compressor Bld. See SARA 313 report
K1 & K2	Vent Systems (Primary and annulus, seal pot pits)	2	67	NA	4, 10, 11, 14	NA	NA	1, 2, 3, 5	4, 5, 6, 7, 10, 11, 14	2, 4	NA	15*	NA	3	Hatchways are a mass; gravity, height hazard
01A-08A	Central Pump pits (101-108)	2	NA	15	NA	NA	NA	5	9, 14	3	NA	NA	NA	NA	NA
01B-08B	Annulus Pump pits (101-108)	2	NA	15	NA	NA	NA	5	9, 14	3	NA	NA	NA	NA	NA
03C,05C	Leak Detection Pit	NA	NA	15	NA	NA	NA	5	9, 14	3	NA	NA	NA	NA	NA
03D	Drain Pit	2	NA	15	NA	NA	NA	5	14	NA	NA	NA	NA	NA	NA
Change trailer	MO 815	NA (b, c)	NA	NA	7, 13, did not open cabinet, assumed contents	NA	NA	NA	14	NA	1 (transport vehicles)	NA	5 2 gas bottles outside trailer supporting PCM1B	3 space heaters in trailer	NA
AP Tank Farm	Satellite Accumulation Area	1, 2, 4	NA	NA	2, 10, 17 (tank contact wastes)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

COB = cleanout box.
DST = double-shell tank.
MO= mobile office.
NA = not applicable.
PCM1B = personal contamination monitor 1B.
Rxtns = reactions.
SARA = *Superfund Amendments and Reauthorization Act of 1986.*

Table A-5-AX. TWRS Facility Hazard Identification. (3 Sheets)

Facility 241-AX-Tank Farm	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
AX TANK FARM		NA	NA	NA	NA	NA	NA	5	6	2, 3	NA	11	NA	NA	NA
241-AX-101	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	AX-101 is a watch list tank (hydrogen/ flammable gas).
241-AX-102	SST	2	6,7,8	15	11,13,14	NA	NA	NA	4	NA	NA	NA	NA	NA	AX-102 is a watch list tank (organics).
241-AX-103	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	AX-103 is a watch list tank (hydrogen/ flammable gas).
241-AX-104	SST	2	6,7,8	15	11,14	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AX-155	Diversion box	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AX-COBs	Cleanout boxes (10)	2	6,7,8	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AX-152	Diverter station	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	10,11	NA	NA	Diverter station includes a valve pit
241-AX-A&B	Flush pits (2)	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	Each metal cover has an open penetration
241-AX-101(1), 102 (2), 103 (2), 104 (2)	Pump pits B (1)	NA	NA	NA	NA	NA	NA	NA	4(2)	NA	NA	NA	NA	NA	(1) Pits are inactive and weather enclosed with polyurethane foam. (2) Operable pit leak detector
241-AX-101 (2), 102 (1), 103 (1), 104 (1)	Sluice pits C,D (1)	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AX-101	Distributor pits (1)	NA	NA	NA	NA	NA	NA	NA	4(2)	NA	NA	NA	NA	NA	NA
241-AX-562	Valve pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-5-AX. TWRS Facility Hazard Identification. (3 Sheets)

Facility 241-AX-Tank Farm	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-AX	Leak detection pits (4)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Probe cords to each pit were lying on the ground.
241-A-211	Control room	NA	NA	NA	NA	NA	NA	NA	4,5(3)	NA	NA	NA	NA	NA	(3) Substation outside of control room
241-A-350	Drainage lift station & catch tank	NA	NA	NA	NA	NA	NA	5	4,9,10	2,3	NA	11	NA	NA	NA
241-AX	Raw water service pit	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	10	NA	NA	NA
241-AX-801A	Instrument building	NA	NA	NA	NA	NA	NA	NA	4,11,16	NA	NA	NA	NA	3	NA
241-AX-A&B	Valve pits	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	3(4)	(4) Heat traces in pit
241-AX-801B	Instrument building	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	Instruments all isolated except for a couple of leak signals. This building had a spill of aging waste previously.
	Old steam coil caissons (3)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Caissons are isolated and filled with sand.
241-AX-2707	Change trailer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-AX-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AX-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AX-501	Valve pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-5-AX. TWRS Facility Hazard Identification. (3 Sheets)

Facility 241-AX-Tank Farm	Type	A-Corrosive	B-Explosive/Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
COB = cleanout box.
NA = not applicable.
Rxtns = reactions.
SST = single-shell tank.

Table A-5-AY. TWRS Facility Hazard Identification. (2 Sheets)

Facility Aging Waste Tanks 101 & 102-AY	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
AY TANK FARM		NA	NA	NA	NA	NA	NA	5	6,9,10, 14	2, 3	5,7	3,11	NA	NA	NA
241-AY-101	DST	2	6,7,8, 11(1)	15	11,14	5	NA	NA	4,6,9,144(2)	3	NA	NA	9	NA	Has been recommended to be included as a watch list tank. (1) PU Oxide (2) High level probe
241-AY-102	DST	2,5	6,7,8, 11(1)	15	11,14	5	NA	NA	4(2)	3	NA	NA	9	NA	(3) Flexible receiver
241-AY-152	Sluice transfer box	Isolated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-AY-801	Instrument building	NA	NA	NA	NA	NA	NA	3	4,5,6,7,8,11,16,18	4	NA	16	NA	3	NA
241-AY-	Central pump pits (2)	NA	6(7)	NA	4	NA	NA	5	4,6,8,9, 10,16	2,3	NA	16	NA	NA	NA
241-AY-	Sluice pits B,C,D,E (8)	NA	NA	NA	4	NA	NA	5	4,6,8,9, 10,16	2,3	NA	16	NA	NA	102-AY-02D has a lube oil pump
241-AY-	Annulus pump pits F (2)	NA	NA	NA	4	NA	NA	5	4,6,8,9, 10,16	2,3	NA	16	NA	NA	NA
241-AY-	Raw water valve pits (10)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16	NA	NA	NA
241-AY-	Leak detector pits (3)	2	NA	NA	NA	NA	NA	5	4,6,9, 10,	2,3	NA	16	NA	NA	NA
241-702-A (in A farm)	Ventilation facility	NA	NA	NA	NA	NA	NA	1,2,3	4,6,10, 11	2,4	NA	16	NA	NA	NA
241-AY-	Annulus ventilation fans (2)	NA	NA	NA	NA	NA	NA	1,2,3	4,6,10, 11	2,4	NA	NA	NA	NA	NA
241-AY-501	Condensate valve pit	NA	NA	NA	NA	NA	NA	NA	4,6,14 (leak detector)	NA	NA	16	NA	NA	NA
	Metal storage-construction	NA	NA	NA	NA	NA	NA	NA	12	NA	NA	NA	NA	NA	NA

Table A-5-AY. TWRS Facility Hazard Identification. (2 Sheets)

Facility Aging Waste Tanks 101 & 102-AY	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
	New ventilation recirculation bldgs (2)	NA	NA	NA	NA	NA	NA	NA	4,6	NA	NA	16	NA	NA	NA
	New primary ventilation intake (2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Satellite Accumulation Area	1, 2, 4	NA	NA	2, 10, 17 (tank contact wastes)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Change trailers (2)	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	5	NA	NA

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
DST = double-shell tank.
NA = not applicable.
Rxtns = reactions.

Table A-5-AZ. TWRS Facility Hazard Identification. (2 Sheets)

Facility Aging Waste Tanks 101 & 102-AZ	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
AZ TANK FARM		NA	NA	NA	NA	NA	NA	5	6,9,10, 14	2, 3	5,7	3,11	NA	NA	NA
241-AZ-101	DST	2,5	6,7,8 , 11(1)	15	11,14	5	NA	NA	4(2)	3	NA	NA	9	NA	(1) PU Oxide (2) High level probe
241-AZ-102	DST	2,5	6,7,8 , 11(1)	15	11,14	5	NA	NA	4(2)	3	NA	NA	9	NA	(3) Flexible receiver
241-AZ-161	Airlift circulator caisson	2(4)	NA	NA	NA	NA	NA	NA	4	NA	6(5)	10,12(6)	NA	NA	(4) Potential, does not currently exist
241-AZ-162	Airlift circulator caisson	2(4)	NA	NA	NA	NA	NA	NA	4	NA	6(5)	10,12(6)	NA	NA	(5) Air flow through ALC ~4 cfm, 35 psi (6) Hatch door
241-AZ-151	Catch tank	2(7)	6,7,8	15	11(1), 14(2)	NA	NA	2(3), 3, 7(5)	4,10(6)	2,3		15	NA	3	(7) Potential waste transfer through 152-AZ (151 catches 152 drain)
241-AZ-152	Sluicing transfer box	2(7)	6(7)	NA	11(7)	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AZ-154	Steam condensate pump pit & catch tank	NA	NA	NA	NA	NA	NA	2,5	4,9,10	2,3	NA	NA	NA	NA	NA
241-AZ-	Cleanout boxes	2,5	6,7,8 , 11(1)	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
241-AZ-155	Contaminated storage pit	2(8)	NA	NA	NA	NA	NA	NA	7,9, 10(8)	NA	NA	NA	NA	NA	Zip cord in cover penetration
241-AZ-801A	Instrument building	NA	NA	NA	NA	NA	NA	3	4,5,6,7, 8,11,16,18	4	NA	NA	NA	3	NA
241-AZ-01A, 02A	Central pump pits A (2)	NA	NA	NA	NA	NA	NA	5	4,6,8,9, 10,16	2,3	NA	16	NA	NA	NA
241-AZ-01B-E, 02B-E	Sluice pits B,C (4)	NA	NA	NA	NA	NA	NA	5	4,6,8,9, 10,16	2,3	NA	16	NA	NA	NA

Table A-5-AZ. TWRS Facility Hazard Identification. (2 Sheets)

Facility Aging Waste Tanks 101 & 102-AZ	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-AZ-01F, 02F	Annulus pump pits F (2)	NA	NA	NA	NA	NA	NA	5	4,6,8,9, 10,16	2,3	NA	16	NA	NA	NA
241-AZ-	Valve pits (6)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16	NA	NA	NA
241-AZ-101/ 102	Leak detector pits (2)	2	NA	NA	NA	NA	NA	5	4,6,9, 10,	2,3	NA	16	NA	NA	Rock sitting in cover block penetration (101-AZ)
241-702-A (in A farm)	Ventilation facility	NA	NA	NA	NA	NA	NA	1,2,3	4,6,10, 11	2,4	NA	16	NA	NA	NA
241-AZ-	Annulus ventilation fans (2)	NA	NA	NA	NA	NA	NA	1,2,3	4,6,10, 11	2,4	NA	NA	NA	NA	NA
	Primary ventilation recirculation bldg (2)	NA	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA
	AY/AZ diesel generators	NA	NA	NA	NA	NA	NA	1,2,4,5	1,4,5,8, 10,14,16	2	NA	NA	NA	NA	NA
241-AZ-	Transformers 2 (outside fence)	NA	NA	NA	NA	NA	NA	NA	3,16	NA	NA	NA	NA	NA	Transformers do not contain PCBs.
216-A-39	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	New primary ventilation intake facilities (2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

cfm = cubic feet per minute.
DST = double-shell tank.
NA = not applicable.
PCB = polychlorinated biphenyl.
psi = pounds per square inch.
Rxtns = reactions.

Table A-5-B. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
B Farm		NA	NA	NA	9*, 17	NA	NA	NA	3, 4, 6,16, 18**	NA	NA	2***	NA	NA	*Two small change trailers on east side of B Farm **High voltage at north end of Farm ***A few stairs leading to change trailers Only tank B-103 is on the organic watch list. None on the high heat or flammable gas watch list [d3]
241-B-101	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-102	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-103	SST	1-6	678	15	11,13,14***	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open) ***Tank B-103 is on the organic watch list. Not on flammable gas watch list [d3]
241-B-104	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)

Table A-5-B. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-B-105	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-106	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-107	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-108	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-109	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-110	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-111	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open) [d3]

Table A-5-B. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-B-112	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-201	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-202	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-203	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
241-B-204	SST	1-6	678	15	111314	NA	NA	NA	6, 14*	NA	NA	11**	NA	NA	*Temperature probes, liquid level devices, etc **Tank has pits, but all are weather covered and inactive (none open)
216-B-55	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive and isolated.
216-B-62	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive and isolated.
216-B-63	Ditch	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive, backfilled with clean fill, downposted to underground radioactive material area, and permanently isolated.
241-B-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diversion boxes are all isolated and weather covered.

Table A-5-B. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-B-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diversion boxes are all isolated and weather covered.
241-B-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diversion boxes are all isolated and weather covered.
241-B-154	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diversion boxes are all isolated and weather covered.
241-B-252	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diversion boxes are all isolated and weather covered.
242-B-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diversion boxes are all isolated and weather covered.
241-B-301B	IMUST rad contaminated	2	6	15	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	Tank is isolated
241-B-302B	IMUST rad contaminated	2	6	15	1113	NA	NA	NA	NA	NA	NA	NA	NA	NA	Tank is stabilized and isolated
216-B-3	Pond (B expansion ponds)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Expansion ponds active. Will remain under WHC. Ecology certified clean closed under RCRA, 6/27/95
	Satellite accumulation area	1,2,4*	NA	NA	2, 6, 10, 17*	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Satellite accumulation boxes were not opened during walkdowns. Hazards listed are the expected, potential hazards.

Table A-5-B. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
RCRA = *Resource Conservation and Recovery Act of 1976.*
Rxtns = reactions.
SST = single-shell tank.
WHC = Westinghouse Hanford Company.

Table A-5-BX. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
BX FARM		1*	NA	NA	9	NA	NA	NA	3, 4, 6, 16, 18	NA	NA	2**, 16	5, 12***	NA	*Large tank of phosphoric acid near BX-112 **Stairs leading into change trailer ***Gas bottles for PCM1B near change trailer, fire hydrant in tank farm. *No tanks are high heat, organic or flammable gas watchlist tanks, but BX-107 has been recommended for addition to the flammable gas watchlist [d3, d7]
241-BX-101	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-102	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-103	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-104	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-105	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Open pit(caisson w/ nothing inside, no lid) south of the tank

Table A-5-BX. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-BX-106	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-107	SST	1-6,	6, 7, 8	15	11, 13, 14*	NA	NA	5	6, 9, 10 14**	2, 3	NA	11***	NA	NA	*Tank BX-107 has been recommended for addition to the flammable gas watchlist. **Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-108	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-109	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-110	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-111	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
241-BX-112	SST	1-6,	6, 7, 8	15	11, 13, 14	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	**Temperature probes, liquid level devices ***Tanks have pits, but none open
244-BX	Catch station	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	See DCRT below (same facility)
241-BXR-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered.

Table A-5-BX. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-BXR-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered.
241-BXR-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered.
244-BX	DCRT	2, 6 (salt well pumping waste)	6,7,8 (same as tank waste)	15 (same as tank waste)	11, 13, 14 (same as tank waste)	NA	NA	3, 5	4, 6, 9, 10, 11	2,3,4	5*	3, 11**	NA	3	*Crane needed to access pits for filter changes **DCRT has pits, but they aren't open (not really hazards)
241-BX-302A	IMUST rad contaminated	unknown	6 (low risk)	15 (low risk)	11 (low risk), 13 (no data)	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive tank.
241-BX-302B	IMUST rad contaminated	unknown	6 (low risk)	15 (low risk)	11 (low risk), 13 (no data)	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive tank.
241-BX-302C	IMUST rad contaminated	unknown	6 (low risk)	15 (low risk)	11 (low risk), 13 (no data)	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive tank.
244-BXR-001	IMUST rad contaminated	6 (metal waste slurry)	6 (low risk)	no risk	11, 13 (low risk)	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive tank.
244-BXR-002	IMUST rad contaminated	1	6 (low risk)	no risk	11, 13 (low risk) 12	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive tank.
244-BXR-003	IMUST rad contaminated	1	6 (low risk)	no risk	11, 13 (low risk) 12	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive tank.
244-BXR-011	IMUST rad contaminated	1	6 (low risk)	no risk	11, 13 (low risk) 12	NA	NA	NA	NA	NA	NA	NA	NA	NA	Inactive tank.
244-BX Instrument Bldg.	Instrument Building	NA	NA	NA	8	NA	NA	NA	3,4, 8, 11, 14, 16	NA	NA	NA	NA	3, 6	Raw water line to service pit goes through this building.

Table A-5-BX. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
BX/BY Raw Water Service Pit	Raw water service pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11*, 16	NA	NA	*Pit, but not open (it is covered) Raw water service pit for BX and BY Farms
	Satellite accumulation area	1,2,4*	NA	NA	2, 6, 10, 17*	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Satellite accumulation boxes were not opened during walkdowns. Hazards listed are the expected, potential hazards.

*The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
DCRT = double-contained receiver tank.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
PCM1B = personal contamination monitor 1B.
Rxtns = reactions.
SST = single-shell tank.

Table A-5-BY. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
BY FARM		NA	NA	NA	8	NA	NA	NA	3, 4, 6, 16, 18	NA	1	16	NA	NA	Vans in farm associated with sampling activities. Tanks BY-103, 104, 105, 106, 107, 108, 110, 111, and 112 are ferrocyanide watchlist tanks. *No flammable gas, high heat, or organic watchlist tanks, but BY-101, 102, 103, 105, 106, and 109 have been recommended for addition to the flammable gas watchlist [d3, d5]
241-BY-101	SST	1-6	6, 7, 8	15	11, 13, 14*	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	*Tank BY-101 recommended for addition to flammable gas watchlist **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-102	SST	1-6	6, 7, 8	15	11, 13, 14*	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	*Tank BY-102 recommended for addition to flammable gas watchlist **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-103	SST	1-6	6, 7, 8	15	11, 13, 14*	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	Tank BY-103 is on the ferrocyanide watchlist. *Tank BY-103 recommended for addition to flammable gas watchlist **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open

Table A-5-BY. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-BY-104	SST	1-6	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	Tank BY-104 is on the ferrocyanide watchlist. **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-105	SST	1-6	6, 7, 8	15	11, 13, 14*	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	Tank BY-105 is on the ferrocyanide watchlist. *Tank BY-105 recommended for addition to flammable gas watchlist **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-106	SST	1-6	6, 7, 8	15	11, 13, 14*	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	Tank BY-106 is on the ferrocyanide watchlist. *Tank BY-106 recommended for addition to flammable gas watchlist **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-107	SST	1-6	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	Tank BY-107 is on the ferrocyanide watchlist. **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-108	SST	1-6	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	Tank BY-108 is on the ferrocyanide watchlist. **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open

Table A-5-BY. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-BY-109	SST	1-6	6, 7, 8	15	11, 13, 14*	NA	NA	5	6, 9, 10, 14**	2, 3	NA	11***	NA	NA	*Tank BY-109 recommended for addition to flammable gas watchlist **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open)
241-BY-110	SST	1-6	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	Tank BY-110 is on the ferrocyanide watchlist. **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-111	SST	1-6	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	Tank BY-111 is on the ferrocyanide watchlist. **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-112	SST	1-6	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14**	NA	NA	11***	NA	NA	Tank BY-112 is on the ferrocyanide watchlist. **Temperature probes, liquid level devices, etc. ***Pits on tank, but none open
241-BY-302	Compressor building	NA	NA	NA	8	NA	NA	1, 2, 3, 5	4, 8, 10, 11, 14, 16	2, 4	NA	NA	6, 8	3, 6	241-BY-302 replaced with a new compressor skid. These hazards refer to the new compressor skid.
241-BYR-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered [rb, wd]
241-BYR-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered [rb, wd]

Table A-5-BY. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-BYR-155	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered [rb, wd]
216-BY-201	IMUST rad contaminated	2 (no data)	no data	no data	no data	NA	NA	NA	no data available	NA	NA	NA	NA	NA	No information found on this IMUST.
241-BY-301	Instrument building	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	241-BY-301 abandoned, replaced by 254-BY and 244-BX Instrument Buildings.
	Satellite accumulation area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	BY Farm shares a satellite accumulation area with BX Farm.
241-BYR-154	Diversion Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered [rb, wd]
254-BY	Instrument Building	NA	NA	NA	8	NA	NA	NA	3, 4, 8, 11, 14, 16	NA	NA	NA	NA	3, 6	NA
	Valve Pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Valve pit is isolated and weather covered [rb, wd]

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
Rxtns = reactions.
SST = single-shell tank.

Table A-5-C. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D-Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
C FARM		NA	NA	NA	9	NA	NA	NA	3, 4, 6, 16, 18	NA	5*	2,3, 15**, 16	5, 12*** (fire hydrant and pressure testing of transfer lines)**	NA	*Abandoned crane in farm, also crane present for construction activities **Gas bottles for PCM1B, also in construction area and near FIC on tank C-105. Raw water hose (insulated and heat traced) lying on the ground from Control Building to Service Pit. Excavation associated with construction near C-106
															***Transfer lines are pressure tested before use (90-110 psi). Only tanks C-102 and C-103 are on the organic watch list. Only C-106 is a high heat tank. Tanks C-108, C-109, C-111, and C-112 are on the ferrocyanide watchlist. No tanks on hydrogen watchlist, but tanks C-104 and C-107 have been recommended for addition to the flammable gas watchlist. [d3, d5]
241-C-101	SST	1-6	6, 7, 8	15	111314	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	**All tanks have pits that are covered (no open pits, not a hazard)

Table A-5-C. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-C-102	SST	1-6	6, 7, 8	15	11,13, 14*	NA	NA	5	6, 9, 10, 14	2, 3	NA	11**	NA	NA	*Tank C-102 is on the organic watch list. Not on hydrogen watchlist [d3] **All tanks have pits that are covered (no open pits, not a hazard) Supplied fresh air required to get near C-102 because of the potential for noxious vapor exposure.
241-C-103	SST	1-6	6, 7, 8	15	11,13, 14*	NA	NA	5	6, 9, 10, 14	2, 3	NA	11**	NA	NA	*Tanks C-103 is on the organic watch list. Not on hydrogen watchlist [d3] **All tanks have pits that are covered (no open pits, not a hazard) Supplied fresh air required to get near C-103 because of the potential for noxious vapor exposure.
241-C-104	SST	1-6	6, 7, 8	15	11,13, 14*	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	*Tank C-104 has been recommended for addition to the flammable gas watchlist **All tanks have pits that are covered (no open pits, not a hazard)
241-C-105	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	5	6, 9, 10, 14	2, 3	NA	11**	NA	NA	**All tanks have pits that are covered (no open pits, not a hazard)

Table A-5-C. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-C-106	SST	1-6*	6, 7, 8	15	11,13, 14	NA	NA	5	6, 9, 10, 14	2, 3	NA	11**	NA	NA	*Tank C-106 is a high heat tank. [d3] **All tanks have pits that are covered (no open pits, not a hazard) Many transient hazards associated with construction activities (high voltage, gas bottles, ditches/excavations, welding equipment, etc)
241-C-107	SST	1-6	6, 7, 8	15	11,13, 14*	NA	NA	5	6, 9, 10, 14	2, 3	NA	11**	NA	NA	*Tank C-107 has been recommended for addition to flammable gas watchlist **All tanks have pits that are covered (no open pits, not a hazard)
241-C-108	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	Tank C-108 is a ferrocyanide watchlist tank **All tanks have pits that are covered (no open pits, not a hazard)
241-C-109	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	Tank C-109 is a ferrocyanide watchlist tank **All tanks have pits that are covered (no open pits, not a hazard)
241-C-110	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	5	6, 9, 10, 14	2, 3	NA	11**	NA	NA	**All tanks have pits that are covered (no open pits, not a hazard)
241-C-111	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	Tank C-111 is a ferrocyanide watchlist tank **All tanks have pits that are covered (no open pits, not a hazard)

Table A-5-C. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D-Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-C-112	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	5	6, 9, 10, 14	2, 3	NA	11**	NA	NA	Tank C-112 is a ferrocyanide watchlist tank **All tanks have pits that are covered (no open pits, not a hazard)
241-C-201	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	**All tanks have pits that are covered (no open pits, not a hazard)
241-C-202	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	**All tanks have pits that are covered (no open pits, not a hazard)
241-C-203	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	**All tanks have pits that are covered (no open pits, not a hazard)
241-C-204	SST	1-6	6, 7, 8	15	11,13, 14	NA	NA	NA	6, 14	NA	NA	11**	NA	NA	**All tanks have pits that are covered (no open pits, not a hazard)
241-CR-271	Control room	NA	NA	NA	8	NA	NA	NA	3, 4, 8, 11, 14, 16	NA	NA	10*	NA	3, 6	*Ladder was outside of building
244-CR	CR-Vault	2,6 (salt well pumping waste)	6,7,8 (same as tank waste)	15 (same as tank waste)	11, 13, 14 (same as tank waste)	NA	NA	35	4, 6, 9, 10, 11	234	NA	11,14*	NA	3, 6	*Vault has pits which are covered and the vault itself is covered
241-C-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered
241-CR-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered
241-C-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered
241-CR-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered

Table A-5-C. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D-Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-C-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered
241-CR-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered
241-C-154	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diversion box shown as isolated on the routing board [rb] Believed to be buried near Hot Semi Works, 201-C
241-C-252	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	All diversion boxes are isolated and weather covered
241-C-301C	IMUST rad contaminated	2	6	15	11, 13	NA	NA	NA	4*	NA	NA	NA	NA	NA	*Heated vapor probe
241-C-801	Process storage building	unknown	unknown	unknown	unknown	unknown	NA	unknown	unknown	unknown	5 [H-2-4569	2, 3, 11, 12 [H-2-4569]	unknown	unknown	Called the Cesium Load-Out Facility. Building not entered during walkdown because of construction. Building currently owned by Bechtel, used as a storage building .
	Satellite accumulation area	1,2,4*	NA	NA	2, 6, 10, 17*	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Satellite accumulation boxes were not opened during walkdowns. Hazards listed are the expected, potential hazards.
241-C-601	Compressor building	NA	NA	NA	8	NA	NA	1235	4, 8, 10, 11, 14, 16	2, 4	NA	NA	6, 8	3, 6	NA
241-C	Valve pit	NA	NA	NA	NA	NA	NA	NA	4, 11	NA	NA	11*	NA	3	*Valve pit is covered. Located within the fresh air zone between C-102 and C-103.

Table A-5-C. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A-Corrosive	B-Explosive/ Pyrophoric	C-Nuclear Criticality	D-Flammable Materials	E-Thermal Radiation	F-Chem. Rxtns.	G-Friction	H-Electrical	I-Kinetic-Rotation	J-Kinetic-Linear	K-Mass, Gravity, Height	L-Pressure-Volume	M-Thermal (except radiant)	Comments
Legend Boxes –>		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
	Water service pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11*, 16	NA	NA	*Service pit is covered, but has a large open hole (4-5" in diameter)
296-P-16	Vent System for C-105 and C-106 tanks	2 (tank condensate)	6, 7, 8 (tank condensate)	NA	11,13,14 (tank waste condensate)	NA	NA	35	4, 10, 11, 14	24	NA	NA	NA	3	Composition of condensate unknown. May not have same potential hazards as the tank contents. No data available.

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

FIC = Food Instrument Corporation.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
PCM1B = personal contamination monitor 1B.
psi = pounds per square inch.
Rxtns = reactions.
SST = single-shell tank.

Table A-5-S. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
S FARM		NA	7*	NA	8, 10 *** 14 *	NA	NA	NA	4, 5, 6, 18 **	NA	1* **	NA	NA	5 ****	* 2 propane tanks northeast corner ** Power lines run south of the farm Old exhausters near S-101 and S-110 are under locked wooden structures. *** Sampling truck located on tank S-110 **** SHMS on tanks S-102, S-111, S-112
241-S-101	SST	2	678	15	11, 13, 14	NA	NA	5, 7 *	6, 9, 10, 14 *	NA	NA	11 ***	6 *	NA	* Saltwell pump skid, includes water and air tanks. Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.
241-S-102	SST	2	678	15	11, 13, 14**** ++	NA	NA	5	6, 9, 10,14 *	23	NA	11 ***	NA	NA	* SHMS, temperature probes, liquid level devices, etc. *** Pits on tank, but none open. **** Must have ammonia monitor or supplied air ++ Hydrogen and organics watch list tank.
241-S-103	SST	2	678	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 ***	NA	NA	* Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.

Table A-5-S. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-S-104	SST	2	678	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 ***	NA	NA	* Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.
241-S-105	SST	2	678	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 ***	NA	NA	*Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.
241-S-106	SST	2	678	15	11, 13, 14	NA	NA	5, 7 *	6, 9, 10,14 *	23	NA	11 ***	6	NA	* Saltwell pump skid, includes water and air tanks. Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.
241-S-107	SST	2	678	15	11, 13, 14	NA	NA	5, 7 *	6, 9, 10, 14 *	23	NA	11 ***	6	NA	* Saltwell pump skid, includes water and air tanks. Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.
241-S-108	SST	2	678	15	11, 13, 14	NA	NA	5 , 7	6, 9, 10, 14 *	23	NA	11 ***	6	NA	* Saltwell pump skid, includes water and air tanks, and flammable gas monitor Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.

Table A-5-S. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-S-109	SST	2	678	15	11, 13, 14	NA	NA	5, 7 *	6, 9, 10, 14 *	23	NA	11 ***	6	NA	* Saltwell pump skid, includes water and air tanks. Temperature probes, liquid level devices, etc. *** Pits on tank, but none open.
241-S-110	SST	2	678	15	10**, 11, 13, 14	NA	NA	5, 7*	6, 9, 10, 14*	23	NA	11***	6	NA	* Saltwell pump skid, includes water and air tanks,and flammable gas monitor. ** Sampling truck *** Pits on tank, but none open.
241-S-111	SST	2	678	15	11, 13, 14 ++	NA	NA	5	6, 9, 10, 14 *	23	NA	11 ***	NA	NA	* SHMS, temperature probes, liquid level devices, etc. *** Pits on tank, but none open. ++ Hydrogen and organics watch list tank.
241-S-112	SST	2	6++,7,8	15	11, 13, 14 ++	NA	NA	5	6, 9, 10, 14 *	23	NA	11 ***	NA	NA	* SHMS, temperature probes, liquid level devices, etc. *** Pits on tank, but none open. ++ Hydrogen watch list tank.
241-S-304	Catch tank	Unknown **	Unknown **	Unknown **	Unknown **	NA	NA	NA	NA	NA	NA	NA	NA	NA	** No data
216-S-25	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-S-26	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-5-S. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
244-S	DCRT catch station	1-6 Same as tank waste	6, 7, 8, Same as tank waste	15	11, 13, 14	NA	NA	3, 5	4, 6, 9 , 11	2, 3, 4	NA	11 *	NA	3, 6	* Catch station has pits that are covered
240-S-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-S-151	Diversion box	1-6 Receives waste from different facilities going to SY Farm.	6, 7, 8, Same as tank waste	NA	11, 13, 14	NA	NA	NA	4	NA	NA	11	NA	NA	NA
241-S-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
240-S-302	IMUST rad contaminated	2	NA	15	13	NA	NA	NA	NA	NA	NA	13	NA	NA	NA
241-S-302A	IMUST rad contaminated	2	NA	15	13	NA	NA	NA	4 *	NA	NA	13	NA	NA	* Leak detection- FIC gauge
241-S-302B	IMUST rad contaminated	2	6	15	13	NA	NA	NA	NA	NA	NA	13	NA	NA	NA
241-S-A	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14	NA	NA	11	NA	6	NA
241-S-B	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14	NA	NA	11	NA	6	NA
241-S-C	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14	NA	NA	11	NA	6	NA
241-S-D	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14	NA	NA	11	NA	6	NA
COB-1 through COB-18, COB 51-1, COB 52-1	Clean out boxes	2 *	6, 7, 8,	NA	11, 13, 14*	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste.
12 inch	Vertical storage units (6)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-5-S. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
	Satellite Accumulation Area	6 *	NA	NA	1, 2, 9, 13*	NA	NA	NA	NA	NA	NA	NA	NA	NA	* Mixed waste storage could have many different constituents.

*The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

COB = cleanout box.
DCRT = double-contained receiver tank.
FIC = Food Instrument Corporation.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
Rxtns = reactions.
SHMS = Standard Hydrogen Monitoring System.
SST = single-shell tank.

Table A-5-SX. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below. Mark any boxes which are not applicable NA. Provide references for each entry.*													*Notes*
SX FARM		NA	NA	NA	8, 14	NA	NA	NA	4, 5, 6, 18	Na	Na	3, 7 *	5 **	6	*Crane and hoist ** SHMS gas bottles on Tanks 101 through 106 and 109.
241-SX-101	SST	2	6, 7, 8	15	11, 13, 14	5	NA	5 *	6, 10, 14 **	2*	NA	11 ***	NA	NA	* SHMS, hydrogen watch list tank. ** emperature probes, liquid level devices, etc. *** Pits on tank but none open.
241-SX-102	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	5 *	6, 10, 14 **	2*	NA	11 ***	NA	NA	* SHMS, hydrogen watch list tank. ** temperature probes, liquid level devices, etc. *** Pits on tank but none open.
241-SX-103	SST	2	6, 7, 8	15	11,13 , 14 ****	NA	NA	5 *	6, 10, 14 **	2*	NA	11 ***	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** Organic watch list tank.

Table A-5-SX. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below. Mark any boxes which are not applicable NA. Provide references for each entry.*													*Notes*
241-SX-104	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	5 *	6, 10, 14 **	2*	NA	11 ***	NA	NA	* SHMS, hydrogen watch list tank ** Temperature probes, liquid level devices, etc. *** Pits on tank but none open.
241-SX-105	SST	2	6, 7, 8	15	11, 13, 14 ****	NA	NA	5 *	6, 10, 14 **	2*	NA	11 ***	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** Organic watch list tank.
241-SX-106	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	5 *	6, 10, 14 **	2*	NA	11 ***	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. *** Pits on tank but none open.
241-SX-107	SST	2 5 ****	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** High heat tank

Table A-5-SX. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below. Mark any boxes which are not applicable NA. Provide references for each entry.*													*Notes*
241-SX-108	SST	2 5 ****	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** High heat tank
241-SX-109	SST	2 5 ****	6, 7, 8	15	11, 13, 14	NA	NA	5 *	6, 10, 14 **	2*	NA	11 ***	NA	NA	* SHMS, hydrogen watch list because tanks 1 through 6 vent through it. ** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** High heat tank
241-SX-110	SST	2 5 ****	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** High heat tank
241-SX-111	SST	2 5 ****	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** High heat tank

Table A-5-SX. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below. Mark any boxes which are not applicable NA. Provide references for each entry.*													*Notes*
241-SX-112	SST	2 5 ****	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** High heat tank
241-SX-113	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. *** Pits on tank but none open.
241-SX-114	SST	2 5 ****	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. *** Pits on tank but none open. **** High heat tank
241-SX-115	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 **	NA	NA	11 ***	NA	NA	** Temperature probes, liquid level devices, etc. ***Pits on tank but none open.
241SX-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-SX-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-SX-302	IMUST rad contaminated	1 - 6	6, 7, 8	NA	11, 13, 14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lateral Wells (4)	NA	NA	NA	NA	NA	NA	NA	4, 6, 8, 13, 14	NA	NA	11	NA	NA	NA
241-SX-A 241-SX-B	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14	NA	NA	11	NA	6	NA
241-SX-271	Instrument building	NA	NA	NA	NA	NA	NA	NA	4, 8, 14	NA	NA	NA	NA	6	NA

Table A-5-SX. TWRS Facility Hazard Identification. (5 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below. Mark any boxes which are not applicable NA. Provide references for each entry.*													*Notes*
241-SX-701	Compressor building	NA	NA	NA	NA	NA	NA	NA	4, 8, 14	NA	NA	NA	NA	6	Compressor building is out of service.
12 inch	Vertical storage units (21)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Used to store riser plugs and miscellaneous tools
24 inch	Vertical storage unit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Used to store riser plugs and miscellaneous tools

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
Rxtns = reactions.
SHMS = Standard Hydrogen Monitoring System.
SST = single-shell tank.

Table A-5-SY. TWRS Facility Hazard Identification. (2 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
SY FARM		NA	7	NA	8	NA	NA	2, 3, 5 *	1+, 4, 6, 10, 14, 16, 19**	2, 4	NA	NA	5, 6****	6 ***	+ Electrical backup battery trailer, batteries are gel filled. Outside fence north side. * K1 , K1A, and K2 ventilation equipment. ** Stadium type lighting. *** Electrical wiring in farm. **** Gas bottles associated with SHMS on tanks SY-101 and SY-103, and bottles with sampling buildings.
241-SY-101	DST	2	6++ , 7, 8	15	11++, 13, 14	NA	NA	5*, ***	4, 6, 9, 10, 14	2, 3	NA	11 **	12 ****	NA	* Mixer motor ** Pits on tank, but not open *** SHMS and miscellaneous sampling gas bottles **** Blowout riser with three blowout plates ~ 3' X 3' ++ Hydrogen watch list tank.
241-SY-102	DST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 9, 10, 14	NA	NA	11 **	NA	NA	** Pits on tank, but not open
241-SY-103	DST	2	6++, 7, 8	15	11 ++, 13, 14	NA	NA	5 ***,	4, 6, 9, 10, 14	NA	NA	11 **	NA	NA	** Pits on tank, but not open 216-T-32 *** SHMS ++ Hydrogen watch list tank.

Table A-5-SY. TWRS Facility Hazard Identification. (2 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-SY-271-P1	Air compressor	NA	NA	NA	NA	NA	NA	1, 2, 3, 5	4, 8, 10	3, 4	NA	NA	6	NA	Air compressor
241-SY-1	Cleanout box	2	6,7,8	NA	11, 13, 14	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
241-SY-2	Cleanout box	2	6,7,8	NA	11, 13, 14	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
241-SY-3	Cleanout box	2	6,7,8	NA	11, 13, 14	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
241-SY-4	Cleanout box	2	6,7,8	NA	11, 13, 14	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
241-SY-5	Cleanout box	2	6,7,8	NA	11, 13, 14	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
241-SY-6	Cleanout box	2	6,7,8	NA	11, 13, 14	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
241-SY-02-E	Feed pump pit	2	6,7,8	NA	11, 13, 14	NA	NA	NA	4, 6, 14	2, 3	NA	11	NA	3	* Same waste as tank waste
241-SY-A	Flush pit	NA	NA	NA	NA	NA	NA	NA	4, 6, 11, 14	NA	NA	11	NA	3	NA
241-SY-B	Flush pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11	NA	NA	NA
241-SY-02E	Flush pit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11	NA	NA	NA
241-SY-271	Instrument building	NA	NA	NA	8,	NA	NA	1, 2, 3, 5	4, 10, 14	3, 4	NA	NA	6,	NA	Air compressor in instrument building
241-SY	Service pit	NA	NA	NA	NA	NA	NA	NA	4, 11, 14	NA	NA	11	NA	3	NA
241-SY-A	Valve pit	2	NA	NA	NA	NA	NA	NA	4, 13	NA	NA	11	NA	NA	NA
241-SY-B	Valve pit	2	NA	NA	NA	NA	NA	NA	4, 13	NA	NA	11	NA	NA	NA

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
DST = double-shell tank.
NA = not applicable.
Rxtns = reactions.
SHMS = Standard Hydrogen Monitoring System.

Table A-5-T. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
T FARM		NA	NA	NA	3*, 8	NA	NA	NA	4, 5, 6, 9, 13, 14, 16	NA	1**	2 ***	5 +	6 ****	* Gas powered generator parked on south side of farm. ** Portable lighting unit in farm and truck picking up saltwell lance. *** Stairs to change trailer. **** Electrical wiring in T-Farm. + Gas bottles associated with SHMS on tank T-110.
241-T-101	SST	2	6, 7, 8	151	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open.
241-T-102	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-103	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-104	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	7 *	4, 6, 9, 10, 14 **	NA	NA	11 ****	6 *	NA	* Saltwell pump skid, includes water and air tanks. ** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.

Table A-5-T. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-T-105	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-106	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-107	SST	2	6, 7, 8	15	11, 13, 14 ++	NA	NA	7 *	4, 6, 9, 10, 14 **	NA	NA	11 ****	6 *	NA	* Saltwell pump skid, includes water and air tanks. ** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open. ++ Ferrocyanide watch list tank.
241-T-108	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-109	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-110	SST	2	6,++ 7, 8	15	11++ 13, 14	NA	NA	5 *	4, 6, 14 **	2 *	NA	11 ****	5 *	NA	* SHMS ** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open. ++ Hydrogen watch list tank.

Table A-5-T. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-T-111	SST	2	6, 7, 8	15	11, 13 ++ 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open. ++ Organics watch list tank.
241-T-112	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-201	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-202	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-203	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-204	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	4, 6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-T-701	Compressor building	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Air compressor out of service
216-T-1	Ditch	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-T-4-2	Ditch	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-T-7	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Potential for Cave-In
216-T-32	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Potential for Cave-In

Table A-5-T. TWRS Facility Hazard Identification. (4 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-T-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-T-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-T-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-T-252	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-TR-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-TR-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-T-301	IMUST rad contaminated	2	6, 7, 8	NA	11, 12, 13, 14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12 inch	Vertical storage units (6)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T-Farm	Satellite Accumulation Area	6 *	NA	NA	1, 2, 9, 13 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	* Mixed waste storage could contain different constituents.

*The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
Rxtns = reactions.
SHMS = Standard Hydrogen Monitoring System.
SST = single-shell tank.

Table A-5-TX. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
TX FARM		NA	NA	NA	NA	NA	NA	NA	3, 4, 5, 6, 16, 18	2	1 *	2+, 7	5 **	6++	* Sampling truck in farm. A-Frame type hoist southwest corner of farm. A plastic wrapped pallet of herbicides ~25 bags found inside farm ** Gas bottles outside change trailer for PCM1B + Stairs on change trailer. ++ Wiring within farm.
241-TX-101	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-102	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-103	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-104	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.

Table A-5-TX. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-TX-105	SST	2	6, 7, 8	15	11, 13++, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open. ++ Organic watch list tank.
241-TX-106	SST	2	6, 7, 8	15	11, 13, 14, 17 ***	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open. *** 2 wood covers or walkways, 4' X 20', purpose could not be identified
241-TX-107	SST	2	6, 7, 8	15	11, 13, 14 ***	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-108	SST	2	6, 7, 8	15	11, 13, 14 ***	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open. *** Must have ammonia monitor or supplied air
241-TX-109	SST	2	6, 7, 8	15	11, 13, 14 ***	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open. *** Must have ammonia monitor or supplied air

Table A-5-TX. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-TX-110	SST	2	6, 7, 8	15	11, 13, 14 ***	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open. *** Must have ammonia monitor or supplied air
241-TX-111	SST	2	6, 7, 8	15	11, 13, 14 ***	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open. *** Must have ammonia monitor or supplied air
241-TX-112	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-113	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-114	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-115	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.

Table A-5-TX. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Box ->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-TX-116	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. **Ppits on tank, but none open.
241-TX-117	SST	2	6, 7, 8	15	11, 13, 14	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open.
241-TX-118	SST	2	6, 7, 8	15	11, 13 , 14 ++	NA	NA	NA	6, 14 *	NA	NA	11 **	NA	NA	* Temperature probes, liquid level devices, etc. ** Pits on tank, but none open. ++ Ferrocyanide and organic watch list tank.
241-TX-302C	Catch tank	2 *	6, 7, 8 *	15 *	11, 13, 14 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	* Waste composition unknown
241-T-601	Compressor building	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
244-TX	DCRT catch station	2 Same as tank waste	6, 7, 8, Same as tank waste, 10 ***	15	11, 13, 14	NA	NA	3, 5	4, 6, 9, 11	2, 3, 4,	NA	11 *	NA	3, 6	* Pits are covered. *** PU from PFP.
241-TXR-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-TXR-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-TXR-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-TX-152	Diversion box	2 Same as tank waste	6, 7, 8 Same as tank waste 10 ***	NA	11, 13, 14	NA	NA	NA	4	NA	NA	11	NA	NA	*** PU from PFP

Table A-5-TX. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-TX-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-TX-154	Diversion box	2 Same as tank waste	6, 7, 8 Same as tank waste 10 ***	NA	11, 13, 14	NA	NA	NA	4	NA	NA	11	NA	NA	MA
241-TX-155	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
242-T-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-TX-302A	IMUST rad contaminated	Unknown	6 *	No data	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	* Waste composition unknown
241-TX-302B(R)	IMUST rad contaminated	Unknown	6	NA	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-TX-302B	IMUST rad contaminated	Unknown	6	15	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
241-TX-302X	IMUST rad contaminated	Unknown	6	15	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
244-TXR-001	IMUST rad contaminated	Unknown	6	NA	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
244-TXR-002	IMUST rad contaminated	Unknown	6	NA	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
244-TXR-003	IMUST rad contaminated	Unknown	6	NA	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
242-T-135	IMUST rad contaminated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No data
242-TA-R1	IMUST rad contaminated	Unknown	6	No data	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12 inch	Vertical storage units (6)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17 *	NA	NA	* 12" pipes used for riser plug storage, may have abandoned tools inside.

Table A-5-TX. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
	Satellite Accumulation Area	6 *	NA	NA	1, 2, 9, 13, *	NA	NA	NA	NA	NA	NA	NA	NA	NA	* Mixed waste storage, could have many different constituents.

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

DCRT = double-contained receiver tank.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
PCM1B = personal contamination monitor 1B.
PFP = Plutonium Finishing Plant.
Rxtns = reactions.
SST = single-shell tank.

Table A-5-TY. TWRS Facility Hazard Identification. (2 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
TY FARM		NA	NA	NA	NA	NA	NA	NA	18 *	NA	NA	NA	NA	NA	TY-Farm is clean closed and stabilized. *Pole mounted transformer
241-TY-101	SST	2	6,7,8	15	14 +	5*	NA	NA	3**,4, 16,	NA	NA	NA	NA	NA	*Tank waste + Ferrocyanide watch list tank.
241-TY-102	SST	2	6,7,8	15	NA	5*	NA	NA	3**,4, 16	NA	NA	NA	NA	NA	*Tank waste
241-TY-103	SST	2	6,7,8	15	14 +	5*	NA	NA	3**,4, 16,	NA	NA	NA	NA	NA	*Tank waste + Ferrocyanide watch list tank.
241-TY-104	SST	2	6,7,8	15	13, 14 +	5*	NA	NA	3**,4, 16,	NA	NA	NA	NA	NA	*Tank waste + Ferrocyanide and organic watch list tank.
241-TY-105	SST	2	6,7,8	15	NA	5*	NA	NA	3**,4, 16,	NA	NA	NA	NA	NA	*Tank waste
241-TY-106	SST	2	6,7,8	15	NA	5*	NA	NA	3**,4, 16,	NA	NA	NA	NA	NA	*Tank waste
241-TY-A	Valve box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Valve box located between TY-105/106.
241-TY-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-TY-201	IMUST rad contaminated	No data	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No data
241-TY-302A	IMUST rad contaminated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TY farm IMUSTS stabilized, no pumpable liquids, verification via CCTV
241-TY-302B	IMUST rad contaminated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	TY farm IMUSTS stabilized, no pumpable liquids, verification via CCTV

Table A-5-TY. TWRS Facility Hazard Identification. (2 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.
CCTV = closed-circuit television.
IMUST = inactive miscellaneous underground storage tank.
NA = not applicable.
Rxtns = reactions.
SST = single-shell tank.

Table A-5-U. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
U FARM		NA	7*	NA	8, 14 *	NA	NA	NA	3, 4, 5, 6, 7, 8, 16, 18	NA	1 , 5 **	2, 3, 5 ***	5 ****	6+	* Large liquid nitrogen and 2 propane tanks outside fence on south side. ** Sampling truck and crane. *** Change trailer **** SHMS, gas bottles on Tanks 103, 105, 107, 108, 109. + Wiring in farm
241-U-101	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open.
241-U-102	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. *** Sampling truck **** Pits on tank, but none open.
241-U-103	SST	2	6, 7, 8	15	11, 13++ 14, *****	NA	NA	5 *	4, 6, 10, 14 **	2*	NA	11 ****	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. ****Ppits on tank, but none open. ***** Must have ammonia monitor or supplied air. ++ Organic watch list tank.
241-U-104	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open.

Table A-5-U. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-U-105	SST	2	6, 7, 8	15	11, 13++ 14, *****	NA	NA	5 *	4, 6, 10, 14 **	2 *	NA	11 ****	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open. ***** Must have ammonia monitor or supplied air. ++ Organic watch list tank.
241-U-106	SST	2	6, 7, 8	15	11, 13++ 14,*****	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open. ***** Must have ammonia monitor or supplied air, also has HCN monitoring area. ++ Organic watch list tank.
241-U-107	SST	2	6, 7, 8	15	11, 13++ 14	NA	NA	5 *	4, 6, 10, 14 **	2 *	NA	11 ****	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open. ++ Organic watch list tank.
241-U-108	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	5 *	4, 6, 10, 14 **	2 *	NA	11 ****	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open.

Table A-5-U. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-U-109	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	5 *	4, 6, 10, 14 **	2 *	NA	11 ****	NA	NA	* SHMS, hydrogen watch list tank. ** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open.
241-U-110	SST	2	6, 7, 8	15	11, 13, 14, *****	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open. ***** Must have ammonia monitor or supplied air.
241-U-111	SST	2	6, 7, 8	15	11, 13++ 14 *****	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open. ***** Must have ammonia monitor or supplied air. ++ Organic watch list tank.
241-U-112	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	NA	6, 14 **	NA	NA	11 **** 17 ++	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open. ++ Tank is roped off and has signs indicating "UNSTABLE GROUND"
241-U-201	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. ****Pits on tank, but none open.

Table A-5-U. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes --->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below.*													*Notes*
241-U-202	SST	2	6, 7, 8	15	11, 13, 14,	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open.
241-U-203	SST	2	6, 7, 8	15	11, 13++ 14	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open. ++ Organic watch list tank
241-U-204	SST	2	6, 7, 8	15	11, 13++ 14	NA	NA	NA	6, 14 **	NA	NA	11 ****	NA	NA	** Temperature probes, liquid level devices, etc. **** Pits on tank, but none open. ++ Organic watch list tank.
241-U-301B	Catch tank	2	6,7, 8 *	15 *	11, 13, 14	NA	NA	NA	4, 14	NA	NA	NA	NA	NA	* Waste composition unknown ENRAF liquid level device
241-UX-302A	Catch Tank	2	6,7, 8 *	15 *	11, 13, 14	NA	NA	NA	4, 14	NA	NA	NA	NA	NA	* Waste composition unknown ENRAF liquid level device
241-U-701	Compressor building	NA	NA	NA	4, 10	NA	NA	1, 2, 3, 5,	4, 8, 10	2	6	NA	6	NA	Air compressor
216-U-12	Crib	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
216-U-17	Crib	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
244-U	DCRT catch station	NA	NA	NA	NA	NA	NA	3, 5	4, 6, 9, 11, 14,	2, 3., 4	NA	11 **	NA	3, 6	* 244-U has not received any waste . ** Pits are covered
216-U-14	Ditch	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-5-U. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes —>		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
241-U-151	Diversion box	2	6,7,8 Same as tank waste	NA	11, 13, 14,	NA	NA	NA	4	NA	NA	11[wd]	NA	NA	NA
241-U-152	Diversion box	2	6,7,8 Same as tank waste	NA	11, 13, 14,	NA	NA	NA	4	NA	NA	11	NA	NA	NA
241-UX-154	Diversion box	2	6,7,8 Same as tank waste	NA	11, 13, 14,	NA	NA	NA	4	NA	NA	11	NA	NA	NA
241-U-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-U-252	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-UR-151	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-UR-152	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-UR-153	Diversion box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-UR-154	Diversion box	NA	NA	[illegible]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Weather covered
241-U-A	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14,	NA	NA	11	NA	6	NA
241-U-B	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14,	NA	NA	11	NA	6	NA
241-U-C	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14,	NA	NA	11	NA	6	NA
241-U-D	Valve pit	Unknown	Unknown	NA	Unknown	NA	NA	NA	4, 14,	NA	NA	11	NA	6	NA
COB U-25	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-26	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-27	Clean out box	2 *	[illegible]	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-28	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste

Table A-5-U. TWRS Facility Hazard Identification. (6 Sheets)

Facility	Type	A- Corrosive	B- Explosive/ Pyrophoric	C- Nuclear Criticality	D- Flammable Materials	E- Thermal Radiation	F- Chem. Rxtns.	G- Friction	H- Electrical	I- Kinetic- Rotation	J- Kinetic- Linear	K- Mass, Gravity, Height	L- Pressure- Volume	M- Thermal (except radiant)	Comments
Legend Boxes -->		*Select applicable hazards from attached table and place corresponding hazard numbers in the boxes below*													*Notes*
COB U-29	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-30	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-31	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-32	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-33	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
COB U-34	Clean out box	2 *	678	NA	11, 13, 14 *	NA	NA	NA	4, 6, 13	NA	NA	11	NA	3, 6	* Same waste as tank waste
241-U-271	Instrument Building	NA	NA	NA	NA	NA	NA	NA	4, 5, 8, 11, 13	NA	NA	NA	NA	6	NA
	Change Trailer	NA	NA	NA	NA	NA	NA	NA	4, 11, 14	NA	NA	2	NA	6	NA
12 inch	Vertical storage units (6)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	* 12 " pipes used for riser plug sorage, may have abandoned tools inside.
	Satellite Accumulation Area	6 *	NA	NA	1, 2, 9, 13 *	NA	NA	NA	NA	NA	NA	NA	NA	NA	* Mixed waste storage, could have many different constituents.

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.
[b]See Table 3.3.1.1-2 for the specific energy classifications represented by the numeric designators.

COB = cleanout box.
DCRT = double-contained receiver tank.
HCN = hydrogen cyanide.
NA = not applicable.
Rxtns = reactions.
SHMS = Standard Hydrogen Monitoring System.
SST = single-shell tank.

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SUMMARY OF OCCURRENCES

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APPENDIX B
SUMMARY OF OCCURRENCES

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LIST OF TERMS

CAM	continuous air monitor
CASS	Computerized-Automated Surveillance System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COB	cleanout box
DACS	Data Acquisition and Control System
Dept.	department
DCRT	double-contained receiver tank
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOV	diaphragm-operated valve
dP	differential pressure
FIC	Food Instrument Corporation
H	hydrogen
HEPA	high-efficiency particulate air (filter)
HPT	health physics technician
HVAC	heating, ventilation, and air conditioning
ICF KH	ICF Kaiser Hanford Company
Inst.	instrument
KEH	Kaiser Engineers Hanford
LCO	Limiting Condition for Operation
LEL	lower explosive limit
LFL	Lower Flammability Limit
LOW	liquid observation well
MCC	motor control center
NFPA	National Fire Protection Association
ON	off-normal
OOS	out of service
OSD	operating specification document
OSR	Operational Safety Requirement
PAS	PUREX acidified sludge
PM	preventive maintenance (activities)
PNL	Pacific Northwest Laboratory
ppm	parts per million
press.	pressure
psig	pounds per square inch (gauge)
PUREX	Plutonium Uranium Extraction (Facility)
REDOX	Reduction Oxidation (Facility)
SAR	safety analysis report
SARP	safety analysis report for packaging
SOV	solenoid-operated valve
SST	single-shell tank

LIST OF TERMS (Cont'd)

TFO	tank farm operator
TWRS	Tank Waste Remediation System
USQ	Unreviewed Safety Question
WHC	Westinghouse Hanford Company

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APPENDIX B
SUMMARY OF OCCURRENCES

Appendix B identifies reported occurrences at the Tank Waste Remediation System (TWRS) facilities. This information will be used to assure that events that have occurred are appropriately considered in the hazard analysis and to support qualitative estimates of hazardous condition frequency. Consideration of actual events contributes to the comprehensiveness, utility, and credibility of the hazard analysis.

This appendix consists of two tables:

- Table B-1, "Tank Farm Events, Off-Normal and Critiques," includes brief descriptions of tank farm events that occurred from January 1, 1986 to April 9, 1996.

- Table B-2, "Occurrence Report Database," includes brief descriptions and causes of tank farm events that occurred from April 20, 1972 to April 2, 1998. The overlap between some of the events listed in both tables is caused by a change in the reporting requirements during the reporting of these events.

This appendix contains the information which was reviewed to help assure the comprehensiveness of the hazard analysis. The purpose of this information was to provide part of the basis for postulation of the hazardous conditions and causes identified in the hazard evaluations and support the qualitative assessment of event frequency. The premise is that for the hazard analysis to be applicable, credible, and comprehensive it must at least address the types of events that have already occurred.

While this information is valuable for the performance of the hazard analysis, it was not necessary to keep it current with the configuration dates of this document. This is because any similar occurrence will have already been included in the analysis of Chapter 3.0 and any significant new occurrence will be captured by the Unreviewed Safety Question (USQ) process. Information in this appendix is subject to update as additional hazard analysis activities include review of more current occurrence data.

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Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
1-8-86	86-01	ON	Diesel generator at 244-AR Vault failed, ran out of fuel
1-8-86	86-02	ON	Tank 101-AW pressurized after transfer, reason unknown
1-9-86	86-03	ON	Tank 101-AW slurry distributor plugged during transfer.
1-16-86	86-06	ON	Valve AX-B-15 leaked, allowing AY-102 to AW-102 transfer to enter AN-101.
1-23-86	86-07	ON	Failure to shutdown AY-102 annulus ventilation when required during transfer, @ minimum level.
2-2-86	86-10	ON	AY and AZ tanks pressurized due to primary and backup exhauster failure.
2-6-86	86-11	ON	204-AR 702 leak detector switch mislabeled, improperly bypassed. Transfer stopped due to bypass signal.
2-7-86	86-12	ON	Inst. technician proceeded with work w/o approval, caused exhauster to shutdown. 241-A control room.
2-11-86	86-13	ON	Primary exhauster shutdown, backup failed. Portable backup started, over-pressurized AY and AZ tanks.
3-28-86	86-14	ON	701-SX air compressor oil line ruptured, spraying oil causing smoke. Smoke detector tripped.
7-22-87	86-15	ON	152-AX catch tank level limit exceeded. Deentrainer flush valve left open.
2-25-86	86-16	ON	Primary exhauster shutdown, backup failed. Portable exhauster started, then backup started. 101-AZ tank pressurized.
2-25-86	86-17	ON	Primary exhauster shutdown, backup failed. Six AW tanks pressurized.
3-3-86	86-18	ON	SY-101 tank burp. Pressurized SY-101 & 103.
11-18-86	86-19	ON	241-AW annulus exhauster fan failed, loose blade caused hole in housing.
1-17-87	86-20	ON	Tank 106-AW pressurized during slurry transfer.
3-26-86	86-21	ON	Tank 105-AW pressurized during PUREX E-5 transfers. (4 times)
4-9-86	86-22	ON	Primary exhauster shutdown, backup failed. AY and AZ tanks pressurized.
4-8-86	86-24	ON	244-AR backup air compressor failed on loss of oil. Primary compressor had failed.
1-17-87	86-25	ON	241-AW primary & annulus exhauster failure. AW tanks pressurized.
1-21-87	86-27	ON	241-AW portable exhauster failed during primary exhauster maintenance. AW tanks pressurized.
6-30-86	86-29	ON	102-AW pressurized due to sump jet air DOV leak-through.
7-21-86	86-31	ON	Power shut off to 241-AN tank farm. Operations notified 30 days prior, but not at the time.
7-21-86	86-32	ON	271-AN air conditioner repair tripped building power off.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
7-23-86	86-33	ON	241-AW portable exhauster fail, would not restart. AW tanks pressurized.
8-7-86	86-35	ON	Backup exhauster failed to start on test. AZ tanks pressurized.
1-17-87	86-36	ON	102-AW tank pressurized during transfer, pressure instruments valved out.
9-17-86	86-38	ON	241-AW Raw water service pit strainer leaked 850 gallons due to improper size of hold down lid.
10-3-86	86-41	ON	AY & AZ farm steam diverter valve stuck during test, flow to 216-A-08 crib.
10-7-86	86-45	ON	AN farm air compressor failed causing loss of air to farm instruments.
11-7-86	86-49	ON	AZ farm airlift circulators shutdown too long. (out for test)
12-1-86	86-52	ON	Tank 101-AZ below minimum level requirement.
1-17-87	86-53	ON	Raw water filter drain left open, filled seal loop, allowed pressurization of AY tanks.
11-29-86	86-54	ON	Electrical outage at 200-East farm, AN, AP, and AW tanks pressure alarms activated.
12-1-86	86-55	ON	Power supply tripped to AP farm, tripped vent systems. Tanks pressurized.
12-1-86	86-56	ON	I-129 emissions from AW exhauster exceeding yearly guidelines.
12-9-86	86-58	ON	216-Z-20 crib level at 36", exceeding vapor barrier @ 30". Insufficient infiltration rate.
7-3-87	WHC-C-87-008	Critique	Four personnel had irritated nose and throats due to breathing in 241-C farm.
8-25-87	WHC-C-87-057-TF-03	Critique	Failure to take vacuum readings in SX farm. No vacuum gauge to read.
1-14-88	WHC-C-88-035-TF01	Critique	Water in crib 216-U-17 riser before crib startup.
2-1-88	WHC-C-88-048-TF-02	Critique	Elevated Ruthenium-106 effluent from 241-AP farm exhaust.
5-21-88	WHC-C-88-105-TF-05	Critique	Contamination spread from 241-S farm while washing sludge to pit drain.
7-14-88	WHC-C-88-118-TF-06	Critique	Liquid observation well failure, resulting contamination spread.
8-2-88	WHC-C-88-128-TF-07	Critique	241-SY exhauster failure, tanks pressurized. Pressure alarms failed.
9-12-88	WHC-C-88-132-TF-08	Critique	Crib 216-S-26 not handling 222-S flows. Level rising.
9-19-88	WHC-C-88-161-TF-09	Critique	101-SY exceeded level increase criteria.
12-10-88	WHC-C-88-185-TF-10	Critique	Misrouted condensate from A-417 to 101-AZ tank, instead of 102-AY receiver tank.
3-22-89	WHC-C-89-54-TF-02	Critique	Weight factor and radiation levels exceed criteria in 101-AX leak detection pit.
4-30-89	WHC-C-89-55-TF-03	Critique	Weight factor and radiation levels exceed criteria in 102-AZ leak detection pit.
9-28-89	WHC-C-89-106-TF-08	Critique	Employee felt ill after walking by AP farm. Assumed ammonia inhalation.
10-27-89	WHC-C-89-117-TF-09	Critique	241-AZ vent header found to contain cracks through the wall.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
9-14-90	WHC-TANKFARM-1990-54	ON	1500 gallon leak through open raw water valve to 244-BX DCRT.
10-1-90	WHC-TANKFARM-1990-102	ON	241-AN annunciator panel power loss, loss of alarm capabilities for AN farm.
10-11-90	WHC-TANKFARM-1990-134	ON	Level decrease in tank C-103. Assumed evaporation.
10-19-90	WHC-TANKFARM-1990-162	ON	One acre of land along Powerhouse ditch found contaminated.
10-24-90	WHC-TANKFARM-1990-173	ON	101-SY vents through crust and level drops.
10-24-90	WHC-TANKFARM-1990-181	ON	Employee smoking, eating and drinking in radiation zone, 271-SY-241 instrument building.
11-04-90	WHC-TANKFARM-1990-205	ON	244-BX flush-pit valve leak adds 700 gallons to 244-BX DCRT.
11-11-90	WHC-TANKFARM-1990-219	ON	242-A Monitoring and Control System failed. No monitoring of some East Area alarms.
11-13-90	WHC-TANKFARM-1990-223	ON	Portable exhauster monitoring failure on tank C-106. Stack effluent not monitored.
12-4-90	WHC-TANKFARM-1990-291	ON	Liquid level increase in 241-BY-101. Assumed crystal growth.
12-10-90	WHC-TANKFARM-1990-315	ON	Radiation readings under tanks A-101, 102, & 105 not taken.
12-19-90	WHC-TANKFARM-1990-346	ON	AW farm backup exhaust fan failed to start as required. High pressure in tank farm.
12-20-90	WHC-TANKFARM-1990-352	ON	Frozen water pipe in 244-TX instrument building ruptured and leaked into 244-TX DCRT. (700 gallons)
12-22-90	WHC-TANKFARM-1990-373	ON	Frozen water line in 244-BX instrument building ruptured and leaked into 244-BX DCRT. (550 gallons)
12-23-90	WHC-TANKFARM-1990-376	ON	Raw water valve in 244-TX service pit ruptured due to freezing, leaked 1750 gallons into 244-TX DCRT.
1-1-91	WHC-TANKFARM-1991-001	ON	244-AR steam leak tripped fire alarm.
1-11-91	WHC-TANKFARM-1991-32	ON	241-AW primary exhaust fan restarted during testing, while personnel near by. "Near-miss" injury.
1-15-91	WHC-TANKFARM-1991-43	ON	702-A exhauster shutdown, standby fan out-of-service. Portable fan started, air-lift circulators stopped. (AY and AZ tanks)
1-23-91	WHC-TANKFARM-1991-72	ON	Portable air compressor failure causes loss of inst. air at 244-AR vault.
1-23-91	WHC-TANKFARM-1991-74	ON	Above ground sensing line failed causing 101-AY high pressure alarm.
1-26-91	WHC-TANKFARM-1991-82	ON	Broken water line in BY-302 compressor building causes fire alarm.
1-28-91	WHC-TANKFARM-1991-85	ON	Annunciator panel failure @ 271-AP caused loss of AP tank farm alarms.
2-16-91	WHC-TANKFARM-1991-141	ON	101-SY pressure increased and level decreased due to venting.
2-28-91	WHC-TANKFARM-1991-175	ON	Sanitary water system underground leaks in 241-BY farm.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
3-13-91	WHC-TANKFARM-1991-203	ON	101-SY hydrogen monitor vacuum pump failure.
3-14-91	WHC-TANKFARM-1991-206	ON	SX-106 liquid level increase beyond limit.
3-21-91	WHC-TANKFARM-1991-226	ON	241-AP primary exhauster failed causing pressurization in 105-AP tank.
4-8-91	WHC-TANKFARM-1991-1003	ON	241-A warm water sump level control out-of-service, not calibrated for four years.
4-9-91	WHC-TANKFARM-1991-1004	ON	241-A evacuation due to valving out instrument air line during maintenance.
4-9-91	WHC-TANKFARM-1991-1005	ON	TY-104 and 105 failed breather filters not replaced within time limit due to windy conditions.
4-23-91	WHC-TANKFARM-1991-1010	ON	244-AR stack CAM and record sampler vacuum pumps out-of-service.
4-30-91	WHC-TANKFARM-1991-1011	ON	Compressor failure causes loss of exhausters at 242-S and high pressure alarm at 102-SY tank.
5-16-91	WHC-TANKFARM-1991-1013	ON	High pressure alarm due to venting in 101-SY.
6-4-91	WHC-TANKFARM-1991-1018	ON	S-302-A catch tank level increase due to hose leak into diversion box (90 gallons).
6-18-91	WHC-TANKFARM-1991-1019	ON	Control room unmanned during pumping of 102 and 109-BY tanks.
6-19-91	WHC-TANKFARM-1991-1020	ON	216-S-26 crib level 6" above limit.
6-21-91	WHC-TANKFARM-1991-1022	ON	241-BY drywells high radiation readings during 102 and 109-BY transfers.
6-22-91	WHC-TANKFARM-1991-1023	ON	Portable compressor seized, high pressure alarms tripped at 241-AW farm.
6-29-91	WHC-TANKFARM-1991-1026	ON	Power lost to 200-East Area during electrical storm.
7-16-91	WHC-TANKFARM-1991-1028	ON	Employee contaminated while taking liquid level readings at 152-AX.
8-6-91	WHC-TANKFARM-1991-1031	ON	Momentary power loss to 200-East and West Areas.
8-23-91	WHC-TANKFARM-1991-1035	ON	Many waste tank FIC instruments are out-of-service, they are not a priority item for maintenance.
8-26-91	WHC-TANKFARM-1991-1036	ON	Failure to obtain tank AN-103 level reading as required.
8-30-91	WHC-TANKFARM-1991-1037	ON	Water valve left open at 244-TX spilling 600 gallons on the ground.
9-6-91	WHC-TANKFARM-1991-1038	ON	Three employees reported vapor inhalation in 103-C farm.
9-16-91	WHC-TANKFARM-1991-1043	ON	Construction worker reported inhaling an unknown vapor in 241-C farm.
9-19-91	WHC-TANKFARM-1991-1045	ON	Failure to take liquid level reading at TK-003-CR vault.
10-4-91	WHC-TANKFARM-1991-1051	ON	Exceeded two-year limit on tank BX-104 dome deflection survey.
10-22-91	WHC-TANKFARM-1991-1054	ON	Tank 244-CR-003 pH readings too low hydroxide concentration.
11-12-91	WHC-TANKFARM-1991-1061	ON	Review determined that 88 tanks were not being monitored for temperature as required for non-watchlist tanks.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
11-22-91	WHC-TANKFARM-1991-1065	ON	Tank 101-SY calculated heat loading exceeded OSD limits.
11-26-91	WHC-TANKFARM-1991-1067	ON	Front-end loader backed into and broke a thermocouple riser at T-108 tank.
11-28-91	WHC-TANKFARM-1991-1068	ON	AY-102 level increased during transfer from 244-CR-003 to AY-101.
12-4-91	WHC-TANKFARM-1991-1069	ON	101-SY level decrease and pressurization during tank venting.
12-4-91	WHC-TANKFARM-1991-1070	ON	76 counts per second spike found when lateral radiation scan completed on tank 103-A.
12-5-91	WHC-TANKFARM-1991-1071	ON	55 gallon drum exceeded requirements for 90-day storage.
12-6-91	WHC-TANKFARM-1991-1072	ON	Liquid level limit exceed for tank AN-103.
12-7-91	WHC-TANKFARM-1991-1074	ON	Water leak into AY service water pit during airlift circulator flush.
12-10-91	WHC-TANKFARM-1991-1075	ON	Employee exceeded weekly radiation exposure limit working in 151-S diversion box.
12-17-91	WHC-TANKFARM-1991-1077	ON	241-AN exhauster shutdown, attempts to start fans failed. Seven tanks had static flow for two hours.
12-20-91	WHC-TANKFARM-1991-1078	ON	Sample bottle exceeded 90-day storage requirement.
12-26-91	WHC-TANKFARM-1991-1082	ON	Data on 107-AN annulus leak detection record copied from previous shift. No new report recorded.
12-31-91	WHC-TANKFARM-1991-1085	ON	Air compressor failure leads to 241-SX exhauster shutdown.
1-1-92	WHC-TANKFARM-1992-01	ON	Truck at 241-TX farm picked up tumbleweeds on carriage, tumbleweeds ignited.
1-6-92	WHC-TANKFARM-1992-03	ON	Both leak detector systems for SY-101 lost. Probe failed while CAM was out-of-service.
1-24-92	WHC-TANKFARM-1992-09	ON	During a transfer line hydro test in 241-S farm, water leaked and drained into valve pit.
1-24-92	WHC-TANKFARM-1992-10	ON	C-105 and 106 exhauster failed.
2-25-92	WHC-TANKFARM-1992-15	ON	SX farm exhauster shutdown due to portable compressor shutdown when it ran out of fuel.
2-25-92	WHC-TANKFARM-1992-16	ON	Engineer tracing annunciator wires tripped airlift circulator alarm and farm high pressure alarm.
2-28-92	WHC-TANKFARM-1992-20	ON	While fueling a portable compressor at 241-BY, fuel was spilled on the ground.
2-28-92	WHC-TANKFARM-1992-23	ON	244-TX receiver tank over-filled due to bad instrumentation.
3-6-92	WHC-TANKFARM-1992-25	ON	Tank C-100 inadvertently transferred to 102-AW.
3-10-92	WHC-TANKFARM-1992-26	ON	DANGER tag at SY farm cleared without proper authorization.
3-24-92	WHC-TANKFARM-1992-29	ON	Operator backed a van into a riser and punctured the gas tank. Spilled fuel onto the ground.
4-2-92	WHC-TANKFARM-1992-31	ON	Hazardous substance in railcar not pumped at 204-AR within time limits.
4-20-92	WHC-TANKFARM-1992-32	ON	101-SY gas venting, level decreased about 9 inches.
4-29-92	WHC-TANKFARM-1992-36	ON	Transformer failure interrupts 241-S farm leak detection and level monitoring instruments.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
5-14-92	WHC-TANKFARM-1992-40	ON	Transfer line SL-116 in 241-S farm, failed hydro test, leak sprayed out heat trace conduit.
5-14-92	WHC-TANKFARM-1992-41	ON	Small animals tracked contamination along the fence line of 241-AY farm.
6-10-92	WHC-TANKFARM-1992-45	ON	Attempting to hydro test transfer line SL-115, 200 gallons more than the calculated line holdup was added. Assume line failed.
6-12-92	WHC-TANKFARM-1992-46	ON	Attempted to hydro test transfer line SN-215, line did not hold pressure for 30 seconds. Assume line failed.
6-18-92	WHC-TANKFARM-1992-49	ON	Failure to comply with lock and tag requirements doing work in 241-TX farm.
7-15-92	WHC-TANKFARM-1992-54	ON	Transfer made through diversion box which drains to catch tank A-302-A which level above 50%. Exceeded level limit.
7-20-92	WHC-TANKFARM-1992-56	ON	105/106-C exhauster CAM failed efficiency test due to moisture inside CAM.
7-28-92	WHC-TANKFARM-1992-57	ON	Improper installation of cryogenic vacuum pump on tank 103-C. Samples invalid because of pump location.
8-21-92	WHC-TANKFARM-1992-58	ON	Personnel entered SX farm without proper respiratory protection.
8-20-92	WHC-TANKFARM-1992-60	ON	High level of contamination in Liquid Observation Well in 104-SX tank.
9-3-92	WHC-TANKFARM-1992-63	ON	Increased pressure and decreased level during venting of 101-SY tank.
9-10-92	WHC-TANKFARM-1992-64	ON	101-SY venting seemed to have broken off one of four air lances in tank.
8-14-92	WHC-TANKFARM-1992-65	ON	Increased radiation readings in 241-C drywell.
9-19-92	WHC-TANKFARM-1992-67	ON	Lock and tag cleared from tank farm without proper authorization.
9-25-92	WHC-TANKFARM-1992-70	ON	Personnel contamination from working in 241-SY farm.
9-30-92	WHC-TANKFARM-1992-72	ON	During 106-AN to 102-AP transfer, 102-AW level increased. 3,575 gallon discrepancy in tank level.
10-6-92	WHC-TANKFARM-1992-76	ON	Thermocouple tree stuck, then bent and broken while removing it from 101-SY.
10-7-92	WHC-TANKFARM-1992-77	ON	Unauthorized pressure increase needed to remove thermocouple tree from 101-SY tank.
10-19-92	WHC-TANKFARM-1992-78	ON	SX-103 level decrease exceeded limits.
10-19-92	WHC-TANKFARM-1992-79	ON	Seven deteriorated waste bags found in 241-S farm. Some broken and spilled on ground.
10-21-92	WHC-TANKFARM-1992-83	ON	AW-101 pressurization and level decrease. Tank placed on flammable gas watchlist.
11-6-92	WHC-TANKFARM-1992-85	ON	Aging waste temperature readings not taken because the data sheet was missing.
10-9-92	WHC-TANKFARM-1992-86	ON	SX-105 level decrease exceeded limits. Assume evaporation is cause.
10-22-92	WHC-TANKFARM-1992-87	ON	Procedure compliance deficiencies during 107-C vapor sampling.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
12-3-92	WHC-TANKFARM-1992-88	ON	Personnel contamination during excavation in 241-SY tank farm.
12-8-92	WHC-TANKFARM-1992-90	ON	Periodic higher than normal radiation readings on AN-107 annulus CAM.
1-7-93	WHC-TANKFARM-1993-02	ON	Personnel contamination during piping grinding operation in 241-SY excavation.
1-13-93	WHC-TANKFARM-1993-06	ON	Packaged air lances in 241-SY farm exceeded 120-day storage limit.
1-15-93	WHC-TANKFARM-1993-08	ON	Transfer from 204-AR to 101-AY failed due to frozen jumpers in path.
1-21-93	WHC-TANKFARM-1993-10	ON	Air lance package leakage while in 241-SY farm.
1-26-93	WHC-TANKFARM-1993-14	ON	Transfer from 204-AR railcar to 101-SY made. Some of flow ended up in 102-AY.
2-2-93	WHC-TANKFARM-1993-16	ON	Pressurization and level decrease resulting from 101-SY venting.
2-1-93	WHC-TANKFARM-1993-17	ON	Fire in waste drum in 241-T due to welding activity catching paper towels on fire.
2-2-93	WHC-TANKFARM-1993-18	ON	204-AR ventilation fan failure, failed to re-start manually.
1-28-93	WHC-TANKFARM-1993-19	ON	Ammonia-like odor in 241-T farm.
2-4-93	WHC-TANKFARM-1993-20	ON	242-A circuits deenergized for modifications, control valve opened allowing raw water flow to 106-AW tank.
2-5-93	WHC-TANKFARM-1993-21	ON	Service water valve left open after flushing in 241-AX, caused unaccounted for raw water usage.
2-12-93	WHC-TANKFARM-1993-24	ON	202-B tank level increase limit exceeded.
2-22-93	WHC-TANKFARM-1993-25	ON	Tank T-101 pumping schedule not met.
2-24-93	WHC-TANKFARM-1993-26	ON	Attempt to install shield plug in 101-SY riser found riser was not symmetrical. Mixer pump will have to be modified to fit in riser.
3-8-93	WHC-TANKFARM-1993-29	ON	Ammonia-like odors from 241-SY farm.
3-10-93	WHC-TANKFARM-1993-30	ON	Failure to return 104-BY ventilation system to service after testing. OOS. from Feb. 24 to Mar. 4.
3-17-93	WHC-TANKFARM-1993-31	ON	Aging waste ventilation system recirc. Pump out-of-service, but not tagged out.
1-18-93	WHC-TANKFARM-1993-36	ON	103-BX level increase exceeded level criteria.
4-7-93	WHC-TANKFARM-1993-38	ON	Ammonia-like odors from 241-BX farm.
4-21-93	WHC-TANKFARM-1993-40	ON	102-T core sample casks uncontrolled.
5-10-93	WHC-TANKFARM-1993-47	ON	Raw water leak to ground at 107-C during and after raw water line pressure test.
5-24-93	WHC-TANKFARM-1993-49	ON	241-AP in-service exhauster heater breaker found open.
5-25-93	WHC-TANKFARM-1993-50	ON	Raw water valve left open after maintenance, puddle formed over 102-BY tank. Check valve failed, 3442 gallons spilled.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
6-17-93	WHC-TANKFARM-1993-55	ON	Operator smelled foul odor in at 101-A, resulted in headache and dry throat.
6-26-93	WHC-TANKFARM-1993-58	ON	101-SY pressurized and level decrease during venting.
7-14-93	WHC-TANKFARM-1993-62	ON	Portable exhauster supporting 241-SY farm shutdown. Primary exhauster out-of-service. Tripped high pressure alarm.
7-29-93	WHC-TANKFARM-1993-65	ON	Work done on ferrocyanide and organic watchlist tank (TX-118) without electrically bonded tools.
7-31-93	WHC-TANKFARM-1993-68	ON	Unexplained raw water usage after flush of 241-AZ airlift circulators. 665 gallons unaccounted for.
8-8-93	WHC-TANKFARM-1993-70	ON	Attempt to start primary exhauster and shutdown backup exhauster results in high pressure alarm, 241-AN farm.
8-10-93	WHC-TANKFARM-1993-71	ON	Attempting to check for un unplugged drain, a rock was tied to a rope and lowered into open nozzle in tank. Contaminated personnel.
8-12-93	WHC-TANKFARM-1993-73	ON	Administrative hold on tank farm work was imposed due to lapses in management and employee accountability.
8-14-93	WHC-TANKFARM-1993-74	ON	Requirement exceeded for taking pressure readings in 241-SX farm.
8-16-93	WHC-TANKFARM-1993-75	ON	Personnel cut off tip of finger while changing nitrogen bottles in 241-SY farm.
8-17-93	WHC-TANKFARM-1993-76	ON	Personnel backed van into riser in 241-S farm. Ruptured fuel tank under van.
8-22-93	WHC-TANKFARM-1993-77	ON	Personnel failed to abort 101-SY mixer pump test when indicator failed.
8-26-93	WHC-TANKFARM-1993-78	ON	On numerous occasions the temperature data for watchlist tanks was not taken.
8-27-93	WHC-TANKFARM-1993-79	ON	101-SY tank atmosphere was pressurized momentarily after mixer pump operation.
9-2-93	WHC-TANKFARM-1993-81	ON	Personnel experienced headache and sore throat from unusual odors from 241-TX farm.
9-6-93	WHC-TANKFARM-1993-83	ON	Aging waste tank farm pressure recorder out of paper, violating an Operational Safety Requirement.
9-7-93	WHC-TANKFARM-1993-84	ON	Unexplained raw water usage in 241-AX farm.
9-26-93	WHC-TANKFARM-1993-88	ON	CAM at 241-AY and AZ farm (Aging waste) failed.
10-25-93, 11-2-93	WHC-TANKFARM-1993-93	ON	Rollover of 101-SY tank waste caused shutdown of mixer pump due to high pressure trip. (2 occasions)
11-16-93	WHC-TANKFARM-1993-98	ON	241-SX sludge cooler exhauster operating with a vacuum beyond limits.
11-23-93	WHC-TANKFARM-1993-100	ON	Low dP alarm for 241-SY exhauster second stage HEPA filter found disabled.
4-13-93	WHC-TANKFARM-1993-102	ON	241-SY ventilation filters not tested within 72 hours of maintenance, as required.
11-30-93	WHC-TANKFARM-1993-103	ON	Waste tank level requirement changed, 101-AW level exceeds new limit of 416".
12-2-93	WHC-TANKFARM-1993-106	ON	18-inch clay pipe discovered within the 110 foot buffer zone in 241-T farm. Pipe installed in 1943.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
12-3-93	WHC-TANKFARM-1993-110	ON	Potential USQ concerning T-111 core samples containing uncharacterized reactive components.
12-10-93	WHC-TANKFARM-1993-111	ON	East/West vent station catch tank level limit exceeded.
12-6-93	WHC-TANKFARM-1993-112	ON	Lock and tag violation on electrical plug in DACS trailer in 241-SY farm.
12-15-93	WHC-TANKFARM-1993-114	ON	241-C farm breathing air carbon monoxide alarm trip due to sampling truck running next to compressor intake.
12-16-93	WHC-TANKFARM-1993-115	ON	U-107 tank added to flammable gas watchlist.
1-8-94	WHC-TANKFARM-1994-01	ON	Transfer not aborted as required when leak detector tripped.
1-26-94	WHC-TANKFARM-1994-04	ON	AN-105 annulus CAM removed from service without invoking surveillance as required.
1-27-94	WHC-TANKFARM-1994-05	ON	Failure to install required alarms in DCRTs.
2-1-94	WHC-TANKFARM-1994-06	ON	Steam trap failure in 241-SX farm causes steam plume.
2-10-94	WHC-TANKFARM-1994-07	ON	Primary ventilation lost at 241-AN farm for one hour. Pressures reached atmospheric, but did not go higher.
2-11-94	WHC-TANKFARM-1994-08	ON	Lack of filter paper in alpha radiation detector and faulty microswitch caused exhauster to trip in 241-SY farm. Portable exhauster started.
3-10-94	WHC-TANKFARM-1994-14	ON	Missed filter differential pressure readings in 241-AW and AP tank farms.
4-27-94	WHC-TANKFARM-1994-23	ON	Spurious shutdown signal at evaporator caused 2000 gallons of waste to dump back into 102-AW.
5-16-94	WHC-TANKFARM-1994-027	ON	East/West vent station catch tank level exceeded limit.
5-4-94	WHC-TANKFARM-1994-29	ON	Sample supporting line broke allowing sampling device to fall into 107-AN riser.
6-3-94	WHC-TANKFARM-1994-33	ON	Electrically "hot" taped wires touched terminal strip housing causing a breaker trip that tripped 241-AP primary exhauster. High pressure alarm tripped.
6-9-94	WHC-TANKFARM-1994-34	ON	Lock and danger tag on 101-SY mixer pump breaker left unlocked.
7-5-94	WHC-TANKFARM-1994-38	ON	Steam heat not returned to service after 241-SY exhauster maintenance.
8-5-94	WHC-TANKFARM-1994-40	ON	Electrical utilities severed power cable, lost ventilation in AN, AP, AW, and C farms, and 244-BX and 244-CR.
8-8-94	WHC-TANKFARM-1994-42	ON	Truck driver drove under steam line near 103-SY tank, striking steam line and knocking off insulating material.
8-19-94	WHC-TANKFARM-1994-45	ON	Feeder breaker to 241-AN farm opened, tripping both primary and annulus ventilation fans. Pressurized waste tanks.
8-19-94	WHC-TANKFARM-1994-46	ON	The pH values for 102-AY and 104-AP samples were below 12. Hydroxide concentrations too low.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
8-19-94	WHC-TANKFARM-1994-47	ON	106-S liquid level float missing, wire had corroded after being installed only two months.
8-25-94	WHC-TANKFARM-1994-48	ON	244-CR vault fan #2 out for repair, fan #1 removed from service due to vibration problems. Loss of both fans violates OSD requirements.
9-13-94	WHC-TANKFARM-1994-49	ON	241-SY CAM tripped and fan shutdown when testing. Procedure did not include trip bypass step. Tanks pressurized due to fan shutdown.
10-1-94	WHC-TANKFARM-1994-55	ON	241-AW primary ventilation shutdown, could not be restarted. Loss of confinement in farm.
10-4-94	WHC-TANKFARM-1994-57	ON	101-AW tank had gas release event. Tank pressure increased, hydrogen concentration increased, and level decreased. Tank is on hydrogen watchlist.
10-26-94	WHC-TANKFARM-1994-59	ON	Transfer line SL-503 failed during transfer from 204-AR to 102-AY. Tripped leak detector in sluice pit on tank 102-AY.
11-2-94	WHC-TANKFARM-1994-60	ON	Excavators in 241-SY farm discovered, and subsequently punched a hole in the top of, an underground tank they did not know was there.
11-2-94	WHC-TANKFARM-1994-62	ON	During saltwell pumping of 109-BY a high radiation dose rate existed. Saltwell pump discharge also developed a leak.
11-16-94	WHC-TANKFARM-1994-64	ON	101-BX manual tape level readings not taken due to airborne activity in area.
12-8-94	WHC-TANKFARM-1994-67	ON	Main control power breaker tripped at 241-AN. Primary and annulus exhausters shutdown.
12-27-94	WHC-TANKFARM-1994-73	ON	104-SX LOW readings showed 102% of LFL and ammonia >700 PPM. Stopped work in area.
12-28-94	WHC-TANKFARM-1994-74	ON	106-AW exhaust isolation valve closed to watch position indicator. Pressurization alarm tripped.
12-29-94	WHC-TANKFARM-1994-75	ON	This occurrence covers many discoveries of suspect parts. Including 56 bolts in 241-U farm.
1-18-95	WHC-TANKFARM-1995-07	ON	241-SY portable exhauster shutdown while HPT was testing CAM. Primary system out-of service.
1-20-95	WHC-TANKFARM-1995-08	ON	Potential environmental regulatory deficiency exists due to unknown status of Miscellaneous Underground Storage Tanks.
1-26-95	WHC-TANKFARM-1995-11	ON	Rotary Mode Core Sampler was operated in an unapproved manner ("bumped" while in push mode) while sampling BY-106.
2-1-95	WHC-TANKFARM-1995-13	ON	Personnel failed to wear correct dosimetry (finger rings) while in 106-C sluice pit.
2-15-95	WHC-TANKFARM-1995-14	ON	Rotary Mode Core Sampler operated without proper detector in service.
2-17-95	WHC-TANKFARM-1995-15	ON	Electrical utilities personnel tripped off electrical power to East/West Areas while installing a microwave transfer trip.
2-22-95	WHC-TANKFARM-1995-16	ON	Installation of new level instrument in 104-AP resulted in current level indication below limit.
2-23-95	WHC-TANKFARM-1995-17	ON	Incorrect valve locked out in 241-TX, to replace air dryer and regulating valve.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
1-30-95	WHC-TANKFARM-1995-18	ON	Tank B-103 breather filter isolated from tank by drywell. Tank in contact through other tanks in cascade.
2-13-95	WHC-TANKFARM-1995-20	ON	Propylene glycol leaked from the Rotary Mode Core Sampler truck causing an electrical short and resulted in a fire.
3-7-95	WHC-TANKFARM-1995-22	ON	Caution tag hung in 241-AN farm without authorization signature.
3-7-95	WHC-TANKFARM-1995-23	ON	Transfer from 204-AR to 102-AY leaked into A-350 catch tank, leak in 241-A-A pit nozzle.
3-13-95	WHC-TANKFARM-1995-26	ON	241-T farm breather filter valve discovered in the closed position.
3-16-95	WHC-TANKFARM-1995-27	ON	In preparation for taking a vapor sample from S-111, a valve that was "danger" tagged out for another job was opened.
3-24-95	WHC-TANKFARM-1995-31	ON	General operating condition; potential environmental regulatory deficiency: failure to remove liquids from catch tanks in a timely manner.
3-30-95	WHC-TANKFARM-1995-34	ON	WHC lock and tag removed from S-111 valves, but ICF KH locks and tags still hung. Violation of procedure.
3-29-95	WHC-TANKFARM-1995-35	ON	Auger rod incorrect length for C-101 auger sampling.
4-4-95	WHC-TANKFARM-1995-36	ON	Aging waste facility stack CAM functional test not completed within time limit.
4-11-95	WHC-TANKFARM-1995-39	ON	Rotary mode core sampling truck energized by 120 volts due to incorrect wiring. (no injuries occurred)
4-12-95	WHC-TANKFARM-1995-40	ON	Work done on TY-104 without using bonded tools as required.
4-13-95	WHC-TANKFARM-1995-41	ON	Leak found by 244-A camera crew during B Plant transfer.
4-26-95	WHC-TANKFARM-1995-42	ON	Failure to meet weekly readings requirement for S-108 liquid observation well.
5-3-95	WHC-TANKFARM-1995-44	ON	241-AW pressurization alarm occurred during camera installation in 106-AW central pump pit.
5-2-95	WHC-TANKFARM-1995-45	ON	Subcontractor employee unescorted in 241-TX farm. Violated radiological controls.
5-6-95	WHC-TANKFARM-1995-47	ON	Rotary mode core sampling truck shielded receiver bent due to transversing the drilling rig while the receiver was in the stored position.
5-24-95	WHC-TANKFARM-1995-49	ON	Sampling done in U-103 tank without using the required bonded tools.
5-30-95	WHC-TANKFARM-1995-50	ON	Energized electrical wire struck during hand excavation near 102-AZ tank.
6-16-95	WHC-TANKFARM-1995-52	ON	Discovery of drug contraband in 241-SX instrument shack.
6-16-95	WHC-TANKFARM-1995-53	ON	Failure of mechanical interlock switches allowed rotation of rotary mode core sampler platform beyond design limits.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
6-29-95	WHC-TANKFARM-1995-54	ON	242-T isolated, monitoring discontinued. Monitoring requirements were not changed, so discontinuing the monitoring violated the requirements.
5-15-95	WHC-TANKFARM-1995-56	ON	241-AW lockout installed without proper signature authorization.
7-25-95	WHC-TANKFARM-1995-64	ON	241-SY stack CAM high radiation alarm would not alarm on high radiation.
8-3-95	WHC-TANKFARM-1995-65	ON	Personnel exceeded weekly exposure limit working at BY-105.
8-4-95	WHC-TANKFARM-1995-66	ON	Rotary mode core sampler unable to retrieve complete sample from BY-108 due to failure to install the waste collection sampler in drill string.
8-7-95	WHC-TANKFARM-1995-67	ON	Diesel generator at BX/BY farm fuel leaked into soil.
8-29-95	WHC-TANKFARM-1995-70	ON	Vapor sample taken from B-110 instead of B-112. Person-in-charge was directing operation from outside farm and directed sampling truck to wrong tank.
8-31-95	WHC-TANKFARM-1995-72	ON	244-BX exhauster shutdown. Saltwell pumping from 103, 106, and 109-BX continued into DCRT without exhauster operation as required.
8-31-95	WHC-TANKFARM-1995-73	ON	Potential organic-nitrate chemical reaction discovered for 13 waste tanks. USQ evaluation in progress.
9-13-95	WHC-TANKFARM-1995-75	ON	Lockout at 102-AY airlift circulator valve had unsecured chain.
9-25-95	WHC-TANKFARM-1995-77	ON	241-SY exhauster shutdown, pressurization alarm.
9-27-95	WHC-TANKFARM-1995-78	ON	Core sampling in S-107 found vapor sample drill string reading 130% of Lower Explosive Limit (LEL). Tank headspace sample read 6% LEL.
10-4-95	WHC-TANKFARM-1995-81	ON	Transfer line SN-274 leaked during transfer between AX-B valve pit and 101-AN. Leak at flexible jumper connection. 2 gallons leaked.
10-3-95	WHC-TANKFARM-1995-82	ON	Result of personnel opening breaker at 241-S farm caused shutdown of backup exhauster at 241-SY.
10-5-95	WHC-TANKFARM-1995-86	ON	Implemented new criticality specifications for transfer systems without changing the Interim Safety Basis.
9-26-95	WHC-TANKFARM-1995-90	ON	Found 8000 gallons of liquid in 240-S-151 diversion box. Assume liquid from snow melt and rain, diversion box out of service since March, 1987.
10-19-95	WHC-TANKFARM-1995-91	ON	Incorrect transfer line filled for pressure test. SN-245 filled rather than SN-246.
10-23-95	WHC-TANKFARM-1995-93	ON	Gravel spreading truck entered and left Radiological Buffer Area in 241-TY farm without proper controls in place.
10-26-95	WHC-TANKFARM-1995-94	ON	Vapor sample of rotary mode core sampler drill string from BY-110 read 300% Lower Explosive Limit. Tank headspace sample read <1% LEL.
10-31-95	WHC-TANKFARM-1995-96	ON	Mobile crane repositioned in 241-AN farm, crushed edge of electrical pull box.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
11-2-95	WHC-TANKFARM-1995-97	ON	High pressure alarm at AW-106 tank. High vacuum alarm setpoint outside LCO limit.
11-6-95	WHC-TANKFARM-1995-99	ON	Potential National Fire Prevention Association (NFPA) code deficiency on push and rotary mode core sampling trucks.
11-9-95	WHC-TANKFARM-1995-100	ON	Waste drum at BX/BY Satellite Accumulation Area exceeded stay time limit.
11-13-95	WHC-TANKFARM-1995-101	ON	241-AZ annulus exhauster shutdown and started smoking.
11-15-95	WHC-TANKFARM-1995-105	ON	Grab sample from 102-AY contains less than the requirement for hydroxide.
11-21-94	WHC-TANKFARM-1995-109	ON	Pressure test of supernate transfer line SN-246 (yard line) failed, indicating loss of integrity.
12-5-95	WHC-TANKFARM-1995-111	ON	Unused 1.5" test riser in 241-TY farm found to contain 450% of LFL.
12-6-95	WHC-TANKFARM-1995-112	ON	AN farm exhauster pre-filter changeout occurred without required air sample taken prior to start of work.
12-11-95	WHC-TANKFARM-1995-114	ON	107-AN tank pressure instrument air line froze due to tripped breaker on heat trace line.
12-13-95	WHC-TANKFARM-1995-115	ON	High winds blew off the AN Farm Primary Ventilation System sheet metal cover, shearing the annulus filter differential pressure instruments when the cover came to rest against the annulus stack.
12-22-95	WHC-TANKFARM-1995-120	ON	Discrepancy found between the Operating Specifications Documents (OSD-T-151-00031) requirement for liquid level readings in Tank 102-S and the operator rounds sheets that had been completed.
1-4-96	WHC-TANKFARM-1996-002	ON	Psychrometrics performed on 241-AN-tank farm without proper signatures on work package.
1-8-96	WHC-TANKFARM-1996-003	ON	Personnel skin contamination due to pumping leak detection pits in 241-AW farm without wearing any Personal Protective Equipment.
1-15-96	WHC-TANKFARM-1996-007	ON	Sampling results indicated the waste in DCRT 244-TX did not meet the requirements for hydroxide concentration.
1-17-96	WHC-TANKFARM-1996-009	ON	When lifting the quill rod portion of the rotary mode core sampler out of tank 109-U (a flammable gas watchlist tank) a mechanical spark was generated.
1-17-96	WHC-TANKFARM-1996-010	ON	During work in the 241-S tank farm to remove the above ground ventilation system ducting, the required surveys of the vacuum outlet HEPA filters had not been performed.
1-22-96	WHC-TANKFARM-1996-011	ON	Inadequate work release at 242-A Evaporator results in near-miss electrical incident.
1-30-96	WHC-TANKFARM-1996-012	ON	Pressure transmitter for tank 106-AW failed which disabled the alarm capabilities.
2-1-96	WHC-TANKFARM-1996-013	ON	Failed pressure switch caused shutdown of 241-SY primary exhauster.
2-7-96	WHC-TANKFARM-1996-014	ON	Decontamination spray wand was being tested when a leaking connection sprayed contamination on the operator. To be used on tank 107-AN camera.
2-9-96	WHC-TANKFARM-1996-015	ON	209-E car and mixer room exhauster unscheduled shutdown due to a fire system valve opening.

Table B-1. Tank Farm Events, Off-Normal and Critiques. (14 sheets)

Date	Event #	Event Type	Event Description
2-13-96	WHC-TANKFARM-1996-016	ON	Discovered cesium-137 under 241-SX tank farm at the 110 foot depth. This is much deeper than previously assumed or modeled.
2-15-96	WHC-TANKFARM-1996-017	ON	While removing a thermocouple tree from 101-AZ the tree got stuck with 37 feet of it out, and 18 feet still in the tank. Operator used his hands to shake the tree and received a high radiation dose.
2-21-96	WHC-TANKFARM-1996-019	ON	Railcar was scheduled to have 1000 to 1500 gallons pumped into it at T-Plant. It was found to have 15,000 to 18,000 gallons in it instead of the 1000 to 1500 gallons.
3-8-96	WHC-TANKFARM-1996-022	ON	The AY-02A pit center cover block was removed for pit upgrade. Cores had been drilled in it, and cracks were appearing, making the structural integrity questionable. To be replaced.
3-7-96	WHC-TANKFARM-1996-023	ON	Plugged instrument air line to 101-AY pressure instruments, caused failure of remote monitoring.
3-18-96	WHC-TANKFARM-1996-026	ON	Unauthorized low flying helicopters performing aerial radiological surveys over 241-A, AW, AX, AY, AZ, and C farms.
3-20-96	WHC-TANKFARM-1996-027	ON	Discovered no pressure on 204-AR Fire Suppression System when conducting fire system tests.
3-21-96	WHC-TANKFARM-1996-028	ON	101-SY mixer pump operated with no ammonia monitoring to the DACS system. One monitor was out of service, the other failed during the pump run.
4-9-96	WHC-TANKFARM-1996-032	ON	241-SY primary exhauster shutdown automatically for no apparent reason. Tanks did not pressurize.

CAM = continuous air monitor.
DACS = Data Acquisition and Control System.
DCRT = double-contained receiver tank.
DOV = diaphragm-operated valve.
dP = differential pressure.
HEPA = high-efficiency particulate air (filter).
HPT = health physics technician.
ICF KH = ICF Kaiser Hanford Company.
Inst = instrument.
LCO = Limiting Condition for Operation.
LEL = lower explosive limit.
LFL = Lower Flammability Limit.
LOW = liquid observation well.
NFPA = National Fire Protection Association.
ON = off-normal.
OOS = out of service.
OSD = operating specifications document.
ppm = parts per million.
USQ = Unreviewed Safety Question.
WHC = Westinghouse Hanford Company.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
72-26	04/20/1972	WASTE TRANSFER LINE THAT FLOWS TO 241-A-152 LEAKED INTO ENCASEMENT, THEN THRU COVER BLOCK JOINTS TO GROUND.	WASTE LINE FAILED, ENCASEMENT DRAINS PLUGGED.
72-49	07/06/1972	IRONWORKER-RIGGER PREPARING TO RELEASE A JAM, CABLE LET GO AND BROKE HIS FINGER.	ERROR IN JUDGMENT WHEN WORKING AROUND PINCH POINTS.
72-54	08/11/1972	BROKE 6-INCH SANITARY WATER LINE WITH BACKHOE.	PERSONNEL ERROR, FAILURE TO NOTE WATER LINE USING DETAILED DRAWING.
72-67	10/29/1972	MISROUTED 3,700 GALLONS OF PAS TO TANK 101-AY INSTEAD OF 003-CR.	PERSONNEL ERROR/INCORRECT SETTING FOR TRANSFER ROUTE MADE AT 151-AX DIVERTER STATION.
72-72	11/20/1972	LEAK FROM TRANSFER LINE DURING FLUSHING CAUSED SPRAY UP THROUGH VALVE OPERATOR HOLES IN VALVE PIT COVER.	GASKET FAILURE IN VALVE PIT.
73-1	01/08/1973	LIVE 13.8 KV LINE DOWN NEAR 244 UR, LINE WAS FLASHING AND BURNING.	WIRE BROKE FROM APPARENT FATIGUE ON WIRE FROM COLD WEATHER AND VIBRATION.
73-45	07/05/1973	BACKHOE RAN OVER AND BROKE A FLANGE ON A BELOW GRADE RISER ON A TRANSFER LINE AT 241-T TANK FARM. WATERY LIQUID WAS SEEN SEEPING FROM THE GROUND.	PIPE FLANGES ON TRANSFER LINES AT T-FARM WERE NOT ADEQUATELY MARKED.
73-73	11/01/1973	FAILURE OF A HEATER IN 241-TX-118 VENTILATION EXHAUST CAUSED LOADING OF PRIMARY FILTER.	MECHANICAL FAILURE OF OFF-GAS HEATER.
73-78	11/14/1973	DURING TRANSFER FROM 107-S TO 102-S THE TRANSFER LINE PLUGGED AND WASTE BACKED UP AND FLOWED OUT THE TANK RISER ONTO THE GROUND.	APPARENT PLUGGING OF TRANSFER LINE BY CRYSTALLIZED MATERIAL.
73-80	11/15/1973	POSSIBLE TANK DOME OVERLOADING AFTER WASTE SPILL IN S-FARM. SOIL WAS PLACED OVER THE SPILL AND POSSIBLY OVERLOADED 102-S AND 103-S DOMES.	PROCEDURE/ WEIGHT OF COVER SOIL WAS NOT KNOWN PRIOR TO COVERING THE TANKS.
73-82	11/21/1973	RAIN AND ROTTING TIMBERS CAUSED SUBSIDENCE OF 216-B-12 CRIB, CRIB REMOVED FROM SERVICE.	DEGRADATION OF CRIB OVER TIME.
73-86	12/11/1973	EMPLOYEE ENTERED THE AREA OF AN OPEN 42" RISER ON 118-TX TANK WITHOUT RESPIRATOR OR LIFE BELT.	PERSONNEL FAILURE TO FOLLOW PROCEDURE CONCERNING ENTRANCE TO AREA WITH OPEN RISER.
74-9	02/15/1974	NEW LEVEL LIMITS ESTABLISHED FOR WASTE TANKS IN AUGUST, 1973, FOUND THAT THERE WERE 19 TANKS THAT EXCEEDED THE NEW LIMITS, 8 TANKS STILL EXCEEDED THE LIMIT ON 2/15/74.	EVAPORATOR OUTAGES HAVE PREVENTED EMPTYING THE TANKS AS RAPIDLY AS SCHEDULED.
74-16	03/09/1974	LARGE AMOUNT OF FOAM (FROM SLUDGE ACIDIFICATION) IN 244-AR VAULT TANK 001 MIGRATED INTO TANKS 002, 004 AND TO THE VESSEL VENT HEADER, WHICH FAILED THE HEPA FILTER.	INCREASED FOAM DEVELOPED DUE TO A RISE IN pH DURING ACIDIFICATION.
74-21	03/27/1974	UNEXPLAINED DECREASE OF 0.3 INCHES IN WASTE TANK 105-S.	UNKNOWN.
74-22	03/24/1974	UNEXPLAINED DECREASE OF 0.45 INCHES IN WASTE TANK 112-S.	UNKNOWN.
74-23	04/03/1974	UNEXPLAINED DECREASE OF 1 1/2 INCHES IN WASTE TANK 110-TX.	UNKNOWN.
74-26	04/08/1974	UNEXPLAINED DECREASE OF 0.30 INCHES IN WASTE TANK 112-BX.	UNKNOWN.
74-27	04/05/1974	UNEXPLAINED DECREASE OF LEVEL IN WASTE TANK 107-BY.	UNKNOWN.
74-28	04/10/1974	UNEXPLAINED DECREASE OF 3 1/2 INCHES IN WASTE TANK 102-TX.	UNKNOWN.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
74-29	04/07/1974	WASTE TANK 109-TX EXCEEDED TEMPERATURE INCREASE LIMIT OF 22oC (40oF) IN EIGHT DAY PERIOD.	RESTART OF EVAPORATOR FEED TO THIS TANK AND INADEQUATE RESPONSE TIME DID NOT ALLOW MIXING PHENOMENA TO DEVELOP.
74-30	03/31/1974	FAILURE TO OBTAIN MONTHLY SAMPLES FROM TANK 102-AY, THE SPARE BOILING WASTE TANK IN 200 EAST AREA	PERSONNEL ERROR, FAILURE TO FOLLOW ADMINISTRATIVE CONTROLS.
74-31	04/13/1974	FAILURE TO OBTAIN FIC GAUGE READINGS IN 241-T FARM AS REQUIRED.	MECHANICAL FAILURE. ELECTRICAL SHORT AND RESULTING MCC FIRE (CAUSED BY BIRD NEST IN MCC ENCLOSURE) PREVENTED TAKING TANK LIQUID LEVEL READINGS.
74-32	04/18/1974	INSTRUMENT POWER OUTAGE IN 241-S TANK FARM CAUSED BY PERSONNEL AUGURING A TEST HOLE TO FIND A PIPING LEAK.	PERSONNEL FAILURE. EMPLOYEE FAILED TO HAND DIG PRIOR TO USING THE AUGER. CABLES WERE NOT IN THE LOCATION INDICATED ON THE TANK FARM DRAWING.
74-37	05/03/1974	DURING A TRANSFER THE LEVEL IN 102-BY DROPPED 10 INCHES, INCREASED 10 3/4 INCHES IN TANK 111-BX. LEVEL IN 111-BX EVENTUALLY DROPPED 3/4 INCH (CONSIDERED SIGNIFICANT LEVEL DECREASE).	LEVEL DECREASE BELIEVED TO BE CAUSED BY STABILIZATION OF THE CRUST SURFACE AFTER TRANSFER.
74-38	05/03/1974	SIGNIFICANT RADIATION READINGS IN A LEAK DETECTION LATERAL BELOW TANK 111-SX.	APPARENT TANK LEAK, TANK SALTWELL PUMPED AFTER LEAK INDICATED.
74-41	05/19/1974	244-AR VAULT VESSEL VENT SECONDARY HEPA FILTERS FOUND WET AND PERFORATED AFTER REPLACEMENT OF PRIMARY FILTERS.	ASSUMED DEPOSITION OF AMMONIUM NITRATE ON FILTERS FROM B PLANT DAMAGED FILTERS.
74-43	05/27/1974	3800 GALLONS OF PUREX ACIDIFIED SLUDGE MISTRANSFERRED FROM 244-AR VAULT TO 106-A TANK INSTEAD OF TO CR VAULT.	PERSONNEL FAILURE. DIVERTER SETTINGS INCORRECT.
74-44	05/27/1974	150 GALLONS OF NITRIC ACID ADDED TO TANK 002 AT 244-AR VAULT INSTEAD OF TANK 001. ADDED TO 10,500 GALLONS OF SLUDGE SLURRY.	PERSONNEL ERROR. OPENED WRONG VALVE OUT OF CHEMICAL MAKEUP TANK.
74-88	06/13/1974	INCREASED ACTIVITY IN TANK 106-TY DRY WELL INDICATES TANK LEAK.	MECHANICAL FAILURE. TANK DEGRADATION OVER TIME. (SUSPECTED LEAKER IS 105-TY)
74-101	06/25/1974	INCREASED ACTIVITY IN DRY WELLS BY TANK 103-TY.	ASSUMED TANK LEAKAGE, DEGRADATION OVER TIME.
74-102	06/26/1974	INCREASED ACTIVITY IN TANK 105-TY DRY WELL INDICATES TANK LEAK.	TANK LEAKAGE, DEGRADATION OVER TIME.
74-103	06/27/1974	SUSPECTED DEFORMED TANK LINER IN TANK 201-B.	CORRODED BAFFLE DROPPED INTO TANK BELOW A RISER, CONJECTURED TO BE A LINER DEFORMATION.
74-104	06/27/1974	INCREASED ACTIVITY IN TANK 101-BX DRY WELL INDICATES TANK LEAK.	TANK LEAKAGE, DEGRADATION OVER TIME.
74-106	07/01/1974	INCREASED ACTIVITY IN TANK 103-BY DRY WELL INDICATES TANK LEAK.	TANK LEAKAGE, DEGRADATION OVER TIME.
74-108	07/07/1974	INCREASED ACTIVITY IN DRY WELL AND TANK 109-T LEVEL DROP INDICATES TANK LEAK.	TANK LEAKAGE, DEGRADATION OVER TIME.
74-112	07/18/1974	INCREASED ACTIVITY IN TANK 110-B DRY WELL INDICATES TANK LEAK.	TANK LEAKAGE, DEGRADATION OVER TIME.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
74-117	08/07/1974	INCREASED ACTIVITY IN TANK 105-BY DRY WELL INDICATES TANK LEAK.	TANK LEAKAGE, DEGRADATION OVER TIME.
74-120	08/13/1974	INCREASED ACTIVITY IN DRY WELLS BETWEEN TANKS 104-C AND 105-C INDICATES POSSIBLE TANK LEAK.	ASSUMED FROM OTHER INDICATIONS THAT THESE TANKS ARE SOUND, NO LEAKAGE. LEAK INDICATION COULD BE FROM EARLIER LEAK IN SPARE FILL LINE TO 105-C.
74-121	08/16/1974	RADIOACTIVE LIQUID LEAKED FROM SAMPLE CUP RISER IN TANK 001-AR AT 244-AR VAULT DURING pH METER STANDARDIZATION.	CAUSE WAS NOT DETERMINED.
74-123	08/16/1974	INCREASED ACTIVITY IN TANK 102-BY DRY WELL INDICATES TANK LEAK.	ASSUMED FROM OTHER INDICATIONS THAT THIS TANK IS SOUND. READINGS COULD BE FROM LATERAL MIGRATION OF SOIL CONTAMINATION.
74-127	08/26/1974	CONTAMINATION SPREAD DURING CLEANUP OF 154-B DIVERSION BOX.	CONTAMINATION SPREAD DUE TO WIND-CARRY OF PARTICULATE.
74-129	09/04/1974	INCREASED ACTIVITY IN TANKS 113 AND 114-TX DRYWELL INDICATE TANK LEAK.	ACTIVITY ASSUMED TO BE FROM TANK LEAKAGE OR SOIL CONTAMINATION MIGRATION.
74-130	09/16/1974	CONTAMINATION SPREAD DURING TRANSFER OF 53 FOOT LONG TUBE BUNDLE HEAT EXCHANGER FROM TANK 104-A TO 101-A.	PERSONNEL ERROR/PROCEDURE.
74-132	09/24/1974	UNEXPLAINED DECREASE OF 1 INCH OF LIQUID LEVEL IN TANK 110-SX.	UNKNOWN.
74-134	10/09/1974	SPILL OF 1 1/2 GALLONS OF RADIOACTIVE LIQUID WHEN OPENING A STRAINER TO ISOLATE A STEAM COIL FOR MAINTENANCE IN 241-A FARM.	PERSONNEL ERROR/PROCEDURE. PIPEFITTER ASSUMED GAUGE WAS INCORRECT WHEN IT SHOWED 20 PSIG REMAINING IN STRAINED AFTER DRAIN OPENED. THEN PLUG UNPLUGGED.
74-141	10/28/1974	INCREASED ACTIVITY IN TANK 101-B DRY WELL INDICATES TANK LEAK.	TANK LEAKAGE, DEGRADATION OVER TIME.
74-144	11/05/1974	CONTAMINATION SPREAD FROM OPEN PUMP PIT ON TANK 106-A DURING REMOVAL OF A FAILED JUMPER. THE JUMPER WAS DROPPED AND CONTAMINATION SPLASHED UP OVER THE PIT WALL.	PROCEDURE, NOT SUFFICIENT CONTAINMENT PROVIDED WHILE PUMP PIT OPEN.
74-148	11/22/1974	INCREASED ACTIVITY BETWEEN TANKS 108-C AND 109-C.	ASSUMED MIGRATION OF SOIL CONTAMINATION.
74-151	12/02/1974	LIQUID LEVEL IN TANK 102-SX DECREASED 1 INCH AFTER A TRANSFER INTO TANK.	ASSUMED TANK SETTLING TOOK LONGER THAN USUAL.
74-152	12/05/1974	LIQUID LEVEL IN TANK 112-TX DECREASED 4 1/2 INCHES AFTER A FLUSH OF MANUAL LIQUID LEVEL TAPE.	ASSUMED A DEPRESSION FORMED IN TANK CRUST AS A RESULT OF WATER FLUSHING THROUGH MANUAL TAPE.
74-153	12/13/1974	INCREASED ACTIVITY IN TANK 107-BY DRY WELLS.	ASSUMED MIGRATION OF SOIL CONTAMINATION.
74-154	12/11/1974	MISROUTING OF WASTE DURING TRANSFER FILLED 241-EW VENT STATION CATCH TANK FROM 18.75 INCHES TO 73.75 INCHES.	PERSONNEL ERROR. TFO PLANNER-SCHEDULER ERRED IN NOZZLE CONNECTION PROCEDURE INSTRUCTIONS.
74-159	12/30/1974	UNDERGROUND ELECTRICAL CABLE POWERING 244-AR VAULT COOLING WATER EFFLUENT DIVERSION VALVE BROKEN BY BACKHOE EXCAVATION.	PERSONNEL ERROR. BACKHOE OPERATOR CLEARED TRENCH WITHOUT HAND DIGGING TAKING PLACE.
75-02	01/06/1975	INCREASED ACTIVITY BETWEEN TANKS 105-T AND 108-T.	ASSUMED THAT TANK 105-T IS SOUND, AND 108-T IS QUESTIONABLE DUE TO OTHER MEASUREMENTS.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
75-03	01/06/1975	244-AR VAULT HAD AN ACTIVATION OF EMERGENCY VENTILATION SYSTEM, AND VESSEL VENT SYSTEM SHUTDOWN.	MECHANICAL FAILURE, OVERHEATED CIRCUIT BREAKER IN ELECTRICAL SUPPLY TO AIR COMPRESSOR.
75-04	01/07/1975	INCREASED ACTIVITY BETWEEN TANKS 110-SX AND 111-SX.	UNKNOWN.
75-05	01/08/1975	ACTIVATION OF 244-AR EMERGENCY VENTILATION SYSTEM SEVERAL TIMES IN MORNING.	HIGH WINDS CAUSED DIFFERENTIAL PRESSURE FLUCTUATIONS THAT TRIPPED EMERGENCY SYSTEM.
75-09	01/31/1975	241-U FARM TANK DOME LOADING INDICATES THE SOIL COVER OVER THE TANKS IS ONE FOOT HIGHER THAN AS-BUILT DRAWINGS, POTENTIAL OVERLOAD.	DRAWINGS WERE INCORRECT, BUT DOME LOADINGS ARE WITHIN LIMITS.
75-15	02/13/1975	SPILL OF CONTAMINATION TO GROUND DURING OVERGROUND TRANSFER FROM TANK 105-BY.	PERSONNEL ERROR, MATERIAL FAILURE. PLASTIC WRAPPED JOINTS ON OVERGROUND LINE DID NOT HOLD THE LEAK.
75-16	02/13/1975	RELEASE OF CONTAMINATION OUTSIDE 244-AR VAULT WHEN WASHING CANYON FLOOR AND WATER PUDDLED UNDER DOOR. A LOSS OF BUILDING NEGATIVE PRESSURE ALLOWED CONTAMINATION OUTSIDE.	PERSONNEL ERROR. FLOOR WASHED DURING PLANNED USE OF EMERGENCY GENERATOR, WHICH CAUSED A TEMPORARY LOSS OF BUILDING NEGATIVE PRESSURE.
75-17	02/18/1975	DECREASE IN LIQUID LEVEL IN TANK 101-T AFTER TRANSFER INTO TANK.	ASSUMED STABILIZATION OF SURFACE AFTER TRANSFER.
75-19	02/18/1975	DECREASE IN LIQUID LEVEL IN TANK 112-BY.	ASSUMED TANK CRUSTING IS ERRATIC.
75-29	03/21/1975	FAILURE OF SECONDARY FILTERS IN 244-AR VAULT VESSEL VENT SYSTEM, FILTERS WERE WET AND WARPED.	UNKNOWN. (ALSO SEE 74-41 OCCURRENCE)
75-33	03/31/1975	244-AR VAULT COOLING WATER DIVERSION VALVE DIVERTED AFTER RADIATION ALARM IN CANYON.	RADIATION ALARMS ATTRIBUTED TO WELDING IN AREA.
75-35	04/04/1975	EMPLOYEE FORCED A SAMPLER INTO TANK AFTER THE SAMPLER HAD REACHED THE BOTTOM OF TANK. SAMPLER BOWED, WHICH CAUSED IT TO BE DIFFICULT TO REMOVE THRU RISER, BREAKING THE SAMPLE WIRE.	PERSONNEL ERROR, DEVIATION FROM PROCEDURE.
75-36	04/06/1975	OVERFILLED TANK 002-CR IN 271-CR, TANK LIMIT IS 13,000 GALLONS, FILLED WITH 16,947 GALLONS.	PERSONNEL ERROR. OPERATOR PUSHED PUMP BUTTON INSTEAD OF AGITATOR BUTTON.
75-38	04/09/1975	TANK 101-BY LIQUID LEVEL EXCEEDED LEVEL LIMIT.	UNCONTROLLED WATER ADDITIONS DURING PUMP INSTALLATION, TESTING AND FLUSHING.
75-39	04/08/1975	LEAKAGE FROM TANK 104-A, AS NOTED IN LATERALS BENEATH TANK.	MECHANICAL FAILURE, TANK LINER FAILED.
75-41	04/08/1975	LIQUID LEVEL IN TANK 107-U DECREASED .80 INCHES.	ASSUMED TRANSFER INTO TANK CAUSED FOAMING WHICH HAD TO STABILIZE.
75-42	04/09/1975	TRANSFER OF WASTE WITH pH OF 4.2 FROM 244-AR TO TANK 107-U. pH LIMIT SHOULD BE GREATER THAN 9.	ASSUMED PERSONNEL ERROR.
75-44	04/08/1975	LIQUID LEVEL IN TANK 104-TX DECREASED .70 INCHES.	ASSUMED LEVEL DECREASE DUE TO ADDITION OF HOT WASTE AND THE RESULTING EVAPORATION VIA EXHAUSTER OPERATION.
75-47	04/09/1975	INCREASED ACTIVITY IN TANK 104-AX DRY WELL.	ASSUME THAT ACTIVITY IS DUE TO SHALLOW CONTAMINATION FROM EARLIER FAILED TRANSFER LINES, SURFACE SPILLS, OR OTHER DIRECT BURIED FACILITY FAILURES.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
75-51	04/18/1975	LIQUID LEVEL IN TANK 108-T DECREASED .60 INCHES.	UNKNOWN.
75-54	04/17/1975	INCREASED RADIATION ACTIVITY IN LATERAL BENEATH TANK 112-SX.	ASSUMED THAT THE ACTIVITY IS DUE TO PRE-EXISTING CONTAMINATION.
75-56	04/18/1975	INCREASED ACTIVITY IN TANK 107-BY DRY WELLS.	UNKNOWN, COULD BE TANK LEAK OR REDISTRIBUTION OF SOIL CONTAMINATION.
75-57	04/25/1975	LIQUID LEVEL IN TANK 107-TX DECREASED .80 INCHES.	ASSUME LEVEL DECREASE DUE TO INCREASED EVAPORATION FROM EXHAUSTER OPERATION.
75-58	04/30/1975	INCREASED ACTIVITY IN TANK 101-B DRY WELL.	UNKNOWN, COULD BE TANK LEAK OR MIGRATION OF SOIL CONTAMINATION.
75-60	05/16/1975	INCREASED ACTIVITY IN TANK 102-AX DRY WELL.	UNKNOWN.
75-61	05/23/1975	HIGH dP ACROSS TANK 118-TX EXHAUSTER HEPA FILTERS.	PERSONNEL ERROR. FAILURE TO RESPOND TO INCREASING dP INDICATION AND CHANGE FILTERS.
75-64	06/07/1975	LIQUID LEVEL IN TANK 106-TX DECREASED 5 1/2 INCHES.	UNKNOWN.
75-67	06/26/1975	LIQUID LEVEL IN TANK 110-U DECREASED .50 INCHES.	TANK DECLARED A LEAKER ON 7/9/75.
75-68	06/25/1975	INCREASED ACTIVITY IN LATERAL BENEATH TANK 112-SX.	TANK IS A LEAKER, INCREASED ACTIVITY COULD BE DUE TO SHIFT IN SOIL CONDITIONS.
75-69	06/25/1975	INCREASED ACTIVITY IN LATERAL BENEATH TANK 115-SX.	LIMITED CHANGE, READINGS TAKEN WITH A NEW, MORE SENSITIVE INSTRUMENT.
75-78	07/16/1975	JUMPER CONNECTOR FAILURE DURING WASTE TRANSFER FROM 107-TX TO 103-U. JUMPER LOCATED IN 153-TXR DIVERSION BOX.	MECHANICAL FAILURE OF FLEX JUMPER, THREADS STRIPPED.
75-82	07/29/1975	VEHICLE ACCIDENT IN 241-U TANK FARM, STRUCK AN 8-INCH WELL CASING THAT PROTRUDED UP 18-INCHES. PICKUP TRUCK HAD TO BE LIFTED OFF THE CASING.	PERSONNEL ERROR. CUT A TURN SHORT, NON-ESSENTIAL TANK FARM TRAFFIC NEEDS TO BE ELIMINATED.
75-87	07/31/1975	INCREASED ACTIVITY IN TANK 101-B DRY WELL.	UNKNOWN, COULD BE FROM PREVIOUS SOIL CONTAMINATION.
75-85	08/05/1975	EXCESSIVE LIQUID LEVEL IN TANK 105-A, LIMIT EXCEEDED BY 4 ½ INCHES.	PERSONNEL ERROR, ACCIDENTAL RAW WATER DISCHARGE TO TANK.
75-86	07/24/1975	MINOR INJURY WHILE LIFTING A COVER PLATE WITH CRANE AT 104-TX PUMP PIT.	PERSONNEL ERROR. WORK BEGUN PRIOR TO CRANE LOAD BEING SECURED.
75-89	08/15/1975	SHARP DECREASE IN TANK 103-SX LEVEL FOLLOWING TRANSFER FROM 106-SX.	ASSUMED TRANSFER OF 100,000 GALLONS OF DILUTE 242-S FEED BROKE DOWN THE HEAVY CRUST FORMATION IN TANK.
75-90	08/17/1975	INCREASED ACTIVITY IN TANK 102-AX DRY WELL.	ASSUMED MIGRATION OF SOIL CONTAMINANTS.
75-92	08/20/1975	244-AR VAULT VESSEL VENT SYSTEM SHUTDOWN DUE TO HIGH dP ACROSS FILTER.	PERSONNEL ERROR. TANK 001-AR pH EXCEEDED LIMITS CAUSING FOAM THAT CARRIED OVER TO VENTILATION SYSTEM.
75-94	06/18/1975	WASTE DRUM CONTAINING GREATER THAN 200 GRAMS OF PLUTONIUM STORED AT THE ASPHALT STORAGE PAD.	PERSONNEL ERROR. FAILURE TO FOLLOW ADMINISTRATIVE PROCEDURE.
75-97	08/22/1975	UNPLANNED WASTE TRANSFER FROM 102-A TANK TO 101-A TANK.	PERSONNEL ERROR. INADVERTENT ENERGIZING OF 102-A PUMP INSTEAD OF 101-A PUMP.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
75-98	08/15/1975	EXCESSIVE DOME LOADING IN TANK FARMS A, AX, AY, AZ, BX, BY, AND TX.	PERSONNEL ERROR. IDENTIFIED BY TOPOGRAPHIC SURVEYS.
75-101	08/09/1975	LIQUID LEVEL DECREASE OF .70 INCHES IN TANK 107-TX FOLLOWING TRANSFER OUT OF TANK.	ASSUMED LEVEL DECREASE DUE TO EVAPORATION VIA EXHAUSTER.
75-102	09/17/1975	BURIAL OF SIX DRUMS OF POTENTIALLY EXPLOSIVE MATERIAL IN BURIAL TRENCH.	PERSONNEL ERROR. FAILURE TO FOLLOW DISPOSAL PROCEDURES.
75-108	09/29/1975	LIQUID LEVEL LIMIT EXCEEDED IN TANK 110-S, INCREASED 9 INCHES IN FIVE MONTHS.	SUSPECTED UNKNOWN CHEMICAL PHENOMENON CAUSING TANK CONTENTS GROWTH.
75-109	09/30/1975	LIQUID LEVEL LIMIT EXCEEDED IN TANK 111-S, INCREASED 10 INCHES IN FIVE MONTHS.	SUSPECTED UNKNOWN CHEMICAL PHENOMENON CAUSING TANK CONTENTS GROWTH.
75-110	10/02/1975	RADIATION ALARM IN 101-AY "B" LEAK DETECTION PIT AFTER TRANSFER FROM 152-AX DIVERTER STATION CATCH TANK.	UNKNOWN, TRANSFER PIPELINE MAY HAVE LEAKED.
75-111	10/03/1975	2200 GALLON WASTE TRANSFER THROUGH OPEN JUMPER NOZZLE FLOWED VIA PUMP PIT DRAIN INTO INCORRECT TARGET TANK.	PERSONNEL ERROR. JUMPER NOT INSTALLED FOR TRANSFER, ROUTE NOT CHECKED.
75-115	10/11/1975	SMALL, SLOW, LEAK OCCURRED IN OVERGROUND TRANSFER LINE BETWEEN 108-C AND 103-C.	MECHANICAL FAILURE. LEAK AT CONNECTOR HEAD TO TRANSFER PUMP.
75-116	10/11/1975	LIQUID LEVEL DECREASE IN TANK 102-SX AFTER 242-S SLURRY TRANSFER IN.	SUSPECTED SLURRY BUILDUP AT ENTRANCE TO TANK, THEN SLOWLY FLOWED OUT OVER WASTE SURFACE.
75-117	10/09/1975	LIQUID LEVEL DECREASE IN TANK 110-BY AFTER TRANSFER IN.	INTRODUCTION OF STEAM AND HOT WATER TRANSFER LINE FLUSH SEEMS TO CAUSE A LEVEL DROP IN TANK.
75-118	10/12/1975	LIQUID LEVEL INCREASE IN TANK 110-SX AFTER TRANSFER OUT.	SUSPECT A DEPRESSED AREA AROUND PUMP OCCURRED DURING TRANSFER IS SLOWLY FILLING IN.
75-119	10/14/1975	401-SX BUILDING VESSEL VENTILATION CONDENSATE COOLING WATER EXCEEDED RADIONUCLIDE SPECIFICATIONS.	UNKNOWN, BUT SUSPECTED FAILED CONDENSER.
75-127	11/09/1975	MISROUTING OF TRANSFER INTO TANK 102-AY INSTEAD OF 103-A.	PERSONNEL ERROR. USED WRONG PROCEDURE FOR SECOND PHASE OF TRANSFER.
75-130	11/14/1975	CONTAMINATION SPREAD IN PARKING AREA NEAR A FARM VENTILATION BUILDING. EXHAUSTS A, AX, AY, AND AZ FARMS.	UNKNOWN, ASSUME SOURCE IS A FARM VENTILATION STACK.
75-132	11/10/1975	LIQUID LEVEL IN TANK 111-BY DECREASED 1 INCH OVER FOUR DAYS.	SUSPECT LEVEL LOST VIA EVAPORATION, AND PROBLEM WITH DIFFICULTY IN READING TANK LEVEL.
75-134	11/21/1975	MISROUTED WASTE TRANSFER FROM 104-SX TO 101-SX PIT.	PERSONNEL ERROR. OPERATOR CHANGED VALVE SETTINGS WHILE WALKING THROUGH A PROCEDURE.
75-135	10/31/1975	A FARM PROCESS CONDENSATE pH TOO LOW.	SUSPECT pH PROBLEM FROM 102-AY STEAM COIL CONDENSATE.
75-141	12/02/1975	SIGNIFICANT MATERIAL BALANCE DISCREPANCY AFTER TRANSFER FROM TANK 102-C TO 103-C.	UNKNOWN, SUSPECT LEVEL GAUGE ANOMALIES A RESULT OF THE CHARACTER OF THE MATERIAL SURFACE IN TANK 102-C.
75-145	12/19/1975	POSSIBLE TRANSFER PIPING LEAKAGE DURING TRANSFER FROM TANK 103-B TO 110-SX.	UNKNOWN, MATERIAL BALANCE PROBLEM WAS NOT RESOLVED.
75-146	12/26/1975	LIQUID LEVEL IN TANK 114-TX DECREASED 11.25 INCHES.	SUSPECT A SHIFT IN SURFACE BEING CONTACTED BY THE LEVEL PROBE.

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75-147	12/30/1975	INCREASED ACTIVITY IN TANK 101-T DRY WELL.	SUSPECT ACTIVITY IS FROM A MIGRATION OF SOIL CONTAMINATION.
76-04	01/09/1976	SIGNIFICANT RADIATION READINGS IN AN EXCAVATION SITE WHERE PERSONNEL WERE WORKING DUE TO A WASTE TRANSFER NEARBY.	PERSONNEL ERROR. RISK TO PERSONNEL FROM WASTE TRANSFER NOT ADEQUATELY CONSIDERED.
76-05	01/16/1976	LIQUID LEVEL IN TANK 101-S DECREASED MORE THAN 1 INCH.	SUSPECT A COLLAPSE OF FOAM AFTER A RECENT TRANSFER INTO TANK.
76-06	01/17/1976	LIQUID LEVEL DECREASE IN TANK 106-TX FOLLOWING A FLUSH OF THE LEVEL MONITORING TAPE.	SUSPECT A BUILDUP OF CRUST ON THE MANUAL TAPE PLUMB.
76-08	01/20/1976	INCREASED ACTIVITY IN TANK 104-AX DRY WELL.	ASSUMED MIGRATION OF SOIL CONTAMINATION.
76-14	01/29/1976	LIQUID LEVEL IN TANK 109-C DECREASED .90 INCHES.	ASSUME LEVEL CHANGE INDICATION DUE TO BUILDUP OF SOLIDS ON TAPE PLUMMET.
76-15	01/27/1976	CROSS-COUNTRY TRANSFER LINE PLUGGED DURING TRANSFER FROM 107-S TO 109-B AFTER PUMP SHUTDOWN DUE TO POWER LOSS.	PLUG DUE TO CUTTING DILUTION WATER DURING TRANSFER.
76-21	02/18/1976	WIND SWEPT TUMBLEWEEDS FORCED A VALVE OPEN SPILLING RAW WATER INTO 241-TX-155 DIVERSION BOX, AND SEVERAL CATCH TANKS AND INTO 20 OPEN NOZZLES. SPILLED 35,000 GALLONS.	ASSUME THAT WIND SWEPT TUMBLEWEEDS FORCED OPEN AN L-SHAPED VALVE HANDLE.
76-22	02/17/1976	RAW WATER SPILL (UOR 76-21) CAUSED LIQUID LEVEL INCREASE BEYOND LIMIT IN TANK 103-TY, A KNOWN LEAKER.	LEVEL INCREASE CAUSED BY OVERFLOW FROM CATCH TANK TX-302-B.
76-23	02/17/1976	LIQUID LEVEL DECREASE IN DIVERSION BOX 155-TX AND CATCH TANK TX-302-B AFTER RAW WATER SPILL (UOR 76-21).	ASSUME WATER LEVEL DECREASE DUE TO LEAKS IN DIVERSION BOX-CATCH TANK STRUCTURE.
76-24	02/23/1976	STEAM USED INSTEAD OF AIR AFTER TRANSFER LINE FLUSH.	PERSONNEL ERROR. FAILURE TO FOLLOW PROCEDURE.
76-25	02/26/1976	OPERATOR INJURED HIS FOOT WHEN HE SLIPPED AS A CAISSON WAS BEING LIFTED OUT OF THE GROUND AT 241-BX TANK FARM.	PERSONNEL ERROR. OPERATOR TRIED TO PULL FALLEN WOODEN BARRICADE FROM HOLE, AND SLIPPED INTO HOLE.
76-30	03/10/1976	LIQUID LEVEL INDICATION DECREASED FOR 152-AX DIVERTER STATION CATCH TANK DURING WASTE TRANSFER.	MECHANICAL FAILURE. APPARENT FAILURE OF LEVEL INSTRUMENTATION.
76-31	03/17/1976	LIQUID LEVEL IN TANK 112-BY DECREASED 2 1/2 INCHES.	ASSUMED CRUST HAS SHIFTED CAUSING LEVEL DECREASE INDICATION.
76-36	03/23/1976	LIQUID LEVEL IN TANK 102-BY DECREASED 1 INCH.	ASSUMED CRYSTAL BUILDUP ON LEVEL PLUMMET CAUSED LEVEL INDICATION CHANGE.
76-38	03/26/1976	LIQUID LEVEL IN TANK 108-TX DECREASED 1 INCH.	ASSUMED SALT BUILDUP ON FIC PLUMMET.
76-39	03/22/1976	LIQUID LEVEL IN TANK 108-SX INCREASED, EXCEEDING THE .50 INCH CRITERIA.	UNKNOWN. TANK IS OUT-OF-SERVICE, A KNOWN LEAKER.
76-40	03/23/1976	LIQUID LEVEL IN TANK 105-SX INCREASED 2.1 INCHES.	ASSUMED SLURRY GROWTH, TYPICAL OF 242-S SLURRIES.
76-41	02/29/1976	RADIATION INCREASE IN 102-AX LEAK DETECTION PIT.	WATER IN LEAK DETECTION PIT EVAPORATED, RADIATION INDICATION INCREASED AS PIT BOTTOM WAS EXPOSED.
76-42	03/23/1976	LIQUID LEVEL IN TANK 111-C INCREASED, EXCEEDING .50 INCH CRITERIA.	UNKNOWN, ASSUME ERRATIC LEVEL READINGS DUE TO PROBLEM WITH OBTAINING GOOD CONTACT WITH SURFACE.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
76-45	03/31/1976	LIQUID LEVEL IN TANK 110-S INCREASED 2.3 INCHES.	ASSUMED SLURRY GROWTH, TYPICAL OF 242-S SLURRIES.
76-46	03/29/1976	103-AX PUMP RUN WITHOUT FLOW TO BEARINGS DUE TO MISVALVING OF COOLING WATER TO 101-AX PUMP.	PERSONNEL ERROR, FAILURE TO FOLLOW VALVING PROCEDURE.
76-47	04/07/1976	TANK 115-TX REUSED AS A SALT WELL LIQUOR RECEIVER AFTER BEING DECLARED REMOVED-FROM-SERVICE.	PERSONNEL ERROR. FAILURE TO FOLLOW TANK IN-SERVICE ADMINISTRATIVE CONTROLS.
76-48	04/12/1976	DURING JUMPER INSTALLATION IN 241-A TANK FARM, RADIATION MONITOR RECOMMENDED WORK HALT DUE TO WIND, OPERATIONS SUPERVISOR DIRECTED THAT ONE MORE CONNECTOR HEAD BE INSTALLED TO FINISH THE JOB.	PERSONNEL, POLICY CONFLICT OF ASSIGNED AUTHORITY.
76-49	04/14/1976	LIQUID LEVEL IN TANK 105-TY INCREASED 32 INCHES.	LEVEL INDICATION INCREASE DUE TO REPLACING THE ROD PLUMMET WITH A DOUGHNUT PLUMMET.
76-50	04/19/1976	LIQUID LEVEL IN TANK 114-TX INCREASED 2.25 INCHES.	ASSUME LEVEL CHANGE DUE TO DRAINBACK OF LIQUID ON SALTCAKE AT HIGHER ELEVATIONS.
76-51	04/14/1976	LIQUID LEVEL IN TANK 113-SX INCREASED 1.5 INCHES.	SUSPECT THE LEVEL PLUMMET IS CONTACTING AN OLD LEVEL TAPE.
76-52	03/24/1976	LIQUID LEVEL IN TANK 105-S INCREASE EXCEEDED CRITERIA.	ASSUME SLURRY GROWTH, TYPICAL OF 242-S SLURRIES.
76-53	04/14/1976	LIQUID LEVEL IN TANK 102-TX INCREASED 2 INCHES.	ASSUME MATERIAL GROWTH ON TAPE PLUMMET.
76-55	04/08/1976	TRANSFER TO 244-AR MADE OF MATERIAL WITH HIGH H+ CONCENTRATION.	PERSONNEL ERROR. MISINTERPRETATION OF SPECIFICATION, FAILURE TO FOLLOW PROCEDURE.
76-56	04/09/1976	RADIATION ACTIVITY INCREASE IN TANK 106-T DRY WELL EXCEEDS CRITERIA.	MIGRATION OF CONTAMINATION FROM PREVIOUS TANK LEAK.
76-59	04/20/1976	RADIATION ACTIVITY INCREASE IN TANK 104-AX DRY WELL EXCEEDS CRITERIA.	MIGRATION OF CONTAMINATION FROM PREVIOUS EXHAUST HEADER LEAK.
76-60	04/20/1976	INCREASED ACTIVITY IN TANK 107-T DRY WELL.	ASSUME DISPERSION MECHANISM IN SOIL OF PREVIOUS CONTAMINATION.
76-61	04/25/1976	SPILLED 500 GALLONS OF WATER WHEN OVERGROUND LINE FROM 104-TX TO 108-TX PUMP PIT CONNECTION FAILED.	MECHANICAL. HOSE CONNECTION FAILED.
76-62	04/26/1976	LIQUID LEVEL IN TANK 105-U INCREASED 2.4 INCHES.	ASSUME SLURRY GROWTH, TYPICAL OF 242-S SLURRIES.
76-64	04/29/1976	CONTAMINATION RELEASE WHEN A PILOT HOLE WAS DRILLED IN A FLUSHED OUT TRANSFER PIPE, BEING READIED FOR REROUTING.	TRAPPED AIR IN THE HEAT TRACED LINE PUSHED OUT LIQUID WHEN THE HOLE WAS DRILLED IN THE PIPE.
76-66	05/05/1976	LIQUID LEVEL IN TANK 106-TX INCREASED GREATER THAN CRITERIA.	LEVEL TAPE WAS FLUSHED AND A CRUSTED ICICLE WAS REMOVED, LEVEL WAS THEN NORMAL.
76-67	05/05/1976	LIQUID LEVEL IN TANK 109-U INCREASED GREATER THAN CRITERIA.	ASSUME THAT SLUDGE IS FORMING ON TANK LIQUID SERVICE.
76-68	04/20/1976	RADIATION ACTIVITY INCREASE IN TANK 101-BX DRY WELL EXCEEDED CRITERIA.	MIGRATION OF CONTAMINATION FROM PREVIOUS LEAK FROM PUMP CASING.
76-69	03/30/1976	CHANGE IN SURFACE LEVEL READING IN TANK 117-TX EXCEEDS CRITERIA.	CHANGING AREA OF MEASUREMENT. LEVEL PLUMMET HAD BEEN STRIKING MOUND OF DIATOMACEOUS EARTH IN THE CENTER OF THE TANK, NEW READINGS WERE TAKEN IN A DIFFERENT LOCATION.

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Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
76-70	05/10/1976	LIQUID LEVEL IN TANK 101-S DECREASE EXCEEDED CRITERIA.	ASSUME THE SURFACE LEVEL IS TOO DRY TO GET AN ACCURATE READING, FLUSHES OF TAPE PLUMMET HAVE WASHED OUT A DEPRESSION IN WASTE SURFACE.
76-71	05/10/1976	LIQUID LEVEL IN TANK 203-T INCREASED 1.25 INCHES.	ASSUME THAT THE INCREASE WAS A TEMPORARY PHENOMENON WHICH FOLLOWED A SALT WELL TRANSFER.
76-72	05/07/1976	PERSONNEL ENTERED BX TANK FARM WITHOUT USING PROTECTIVE CLOTHING.	PERSONNEL ERROR. FAILURE TO FOLLOW TANK FARM ENTRANCE PROCEDURE.
76-73	05/05/1976	MONITORING OF 101-A DRY WELL NOT PERFORMED ON SCHEDULE.	PERSONNEL ERROR. A DRILLING RIG WAS IN THE WAY SO THAT THE SURVEILLANCE COULD NOT BE MADE.
76-74	05/17/1976	RADIATION ACTIVITY INCREASE IN TANK 110-U DRY WELL.	ASSUME MIGRATION OF PREVIOUS SOIL CONTAMINATION.
76-76	05/22/1976	LIQUID LEVEL IN TANK 204-T INCREASED 1.25 INCHES.	INCREASE FOLLOWED A SALT WELL TRANSFER, ASSUME A DRAIN DOWN FROM OUTLYING WASTE SURFACES.
76-77	05/24/1976	LIQUID LEVEL IN TANK 106-U INCREASED 1.10 INCHES.	ASSUME A BUILDUP OF CRUST OVER TIME.
76-80	05/27/1976	LIQUID LEVEL IN TANK 108-U INCREASED 1.05 INCHES.	ASSUME INCREASE IS DUE TO DRAINAGE FROM EXHAUST SYSTEMS CONDENSATE.
76-81	05/28/1976	LIQUID LEVEL IN TANK 107-S DECREASED 0.5 INCHES.	DECREASE IN LEVEL IS APPARENTLY DUE TO EVAPORATIVE LOSS AND DROP IN TEMPERATURE OF THE LIQUID WASTE.
76-83	06/02/1976	LIQUID LEVEL IN TANK 103-SX INCREASED 2.10 INCHES.	ASSUME LEVEL INCREASE IS TYPICAL OF 242-S SLURRY SALT CAKE BEHAVIOR.
76-85	06/08/1976	LIQUID LEVEL IN TANK 104-SX INCREASED 2.10 INCHES.	ASSUME LEVEL INCREASE IS TYPICAL OF 242-S SLURRY SALT CAKE BEHAVIOR.
76-87	06/13/1976	LIQUID LEVEL IN TANK 111-TX INCREASED 1.25 INCHES.	LEVEL INCREASE DUE TO IN-LEAKAGE FROM A STEAM LEAK INTO A FLUSH PIT.
76-89	06/21/1976	LIQUID LEVEL IN TANK 105-U DECREASE EXCEEDED CRITERIA.	ASSUME LEVEL DECREASE IS DUE TO A BREAKDOWN OR PENETRATION OF FLOATING MATERIAL ON TANK WASTE SURFACE.
76-90	06/28/1976	SURFACE LEVEL IN TANK 110-U INCREASED 1.0 INCH.	ASSUME A SURFACE ANOMALY OR TEMPORARY MATERIAL BUILDUP ON THE GAUGE PLUMMET.
76-91	06/29/1976	LIQUID LEVEL IN TANK 110-SX DECREASED 0.75 INCHES.	ASSUME DECREASE DUE TO EVAPORATION AND ERRATIC READINGS USING MANUAL TAPE.
76-94	07/20/1976	LIQUID LEVEL IN TANK 108-C DECREASED 0.50 INCHES.	ASSUME SURFACE LEVEL SETTLING FOLLOWING SALT WELL PUMPING.
76-95	07/23/1976	LIQUID LEVEL IN TANK 101-S DECREASED 1.10 INCHES.	ASSUME DECREASE DUE TO EVAPORATION AND ERRATIC READINGS DUE TO SURFACE CONDITION.
76-96	07/28/1976	LIQUID LEVEL IN TANK 103-SX DECREASED 1.6 INCHES.	ASSUME DECREASE IS DUE TO LIQUEFACTION OF THE CRUST AFTER A 60,000 GALLON TRANSFER FROM 110-SX.
76-97	07/08/1976	LIQUID LEVEL IN TANK 106-TX INCREASED 1.25 INCHES.	ASSUME INCREASE IS DUE TO BUILDUP ON THE GAUGE PLUMMET.
76-98	07/08/1976	LIQUID LEVEL IN TANK 102-S INCREASED 1.20 INCHES.	ASSUME INCREASE IS DUE TO SLUDGE FORMATION TYPICAL OF 242-S FEED.
76-99	07/08/1976	LIQUID LEVEL IN TANK 115-TX INCREASED 1.25 INCHES.	UNKNOWN.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
76-100	07/13/1976	RADIATION ACTIVITY INCREASE IN TANK 104-A LATERALS.	ASSUME MIGRATION OF PREVIOUSLY LEAKED WASTE.
76-101	07/16/1976	LIQUID LEVEL IN TANK 114-TX INCREASE EXCEEDED CRITERIA.	INCREASE DUE TO GAUGE CONTINUITY REPAIR.
76-102	07/20/1976	LIQUID LEVEL IN TANK 109-TX DECREASED, POSSIBLY EXCEEDING CRITERIA.	DECREASE IS DUE TO EVAPORATION AND TEMPERATURE DROP OF LIQUID WASTE.
76-103	07/20/1976	LIQUID LEVEL IN TANK 104-TX DECREASED 0.55 INCHES.	ASSUME LEVEL DECREASE IS DUE TO WASTE TEMPERATURE DROP.
76-109	07/28/1976	SURFACE LEVEL IN TANK 102-BX EXCEEDED LEVEL LIMIT.	LEVEL READINGS ARE ERRATIC DUE TO SURFACE IRREGULARITIES.
76-115	08/24/1976	PERSONNEL AND EQUIPMENT CONTAMINATION DURING PUMP REMOVAL FROM TANK 103-A.	PERSONNEL AND PROCEDURE ERRORS. PUMP BASE NOT SUPPORTED SO IT MOVED DURING TRANSFER, CONTAMINATION WAS DISLODGED.
76-118	08/31/1976	CROSS-COUNTRY TRANSFER LINE V361 ENCASEMENT SWAB RISERS HAD ACTIVITY INCREASE.	POSSIBLE MIGRATION OF PREVIOUS CONTAMINATION.
76-119	08/31/1976	RADIATION ACTIVITY IN TANK 107-SX DRY WELL INCREASED.	ASSUME INCREASED ACTIVITY DUE TO MIGRATION OF SOIL CONTAMINATION.
76-124	09/14/1976	MAXIMUM LEVEL LIMIT IN TANK 105-A EXCEEDED.	PERSONNEL, PROCEDURE ERRORS. ADDED TOO MUCH WATER TO TANK DURING SPRINKLING OPERATION.
76-125	09/21/1976	SURFACE LEVEL IN TANK 104-SX INCREASED 3.05 INCHES.	ASSUME INCREASE DUE TO FLOTATION AND GROWTH OF SALT CRUST FOLLOWING SLURRY RECEPTION.
76-126	09/21/1976	LIQUID LEVEL IN TANK 106-S INCREASED 3.0 INCHES.	SUSPECTED TRANSFER LINE VALVE IN-LEAKAGE IN SA VALVE PIT.
76-128	09/25/1976	APPARENT MAXIMUM LEVEL LIMIT EXCEEDED IN 002-AR SUMP.	LEVEL READINGS CHANGED WHEN THE ZIPCORD LEVEL GAUGE WAS REPLACED WITH A MANUAL TAPE REEL.
76-129	09/25/1976	APPARENT MAXIMUM LEVEL LIMIT EXCEEDED IN 003-UR SUMP.	LEVEL READINGS CHANGED WHEN THE ZIPCORD LEVEL GAUGE WAS REPLACED WITH A MANUAL TAPE REEL.
76-131	09/27/1976	RADIOACTIVE WASTE SPILL DURING JUMPER DISCONNECTION IN 105-U PUMP PIT.	MECHANICAL FAILURE. WASTE TRANSFER ONGOING IN ADJACENT TANK PRESSURIZED JUMPER DUE TO PARTIAL FAILURE OF A CLOSED VALVE.
76-132	09/21/1976	RADIATION INCREASE IN TANK 101-AY ANNULUS EXHAUST AIR.	ASSUME PROCESS CONDENSATE PASSING THROUGH CROSS-TIE BETWEEN ANNULUS VENT SYSTEM AND THE VESSEL VENT SYSTEM.
76-136	10/05/1976	RADIOACTIVE LIQUID SPRAYED FROM A CHECK VALVE UNDER REPAIR ONTO THREE PERSONNEL IN BX TANK FARM.	PERSONNEL ERROR. PREPARATIONS FOR THE REPAIR WERE INADEQUATE.
76-137	10/06/1976	LIQUID LEVEL IN TANK 108-TX DECREASE EXCEEDED CRITERIA.	ASSUME MANUAL TAPE PLUMMET IS CONTACTING A MOUND OF SALT IN THE TANK RESULTING IN ERRONEOUS READINGS.
76-138	10/04/1976	LIQUID LEVEL IN TANK 102-AY DECREASED 2.5 INCHES.	DECREASE IN TANK VOLUME DUE TO SHUTTING OFF STEAM TO HEATING COIL AND HIGH TEMPERATURES CAUSING EVAPORATION.
76-139	10/07/1976	INCREASED ACTIVITY IN CROSS-COUNTRY TRANSFER LINE V361 SWAB RISERS.	ASSUME CONTAMINATION IS FROM PREVIOUS LEAKS.
76-142	10/16/1976	LIQUID LEVEL IN TANK 108-BY INCREASED 3.5 INCHES.	ASSUME SURFACE SHIFT FROM SALT WELL PUMPING. ALSO, TAPE PLUMMET IS NESTLED IN A SWIRL OF OLD TAPE.
76-143	10/04/1976	APPARENT LEAK DETECTION PIT LEVEL INCREASES FOR TANK 102-AZ.	INSTRUMENT AIR VALVED OFF SOME INSTRUMENTS AND FAULTY TRANSMITTER. TANK NOT IN SERVICE AT TIME OF ANOMALIES.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
76-146	10/25/1976	SURFACE LEVEL INDICATION IN TANK 108-SX INCREASED WHEN NEW MANUAL TAPE INSTALLED.	NEW TAPE NOT CALIBRATED CORRECTLY ACCORDING TO SYSTEM REFERENCE DRAWING.
76-148	10/28/1976	LIQUID LEVEL IN TANK 102-AY BELOW MINIMUM LIMIT.	PROCEDURE. TANK PUMPED DOWN TO MINIMUM, THEN MAINTENANCE ON LEVEL TAPE OCCURRED, RESULTING IN LEVEL INDICATION BELOW MINIMUM LIMIT.
76-153	11/04/1976	LIQUID LEVEL IN TANK 105-C DECREASE EXCEEDED CRITERIA.	ASSUME LEVEL DECREASE DUE TO EVAPORATION.
76-155	11/08/1976	LIQUID LEVEL IN TANK 113-SX INCREASE EXCEEDED CRITERIA.	ASSUME LEVEL GAUGE PLUMMET MANIPULATION EFFECTS LEVEL INDICATION.
76-156	11/12/1976	LIQUID LEVEL IN TANK 115-TX INCREASED 3.0 INCHES.	ASSUME LIQUID DRAINING FROM SURROUNDING AREA OR SALT HAS SLUMPED INTO POOL AFTER TANK PUMPOUT.
76-163	12/03/1976	RADIATION ACTIVITY IN TANK 107-SX DRY WELL INCREASED.	ASSUME PREVIOUS LEAK CONTAMINATION IS MIGRATING.
76-164	12/03/1976	RADIATION ACTIVITY IN TANK 114-TX DRY WELL INCREASED.	ASSUME ACTIVITY IS DUE TO MIGRATION OF SOIL CONTAMINATION.
76-165	12/03/1976	WATER USED FOR 102-AX PUMP PIT WASH DOWN VAPORIZED AND CONTAMINATED THE GROUND AND VEHICLES NEAR THE PIT.	PERSONNEL ERROR. PERSONNEL DID NOT ANTICIPATE THE WATER FLASHING TO STEAM DUE TO COLD AMBIENT TEMPERATURE (22oF) AND LOW HUMIDITY.
76-172	12/15/1976	LIQUID LEVEL IN TANK 105-SX INCREASED 3.0 INCHES.	ASSUME SLURRY GROWTH TYPICAL OF 242-S EVAPORATOR SLURRIES.
76-174	12/21/1976	LIQUID LEVEL IN TANK 106-U DECREASED 0.5 INCHES.	UNKNOWN. ASSUME TANK IS SOUND.
76-175	12/28/1976	RADIATION ACTIVITY IN TANK 105-T DRY WELL INCREASED.	ASSUME LATERAL MIGRATION OF SOIL CONTAMINATION.
76-176	12/28/1976	RADIATION ACTIVITY IN TANK 101-T DRY WELL INCREASED.	ASSUME FURTHER MIGRATION OF PREVIOUS SOIL CONTAMINATION.
	01/03/1977	LIQUID LEVEL IN 001-TXR SUMP DECREASED 2.0 INCHES.	ASSUME RAINWATER DRAINAGE OR ZIPCORD LOCATION WAS THE CAUSE OF LEVEL INDICATION CHANGE.
77-01	01/10/1977	LIQUID LEVEL IN TANK 104-TX DECREASED .60 INCHES.	ASSUME LEVEL DECREASE ATTRIBUTABLE TO TEMPERATURE DROP.
77-06	01/14/1977	RADIOACTIVE ACTIVITY IN TANK 114-TX DRY WELL INCREASED.	ASSUME MIGRATION OF SOIL CONTAMINATION.
77-07	01/13/1977	LIQUID LEVEL IN TANK 102-SX INCREASED 3.0 INCHES.	ASSUME LEVEL CHANGE TYPICAL OF SLURRIES FROM 242-S EVAPORATOR.
77-08	01/13/1977	LIQUID LEVEL IN TANK 103-SX INCREASED 3.0 INCHES.	ASSUME LEVEL CHANGE TYPICAL OF SLURRIES FROM 242-S EVAPORATOR.
77-11	01/17/1977	LIQUID LEVEL IN TANK 101-S DECREASED .70 INCHES.	ASSUME CRUST MOVEMENT OR SURFACE DRYING COULD CAUSE LEVEL INDICATION CHANGES.
77-17	01/27/1977	SURFACE LEVEL IN TANK 104-SX INCREASED 3.01 INCHES.	ASSUME LEVEL INCREASE DUE TO FLOTATION AND GROWTH OF SALT CRUST.
77-18	01/27/1977	LIQUID LEVEL IN TANK 115-TX INCREASED 3.75 INCHES.	MECHANICAL FAILURE. BROKEN WATER VALVE IN FLUSH PIT DRAINING TO 115-TX.
77-19	01/31/1977	LIQUID LEVEL IN TANK 104-AX DECREASED 1.20 INCHES.	ASSUME LEVEL DECREASE DUE TO INCREASED EVAPORATION WITH INSTALLATION OF AN INLET AIR FILTER.
77-20	02/01/1977	LIQUID LEVEL IN TANK 107-TX DECREASED .40 INCHES.	ASSUME LEVEL DECREASE DUE TO REACTIVATING THE EXHAUSTER.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
77-22	02/03/1977	TRANSFER PIPELINE EXPOSED AND STRUCK DURING EXCAVATION NEAR 244-AR VAULT.	PERSONNEL ERROR. PIPELINE LOCATION NOT NOTED ON EXCAVATION PERMIT.
77-23	02/07/1977	WATER LEAKAGE FROM 108-BX FLUSH PIT DRAINED TO TANK 108-BX.	MECHANICAL FAILURE. WATER VALVE BONNET BLEW OFF DURING FLUSH OF LINE BETWEEN 110-BY AND 105-BX.
77-25	02/08/1977	RADIATION ACTIVITY IN TANK 110-U DRY WELL INCREASED.	ASSUME MIGRATION OF SOIL CONTAMINATION.
77-29	02/22/1977	LIQUID LEVEL IN TANK 106-SX INCREASED 3 INCHES.	ASSUME LEVEL INCREASE TYPICAL OF WASTE SLURRIES RECEIVED FROM 242-S EVAPORATOR.
77-30	02/27/1977	LIQUID LEVEL IN TANK 111-U DECREASED .65 INCHES.	ASSUME LEVEL DECREASE DUE TO VOLUME CHANGES FROM TEMPERATURE DECREASE.
77-31	02/28/1977	004-AR WEIGHT FACTOR REFERENCE LINE PLUGGED DURING TRANSFER, CAUSING OVERFILLING OF TANK AND AUTOMATIC SHUTDOWN OF VESSEL VENT SYSTEM.	MATERIAL. PLUGGED WEIGHT FACTOR REFERENCE LINE.
77-33	03/06/1977	LIQUID LEVEL IN TANK 103-SX INCREASED 3 INCHES.	ASSUME LEVEL INCREASE TYPICAL OF WASTE SLURRIES RECEIVED FROM 242-S EVAPORATOR.
77-34	03/02/1977	RADIATION ACTIVITY IN TANK 107-SX DRY WELL INCREASED.	ASSUME MIGRATION OF SOIL CONTAMINATION.
77-35	03/08/1977	LIQUID LEVEL IN TANK 202-C INCREASED >2.25 INCHES.	UNKNOWN. POSSIBLE RAW WATER IN-LEAKAGE CAUSE FOR LEVEL INCREASE.
77-36	03/10/1977	LIQUID LEVEL IN TANK 101-AX DECREASED >.50 INCHES.	ASSUME TANK INVENTORY OF WARM WASTE INCREASED EVAPORATIVE LOSS.
77-37	03/13/1977	LIQUID LEVEL IN TANK 102-SX INCREASED >3 INCHES.	ASSUME LEVEL INCREASE TYPICAL OF WASTE SLURRIES RECEIVED FROM 242-S EVAPORATOR.
77-43	03/25/1977	LIQUID LEVEL IN TANK 103-SX EXCEEDED MAXIMUM OPERATING LIMIT.	ASSUME LEVEL INCREASE DUE TO SALT CAKE GROWTH.
77-46	03/31/1977	LIQUID LEVEL IN 002-BXR-SUMP INCREASED >2 INCHES.	ASSUME LEVEL INCREASE DUE TO DRAINAGE OF RAINWATER.
77-52	04/12/1977	RADIOACTIVE CONDENSATE DRIPPING ONTO GROUND FROM 102-SY VENTILATION EXHAUST LINE.	MECHANICAL FAILURE. LEAKS DEVELOPED WITHIN THREE DAYS OF STARTING TO FILL NEW TANK.
77-53	04/15/1977	LIQUID LEVEL IN TANK 103-SX DECREASED >.5 INCHES.	ASSUME LATERAL MOVEMENT OF CRUST AFTER TRANSFER OUT OF TANK.
77-54	04/17/1977	RADIOACTIVE ACTIVITY ON 102-SY ANNULUS AIR SAMPLING FILTER FOLLOWING TRANSFER INTO TANK.	ASSUME RADIOACTIVE AEROSOL TRAVELED FROM TANK UP THROUGH PUMP PIT DRAIN AND INTO ANNULUS THROUGH ANNULUS PUMP PIT DUE TO NEGATIVE PRESSURE.
77-55	04/22/1977	LIQUID LEVEL IN TANK 107-TX INCREASED AND THEN DECREASED FOLLOWING CRANE WORK IN AREA.	UNKNOWN.
77-58	04/23/1977	LIQUID LEVEL IN 240-S-302 CATCH TANK DECREASED >2 INCHES.	ASSUME INCREASED EVAPORATION DUE TO NEGATIVE PRESSURE APPLIED TO TANK FROM THE REDOX PLANT.
77-59	04/24/1977	LIQUID LEVEL IN 002-UR TANK DECREASED 0.25 INCHES.	UNKNOWN.
77-60	04/26/1977	LIQUID LEVEL IN TANK 105-U DECREASED 1.35 INCHES.	ASSUME LEVEL INCREASE DUE TO SURFACE MATERIAL MOVEMENT OR SLOUGHING OFF OF MATERIAL COLLECTED ON FIC PLUMMET.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
77-64	04/30/1977	MISROUTED WASTE TRANSFER INTO TANKS 101-SY, 103-SY, AND 103-SY LEAK DETECTION PIT, DURING TRANSFER FROM 111-U TO 102-SY.	PERSONNEL ERROR. TRANSFER MISROUTED.
77-65	04/29/1977	LIQUID LEVEL IN TANK TX-302-A CATCH TANK DECREASED >2 INCHES.	UNKNOWN.
77-66	05/04/1977	LIQUID LEVEL IN TANK 12-BX DECREASED >.5 INCHES.	FAILURE TO READJUST THE BASELINE FOLLOWING MAINTENANCE ON FIC PLUMMET.
77-68	05/10/1977	OVERFILLED TANK 103-S DURING TRANSFER FROM 242-S EVAPORATOR AND DIVERSION OF STEAM CONDENSATE.	PERSONNEL ERROR. STEAM CONDENSATE WAS INADVERTENTLY VALVE TO WASTE TANK INSTEAD OF CRIB.
77-69	05/10/1977	LIQUID LEVEL IN TANK 106-BY INCREASED 2 INCHES.	ASSUME FAILURE OF MANUAL LIQUID LEVEL MEASURING DEVICE.
77-70	05/11/1977	LIQUID LEVEL IN TANK 108-TX SHOWED DISCREPANCY OF 24 INCHES BETWEEN FIC AND THE MANUAL TAPE.	FIC TAPE WAS FABRICATED INCORRECTLY.
77-71	05/13/1977	LIQUID LEVEL IN TANK 102-SX DECREASED 2.95 INCHES AFTER TRANSFER FROM 103-S.	ASSUME MIXING SALT CAKE AND DILUTE WASTE IN TRANSFER CAUSED LEVEL DECREASE. NO CAUSE WAS CERTAIN.
77-73	05/20/1977	LIQUID LEVEL IN TANK 106-U DECREASED 1.7 INCHES.	UNKNOWN. TANK CONTENTS ORDERED TRANSFERRED.
77-74	05/23/1977	LIQUID LEVEL IN TANK 105-SX DECREASED >.5 INCHES.	ASSUME THE FIC INSTRUMENT IS NOT IN CONTACT WITH LIQUID, EXPECTED TO VARY.
77-76	05/25/1977	LIQUID LEVEL IN TANK 110-BX DECREASED 1.25 INCHES.	ASSUME INACCURATE INSTRUMENT READING OF THE LIQUID LEVEL.
77-77	05/24/1977	LIQUID LEVEL IN TANK 107-BY INCREASED 2.25 INCHES.	ASSUME LEVEL INDICATION CHANGE DUE TO UNEVEN SURFACE OF WASTE.
77-78	05/25/1977	LIQUID LEVEL IN 151-AX DIVERTER STATION CATCH TANK EXCEEDED MAXIMUM LIMIT.	OVERFLOW TO CATCH TANK WAS ANTICIPATED, BUT EXCEEDED THE LEVEL LIMIT WAS NOT. PROCEDURE PROBLEM.
77-79	05/24/1977	OPERATIONS PERSONNEL CONTAMINATED WHILE INSERTING A NEW MANUAL TAPE IN TANK 106-SX.	PERSONNEL AND PROCEDURE ERROR. SHOULD HAVE WORN WATER PROOF GLOVES.
77-81	05/25/1977	LIQUID LEVEL IN TANK 103-B EXCEEDED REUSE CRITERION.	PERSONNEL AND PROCEDURE ERROR. EMPLOYEE FAILED TO USE REUSE PROCEDURE AND PROCEDURE HAD INADEQUATE APPROVAL FORM.
77-82	05/29/1977	LIQUID LEVEL IN TANK 106-SX INCREASED >3 INCHES.	ASSUME INCREASE DUE TO WASTE VOLUME EXPANSION, AND ACCUMULATION OF MATERIAL ON FIC LEVEL DEVICE.
77-84	05/31/1977	PERSONNEL CONTAMINATION WHILE REMOVING A SLUDGE WEIGHT FROM TANK 104-AX RISER.	PERSONNEL ERROR. IMPROPER REMOVAL OF PROTECTIVE CLOTHING.
77-87	06/06/1977	LIQUID LEVEL IN 002-TXR SUMP EXCEEDED LIMIT.	INCREASE DUE TO RAINWATER SEEPING INTO SUMP.
77-91	06/10/1977	RAW WATER LINE BREAK NEAR TANKS 112-SX AND 115-SX CAUSING 100 SQUARE FOOT PUDDLE.	MECHANICAL FAILURE. RAW WATER LINE BREAK.
77-92	06/09/1977	LIQUID LEVEL IN TANK 101-SY INCREASED 2.95 INCHES.	ASSUME WASTE EXPANSION IN TANK. RECEIVER OF 242-S EVAPORATOR CRYSTALLIZER.
77-93	06/11/1977	LIQUID LEVEL IN TANK 103-BX DECREASED .6 INCHES.	ASSUME REDISTRIBUTION OF SLUDGE FOLLOWING TRANSFER OF 46 INCHES.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
77-100	06/21/1977	LIQUID LEVEL IN 011-BXR TANK DECREASED 1.25 INCHES.	UNKNOWN.
77-101	06/21/1977	LIQUID LEVEL 002-BXR SUMP INCREASED 2.25 INCHES.	ASSUME LEVEL INCREASE MAY BE DUE TO RAINWATER DRAINAGE.
77-103	12/07/1977	MANY INSTANCES OF RADIATION ACTIVITY IN TANK 103-TX DRY WELLS.	ASSUME MANY CAUSES OF INCREASED ACTIVITY: TANK LEAK, TANK OVERFILL, TRANSFER LINE LEAKAGE, MIGRATION OF SOIL CONTAMINATION, OR CONTAMINATION CARRIED BY MATERIAL CHANNELING.
77-105	06/29/1977	TANK 111-U OVERFILLED DURING A TRANSFER FROM 107-TX AND 102-U.	PERSONNEL ERROR. FAILURE TO NOTE LEVEL LIMIT, AND FAILURE TO RESPOND TO HIGH LEVEL ALARM.
77-107	06/30/1977	LIQUID LEVEL IN TANK 102-TX DECREASED 7 INCHES.	HOT WATER FLUSH OF LEVEL TAPE AND PLUMMET CAUSED LEVEL INDICATION CHANGE.
77-108	06/30/1977	LIQUID LEVEL IN TANK 106-A DECREASED 1 INCH.	ASSUME INCREASED EVAPORATION CAUSED LEVEL DECREASE.
77-109	07/05/1977	LIQUID LEVEL IN TANK 105-TX DECREASED 2.5 INCHES.	UNKNOWN.
77-114	05/06/1977	LIQUID LEVEL IN TANK 109-B DECREASED 3.5 INCHES.	ASSUME LEVEL INDICATION CHANGE CAUSED BY EROSION OF SALT CRUST UNDER THE PLUMMET CAUSED BY A FLUSH.
77-115	07/06/1977	LIQUID LEVEL IN TANK 107-TX DECREASED .5 INCHES.	LEVEL CHANGE CAUSED BY OPERATION OF A SUBMERSIBLE PUMP.
77-116	07/09/1977	LIQUID LEVEL IN TANK 102-TY DECREASED .8 INCHES.	ASSUMED SLUMPING OF SLUDGE FOLLOWING TANK PUMPING CAUSED THE LEVEL CHANGE.
77-117	07/07/1977	PIPEFITTERS WERE WORKING IN A FLUSH PIT THAT HAD A BACK UP OF PROCESS SOLUTION IN THE FLUSH LINE.	PERSONNEL ERROR. HPT THOUGHT THE WORK WOULD BE DONE IN A CLEAN PIT.
77-118	07/13/1977	TANK 101-S OVERFILLED TO STANDARD LIMIT, WHICH IS 3 INCHES ABOVE THE OPERATING LIMIT.	PERSONNEL ERROR. PERSONNEL FAILED TO REALIZE THAT LEVEL WAS CLOSE TO THE LIMIT.
77-120	07/15/1977	LIQUID LEVEL IN TANK 108-U INCREASED 3.2 INCHES.	FAILURE TO RESET BASELINE AFTER FLUSH TRANSFERRED TO TANK, AND APPARENT TYPICAL GROWTH OF SLURRY FROM 242-S EVAPORATOR.
77-122	07/19/1977	RADIOACTIVE MATERIAL ON AIR SAMPLE FILTERS FROM TANKS 101-AZ AND 102-AZ.	APPARENT COLLECTION OF NATURALLY OCCURRING RADIONUCLIDES FROM A THORIUM SERIES.
77-125	07/21/1977	LIQUID LEVEL IN TANK 101-A DECREASED .7 INCHES.	APPARENT HIGHER RATE OF EVAPORATION DUE TO INCREASED TEMPERATURE FROM SLURRY ADDITION.
77-132	08/03/1977	OPERATION OF 002-BXR PUMP IN STRONG ACID SOLUTION.	PERSONNEL ERROR. ACID WAS TO HAVE BEEN NEUTRALIZED BEFORE PLACING PUMP IN SOLUTION.
77-133	08/03/1977	LIQUID LEVEL IN TANK 105-SX INCREASED 3.2 INCHES.	ASSUME LEVEL INCREASE DUE TO TYPICAL GROWTH OF 242-S SLURRIES.
77-136	08/06/1977	LIQUID LEVEL IN TANK 103-SX INCREASED 3.1 INCHES.	ASSUME LEVEL INCREASE DUE TO TYPICAL GROWTH OF 242-S SLURRIES.
77-137	08/08/1977	2200 GALLONS MISROUTED TO TANK 109-TX DURING 102-TY TO 105-TX TRANSFER.	VALVE IN 109-TX PIT COULD NOT BE COMPLETELY CLOSED DUE TO INTERFERENCE FROM JUMPER.
77-138	08/13/1977	LIQUID LEVEL IN TANK 114-TX INCREASED 2.25 INCHES.	ASSUME LIQUID IS SEEPING INTO DEPRESSION LEFT BY SALT WELL PUMPING.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
77-139	08/13/1977	LIQUID LEVEL IN TANK 101-AX DECREASED 1 INCH.	UNKNOWN.
77-140	08/14/1977	LIQUID LEVEL IN TANK 109-U INCREASED 3.1 INCHES.	ASSUME LEVEL INCREASE DUE TO TYPICAL GROWTH OF 242-S SLURRIES.
77-141	08/15/1977	LIQUID LEVEL IN TANK 103-A DECREASED .9 INCHES.	ASSUME DISSOLUTION OF A FOAM WHICH HAD BEEN OBSERVED DURING LAST SLURRY TRANSFER.
77-144	08/18/1977	RADIATION ACTIVITY IN TANKS 110-TX AND 114-TX DRY WELL.	ASSUME MIGRATION OF SOIL CONTAMINATION.
77-146	08/24/1977	241-SY EXHAUSTER MOISTURE SEPARATOR LEAKED EXTERNALLY, SPREADING CONTAMINATION ONTO CONCRETE PAD.	MECHANICAL FAILURE. APPARENT WELD LEAKS.
77-147	08/24/1977	LIQUID LEVEL IN TANK 101-S DECREASED .7 INCHES.	LEVEL CHANGE IS APPARENT TRANSIENT PHENOMENA ASSOCIATED WITH 242-S EVAPORATOR TRANSFER.
77-148	08/25/1977	LIQUID LEVEL IN TANK 101-TY INCREASED 4.1 INCHES.	ASSUME LEVEL INDICATION CHANGE IS DUE TO LEVEL DEVICE MOVING OVER A DISCARDED FIC TAPE.
77-150	08/30/1977	LIQUID LEVEL IN TANK 105-TX DECREASED 6.75 INCHES.	APPARENT CAUSE OF LEVEL INDICATION CHANGE IS LATERAL MOVEMENT OF THE FIC PLUMMET OVER RAPIDLY CHANGING TERRAIN.
77-151	09/02/1977	LIQUID LEVEL IN TANK 101-B INCREASED 1.15 INCHES.	ASSUME LEVEL INDICATION CHANGE CAUSED BY A RAINWATER ACCUMULATION UNDER LEVEL MEASUREMENT TAPE.
77-152	09/04/1977	LIQUID LEVEL IN TANK 111-S INCREASED 3.1 INCHES.	LEVEL INCREASE CHANGE CAUSED BY REDISTRIBUTION OF LIQUID PRESENT IN THE SALT CAKE AND SLUDGE.
77-155	09/08/1977	EXCEEDED MAXIMUM LEVEL LIMIT IN 002-TXR TANK BY 4.25 INCHES.	PERSONNEL ERROR. TANK OVERFILLED WHEN FLUSHING LINE FROM 155-TX DIVERSION BOX TO 002-TXR TANK.
77-156	09/12/1977	LIQUID LEVEL IN TANK 105-U INCREASED 3.1 INCHES.	ASSUME LEVEL CHANGE DUE TO EXPANSION OF SLURRY MATERIAL IN TANK.
77-158	09/12/1977	EXCEEDED MAXIMUM LEVEL LIMIT IN 002-TXR SUMP.	FLUSH OF LINE BETWEEN TANKS 103-TX AND 102-SY OCCURRED, THE LINE BROKE IN 151-TXR DIVERSION BOX WHICH OVERFILLED THE SUMP.
77-160	09/14/1977	LIQUID LEVEL IN TANK 114-TX EXCEEDED MAXIMUM OPERATING LIMIT.	APPARENT CAUSE OF LEVEL INCREASE IS DUE TO WATER ENTERING THE TANK FROM PRESSURE TESTING A LINE INTO THE TANK.
77-161	09/15/1977	LIQUID LEVEL IN TANK 106-BY INCREASED 1.25 INCHES.	APPARENT CAUSE OF LEVEL INCREASE IS SHIFTING OF THE UNEVEN SALT CRUST.
77-163	09/19/1977	LIQUID LEVEL IN TANK 102-BY INCREASED 1.25 INCHES.	APPARENT CAUSE OF LEVEL INCREASE IS REDISTRIBUTION OF LIQUID AFTER A SALT WELL TRANSFER.
77-168	09/23/1977	LIQUID LEVEL IN TANK 111-U INCREASED 2.1 INCHES.	APPARENT CAUSE OF LEVEL INCREASE ID DRAINAGE FROM U-C AND U-D VALVE PITS AND FLUSH PITS.
77-169	09/23/1977	LIQUID LEVEL IN TANK 115-TX DECREASED 2.25 INCHES.	ASSUME LEVEL CHANGE IS DUE TO SETTLING OF SLUDGE FOLLOWING SALT WELL PUMPING.
77-171	09/29/1977	PUREX SUMP WASTE JETTED TO TANK 104-C INSTEAD OF TANK 102-A.	PERSONNEL AND PROCEDURE ERRORS. PROCEDURE CHANGES HAD NOT BEEN COMPLETED.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
77-172	09/29/1977	LIQUID LEVEL IN TANK 201-C INCREASED 2.25 INCHES.	ASSUME LEVEL INCREASE DUE TO NATURALLY OCCURRING PRECIPITATION.
77-174	10/03/1977	LIQUID LEVEL IN TANK 102-U INCREASED 2.05 INCHES.	ASSUME LEVEL INCREASE DUE TO EXPANSION OF SLURRY IN TANK.
77-175	10/04/1977	LIQUID LEVEL IN TANK 101-SY INCREASED 2.05 INCHES.	ASSUME LEVEL INCREASE DUE TO EXPANSION OF SLURRY IN TANK.
77-177	10/10/1977	LIQUID LEVEL IN TANK 202-B DECREASED 1 INCH.	ASSUME LEVEL DECREASE DUE TO SLUDGE SETTLING FOLLOWING PUMPING OF THE TANK.
77-178	10/11/1977	LIQUID LEVEL IN TANK 111-BY DECREASED 1 INCH.	ASSUME LEVEL CHANGE DUE TO TAPE PLUMMET TOUCHING UNEVEN SURFACE CRUST.
77-182	10/12/1977	LIQUID LEVEL IN TANK 105-TX DECREASED 36.75 INCHES.	LEVEL CHANGE DUE TO MOVEMENT OF LEVEL TAPE PLUMMET INTO A HOLE IN THE TANK SURFACE LEFT AFTER SALT WELL PUMPING.
77-184	10/15/1977	LIQUID LEVEL IN TANK 105-SX INCREASED 4.2 INCHES.	ASSUME LEVEL INCREASE DUE TO EXPANSION OF THE SLURRY IN THE TANK.
77-186	10/18/1977	LIQUID LEVEL IN TANK 108-T INCREASED .75 INCHES.	ASSUME LEVEL INCREASE IS DUE TO ACCUMULATION OF MATERIAL ON THE TAPE PLUMMET.
77-188	10/20/1977	LIQUID LEVEL IN TANK 104-SX INCREASED 3.55 INCHES.	ASSUME LEVEL INCREASE IS DUE TO EXPANSION OF THE SLURRY IN THE TANK.
77-189	10/19/1977	RADIOACTIVE ACTIVITY ON 102-SY ANNULUS AIR FILTER.	MECHANICAL FAILURE. FAILURE OF BLANK BETWEEN TANK PUMP PIT AND LEAK DETECTION PIT. FLOW IS THEN THROUGH AN UNDERGROUND LINE.
77-190	10/23/1977	LIQUID LEVEL IN TANK 106-SX INCREASED 3.1 INCHES.	ASSUME LEVEL INCREASE DUE TO RECEIPT OF CONDENSATE FROM OTHER SX TANKS.
77-191	11/02/1977	LIQUID LEVEL IN TANK 102-S INCREASED 7 INCHES.	ASSUME CAUSE OF LEVEL INCREASE IS DUE TO DRAINAGE FROM SA AND SB VALVE PITS.
77-193	11/05/1977	LIQUID LEVEL IN TANK 105-U DECREASED .55 INCHES.	ASSUME DECREASE DUE TO SETTLING OF TANK MATERIAL FOLLOWING TRANSFER.
77-194	11/06/1977	LIQUID LEVEL IN TANK 109-U INCREASED 3.05 INCHES.	ASSUME LEVEL INCREASE DUE TO GROWTH OF CRUST ON TANK SURFACE.
77-196	11/08/1977	RADIATION ACTIVITY IN TANK 105-T DRY WELL INCREASED.	ASSUME ACTIVITY DUE TO REDISTRIBUTION OF TANK 106-T LEAK PLUME.
77-199	11/12/1977	LIQUID LEVEL IN TANK 104-TX DECREASED .9 INCHES.	ASSUME LEVEL DECREASE IS DUE TO MOVEMENT OF A PATCH OF CRUST FROM THE VICINITY OF THE TAPE PLUMMET.
77-200	11/15/1977	DURING PRESSURE TEST OF 001-AR TANK UPPER COIL, CONTAMINATION RELEASED IN A VALVE PIT AND THE PIT THAT RECEIVES ALL COOLING WATER FROM THE AR VAULT.	PROCEDURE ERROR. PROCEDURE INCORRECT TO PREVENT SPREAD OF CONTAMINATION, AND LACK OF WARNINGS IN PROCEDURE FOR PERSONNEL.
77-201	11/18/1977	LIQUID LEVEL IN TANK 112-T DECREASED 1 INCH.	ASSUME LEVEL DECREASE IS DUE TO LEVEL TAPE PLUMMET MOVEMENT OVER AN IRREGULAR SURFACE.
77-202	11/22/1977	RADIATION ACTIVITY IN TANK 104-AX DRY WELL INCREASED.	SEVERAL CAUSES ARE CONSIDERED FOR THIS EVENT. CONTAMINATION FROM PREVIOUS COUPLING LEAK, FROM EXHAUST SYSTEM, FROM NEARBY PROCESS PIPING, OR FROM TANK LEAK.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
77-205	12/06/1977	SPRAY LEAK FROM 111-S PUMP PIT DURING LEAK CHECK OF SALT WELL PUMP AND JUMPER.	PROCEDURE ERROR AND MECHANICAL FAILURE. LEAK CHECK SHOULD BE DONE WITH COVER BLOCKS INSTALLED, AND FAILED GASKET AT PUMP INLET FLANGE.
77-206	12/08/1977	LIQUID LEVEL IN TANK 101-S INCREASED 2.35 INCHES.	ASSUME CRYSTAL GROWTH IN THE SLURRY IN THE TANK.
77-207	12/08/1977	LIQUID LEVEL IN TANK 101-SY INCREASED 2.9 INCHES.	ASSUME CRYSTAL GROWTH IN THE SLURRY IN THE TANK.
77-208	12/10/1977	LIQUID LEVEL IN TANK 106-TX DECREASED 2.25 INCHES.	ASSUME LEVEL INDICATION DECREASE DUE TO DEPRESSION IN SURFACE CRUST CAUSED BY MANUAL TAPE PLUMMET.
77-210	12/20/1977	LIQUID LEVEL IN TANK 203-T DECREASED 2.5 INCHES.	ASSUME LEVEL DECREASE IS DUE TO SETTLING OF THE SLUDGE FOLLOWING SALT WELL PUMPING.
77-211	12/23/1977	LIQUID LEVEL IN TANK 101-SX DECREASED 1.1 INCHES.	ASSUME LEVEL DECREASE CAUSED BY DISSOLUTION OF SALT CRYSTALS FOLLOWING WATER ADDITION.
77-212	12/23/1977	LIQUID LEVEL IN TANK 103-TX DECREASED .6 INCHES.	ASSUME LEVEL DECREASE CAUSED BY MOVEMENT OF FOAM OR SLUDGE UNDER THE TAPE PLUMMET.
78-1	01/02/1978	LIQUID LEVEL IN TANK 101-A INCREASED 3.1 INCHES.	ASSUME LEVEL INCREASE DUE TO MATERIAL ON THE TAPE PLUMMET.
78-2	01/02/1978	WASTE MISROUTED FROM 004-AR TO TANK 102-A RATHER THAN TANK 106-A.	PERSONNEL AND PROCEDURE ERRORS. SUPERVISOR SIGNED INCOMPLETE DATA SHEET WITHOUT PROPER REVIEW, AND PROCEDURE LACKS ADEQUATE CHECKS AND APPROVALS.
78-3	01/06/1978	LIQUID LEVEL IN TANK 103-SX DECREASED 1 INCH.	ASSUME LEVEL DECREASE DUE TO FIC MOVING OVER IRREGULAR FISSURED CRUST.
78-4	01/08/1978	LIQUID LEVEL IN TANK 101-S DECREASED .6 INCHES.	UNKNOWN.
78-6	01/10/1978	BACKFLOW OF CONTAMINATION INTO RAW WATER SYSTEM IN 241-TX TANK FARM.	PERSONNEL ERROR/PROCEDURE. CHECK VALVE ON FLUSH PIPING INSTALLED IN THE INVERTED POSITION, MANUAL FLUSH VALVE LEFT PARTIALLY OPEN.
78-13	01/23/1978	UNDETECTED FILLING OF A-40 RETENTION BASIN AT 244-AR VAULT WITH 200,000 GALLONS.	MECHANICAL FAILURES. RADIATION ALARM FAILED CAUSING DIVERTER VALVE TO DIVERT. VALVE STEM WAS BINDING AND THE VALVE DID NOT CLOSE COMPLETELY, INDICATING LIGHT SHOWED VALVE CLOSED.
78-14	01/20/1978	CONTAMINATED LIQUID SPRAYED FROM HOLE DRILLED IN TOP OF TRANSFER LINE V453 WHEN PREPARING TO CUT LINE.	PROCEDURE ERROR. NO CONTAINMENT USED WHEN DRILLING INTO LINE. (SIMILAR TO 76-64)
78-15	01/23/1978	LIQUID LEVEL IN TANK 103-A DECREASED .75 INCHES.	ASSUME LEVEL DECREASE INDICATION DUE TO FIC PLUMMET MOVEMENT OVER IRREGULAR SURFACE.
78-16	01/23/1978	LIQUID LEVEL IN TANK 101-SY INCREASED 3.05 INCHES.	ASSUME LEVEL INCREASE DUE TO EXPANSION OF THE TANK MATERIAL.
78-18	02/09/1978	LIQUID LEVEL IN TANK 111-BY DECREASED 1.25 INCHES.	ASSUME LEVEL DECREASE DUE TO COMPACTION OF THE SURFACE BY THE TAPE PLUMMET, OR TO CONTACT WITH A DISCARDED TAPE LYING ON THE WASTE SURFACE.
78-24	02/23/1978	UNDERGROUND RAW WATER LINE BREAK RELEASED 60,000 GALLONS IN 241-A TANK FARM AND CAUSED CAVE-IN BETWEEN 102-A AND 105-A. HOLE READ 1R/HR DUE TO WATER FLOW THROUGH A BURIED UNUSED DE-ENTRAINER.	MECHANICAL FAILURE. RAW WATER LINE M5a RUPTURE.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
78-26	03/02/1978	ELECTRICIAN ENTERED A 15 R/HR RADIATION FIELD IN 244-AR CANYON.	PERSONNEL ERROR. FAILURE OF TEAM IN CANYON TO RECOGNIZE THE RADIATION HAZARD.
78-30	03/22/1978	LIQUID LEVEL IN TANK 106-SX DECREASED .7 INCHES.	ASSUME LEVEL DECREASE DUE TO SLUDGE SETTLING FOLLOWING PUMP OUT.
78-39	04/17/1978	LIQUID LEVEL IN TANK 109-B DECREASED .55 INCHES.	ASSUME LEVEL DECREASE IS DUE TO SLIPPAGE OF THE FIC PLUMMET DOWN SLOPE IN CRUST.
78-44	04/25/1978	RAW WATER LINE LEAK OF 5000 GALLONS BETWEEN 241-S AND 241-SX TANK FARMS.	MECHANICAL FAILURE OF A BELL AND SPIGOT JOINT IN THE RAW WATER LINE.
78-47	05/08/1978	RADIOACTIVE DISCHARGE TO 216-A-8 CRIB EXCEEDED LIMITS.	ASSUME VENT HEADER EXTENSION SEAL LOOP CONDENSATE FOR A, AX, AY, AND AZ FARMS DRAINED INTO LINE.
78-49	05/15/1978	RADIATION ACTIVITY IN TANK 105-A DRY WELL INCREASED.	ASSUME TWO CAUSES: ADDING COOLING WATER TO THIS KNOWN LEAKING TANK, EARLIER RAW WATER SPILL IN 241-A FARM.
78-53	05/23/1978	LIQUID LEVEL IN TANK 103-SX DECREASED .55 INCHES.	ASSUME LEVEL DECREASE DUE TO PLUMMET MOVEMENT OVER IRREGULAR SURFACE.
78-54	05/19/1978	LIQUID LEVEL IN TANK 111-U DECREASED .7 INCHES.	ASSUME LEVEL DECREASE DUE TO FOAM MATERIAL UNDER THE FIC PLUMMET.
78-60	06/09/1978	RADIATION ACTIVITY IN TANK 108-T DRY WELL INCREASED.	ASSUME ACTIVITY INCREASE DUE TO 106-T LEAK PLUME.
78-64	06/21/1978	ROAD GRADER STRUCK TRANSFER LINES HSW-202-M8 AND HSW-203-M8, LINE 202 ENCASEMENT WAS BENT AND PARTIALLY CRUSHED.	PERSONNEL ERROR. RESPONSIBLE PARTY WAS NOT FOLLOWING THE ROAD GRADING WORK, TRANSFER LINES WERE WELL MARKED AND BERMED.
78-69	07/05/1978	HIGH LEVEL WASTE LODGED STUCK IN CAISSON CHUTE WHILE BEING UNLOADED INTO FACILITY.	PROCEDURE ERROR AND DESIGN INADEQUATE. CASK AND CAISSON CHUTE DO NOT MATE PROPERLY AND UNLOADING PROCEDURAL CONTROL INADEQUATE.
78-73	06/12/1978	VACUUM TEST OF FIBERGLASS REINFORCED PLASTIC AND WOOD BOXES RESULTED IN STRUCTURAL FAILURE OF THE BOXES. SUSPECT THAT ALREADY BURIED BOXES ALSO WOULD FAIL.	DESIGN PROBLEMS OF THE BURIAL BOXES.
78-76	07/26/1978	MINOR LEAK IN 4-INCH RAW WATER LINE NEAR 241-TX TANK FARM.	MECHANICAL FAILURE OF A BELL AND SPIGOT JOINT IN LINE.
78-78	07/25/1978	RADIOGRAPHY CREW LEFT THE JOB SITE IN 241-TX FARM DUE TO AN UNDERGROUND TRANSFER IN PROGRESS.	PERSONNEL ERROR. PROBLEMS IN SCHEDULING AND MANAGING PERSONNEL.
78-80	07/27/1978	PROCESS TRANSFER LINE EXPOSED DURING HAND EXCAVATION, OVER-EXPOSURE OF PERSONNEL.	PROCEDURE ERROR. PERSONNEL NOT MADE AWARE OF THE PRESENCE OF THE UNDERGROUND LINE.
78-83	08/10/1978	MISTRANSFER OF WASTE FROM TANK 101-A TO TANK 104-BX INSTEAD OF 102-A.	PERSONNEL ERROR. VALVING CHANGED IN AA VALVE PIT INSTEAD OF AB VALVE PIT DURING TRANSFER.
78-87	08/17/1978	TWO 55-GALLON DRUMS ON 4-C ALPHA PAD APPEAR DISTORTED. DRUMS CONTAIN PLUTONIUM IN SOLUTION.	ASSUME THE CONTAINERS ARE PRESSURIZING AS A RESULT OF CHEMICAL REACTIONS OF THEIR CONTENTS.
78-88	08/22/1978	TRANSFER LINE BETWEEN TANK 107-S AND 105-BX PLUGGED DURING TRANSFER.	PLUGGAGE APPEARS TO BE CAUSED BY SOLIDS SETTLED IN LINE WHEN POWER WAS LOST TO 107-S TRANSFER PUMP.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
78-89	08/24/1978	RADIATION ACTIVITY IN DRY WELL BETWEEN TANK 104-U AND 105-U INCREASED.	APPARENT SOURCE OF INCREASED ACTIVITY IS TANK 104-U WHICH IS A LEAKER.
78-90	08/26/1978	FRACTURED 6" SANITARY WATER LINE AND 8" RAW WATER LINE NEAR 275-EA BUILDING. AFFECTED WATER SUPPLY TO 244-AR FACILITY.	APPARENT CAUSE OF BROKEN PIPES WAS FROM HEAVY WEIGHT OF A CRANE UNLOADING PLATES FROM A RAILROAD CAR FOR USE AT 241-AW TANK FARM.
78-98	09/12/1978	PERSONNEL WIPING OFF POLE USED TO RELOCATE JUMPER IN 152-A DIVERSION BOX INGESTED RADIOACTIVE MATERIAL AND SUFFERED SKIN CONTAMINATIONS.	PERSONNEL ERROR. FAILURE TO FOLLOW PROCEDURE OR WEAR APPROPRIATE PROTECTIVE CLOTHING.
78-117	10/30/1978	UNDETECTED FAILURE OF LEAK DETECTORS IN 241-SA AND 241-SB VALVE PITS DURING CROSS-COUNTRY TRANSFER.	MECHANICAL PROBLEM. COMMON DRAIN FOR BOTH VALVE PITS BLOCKED.
78-121	11/15/1978	LIQUID LEVEL IN TANK 106-B DECREASED .6 INCHES.	UNKNOWN.
78-129	12/04/1978	LIQUID LEVEL IN CATCH TANK TX-302-A DECREASED 2.25 INCHES.	UNKNOWN.
78-130	12/02/1978	CONTAMINATED VAPOR VENTING FROM TANK 105-BX AIR INLET RISER AND 104-BX CENTER PIT.	TRANSFER INTO TANK DISPLACED WARM VAPORS OUT THIS TANK'S OPENINGS. TANK IS NOT EXHAUSTED.
79-02	01/02/1979	RAW WATER LEAK OF 37,500 GALLONS LEAKED FROM 241-S/SX SERVICE PIT.	PERSONNEL AND MECHANICAL FAILURES. HOUSING ON PIT WATER METER FAILED, AND PERSONNEL DID NOT VALVE OUT RAW WATER SUPPLY AS REQUIRED.
79-17	02/02/1979	LIQUID LEVEL IN TANK 103-SY DECREASED 2.8 INCHES.	ASSUME LEVEL DECREASE DUE TO COLLAPSE OF SURFACE CRUST.
79-20	02/07/1979	LIQUID LEVEL IN TANK 110-U INCREASED .2 INCHES.	LEVEL INCREASE ATTRIBUTED TO WATER INTRUSION THROUGH PUMP PIT.
79-22	02/08/1979	RADIATION ACTIVITY IN DRY WELL NEAR TANKS 103-TX AND 107-TX INCREASED.	APPARENT MIGRATION OF CONTAMINATION IN SOIL.
79-25	02/12/1979	IMPROPER VALVE LINE-UP DURING WASTE TRANSFER OR SUBSEQUENT FLUSHING CONTAMINATED RAW WATER HOSE BIB IN 241-S FLUSH PIT.	PERSONNEL ERROR. IMPROPER VALVING IN FLUSH PIT OR VALVE PIT.
79-26	02/17/1979	MISROUTING OF TRANSFER FROM TANK 102-S TO TANK 103-SX INSTEAD OF TANK 106-SX.	PERSONNEL ERROR. IMPROPER VALVING IN 241-SX-A VALVE PIT.
79-29	01/31/1979	CONTAMINATED VAPOR VENTED FROM TANK 118-TX #1 RISER WHICH CONTAINS THE LIQUID LEVEL REEL.	UNKNOWN CAUSE AT TIME OF REPORT.
79-31	03/21/1979	LIQUID LEVEL IN TANK 110-TX DECREASED 2.5 INCHES.	UNKNOWN.
79-34	03/22/1979	CONTAMINATED VAPOR VENTED FROM TANK 106-U RISER #9, WHICH CONTAINS THE LIQUID LEVEL REEL.	NOT REPORTED.
79-35	03/22/1979	CORE DRILL STRING CONTACT WITH BOTTOM OF TANK 107-BX, WHICH BROKE THE DRILL ROD.	PROCEDURE ERROR. INADEQUATE ADMINISTRATIVE CONTROL OF DOCUMENTATION OF DRILL ROD SEGMENTS.
79-37	03/28/1979	RADIATION ACTIVITY IN TANK 107-BY DRY WELL INCREASED.	UNKNOWN.
79-38	03/28/1979	LIQUID LEVEL IN TANK 102-S EXCEEDED LIMIT.	PERSONNEL ERROR. INATTENTION BY CASS OPERATORS TO LEVEL ALARMS.
79-39	03/29/1979	LIQUID LEVEL IN 103-AX LEAK DETECTION PIT INCREASED.	ASSUME SNOW MELT INTRUSION THROUGH DRAIN BELLOWS ASSEMBLY.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
79-60	05/23/1979	CONTAMINATED SWALLOW NESTS FOUND AT 244-AR VAULT.	BIRDS PICKED UP CONTAMINATED MUD FROM 216-A-40 RETENTION BASIN. BLADDER TYPE BAGS AT RETENTION BASIN HAVE LEAKS.
79-61	05/25/1979	SLURRY LINE SL-113 LEAKED IN 241-S FARM WHEN BEING READIED FOR A PRESSURE TEST.	MECHANICAL FAILURE OF 2-INCH CARBON STEEL LINE.
79-65	06/06/1979	WASTE TANK SURVEILLANCE SIGNALS LOST WHEN LINES CUT BY BACKHOE NEAR 241-B AND BX TANK FARMS.	PERSONNEL ERROR. PROCEDURE INDICATED HAND DIGGING IN THIS AREA INSTEAD OF BACKHOE USE.
79-68	07/11/1979	LIQUID LEVEL IN TANK 001-TXR DECREASED 1.25 INCHES.	UNKNOWN. TANK INTEGRITY IS QUESTIONABLE.
79-70	07/13/1979	LIQUID LEVEL IN 011-BXR VAULT TANK DECREASED 1.25 INCHES. ALSO TANK CELL HAS STRUCTURAL ANOMALIES.	LEVEL DECREASE CAUSE UNKNOWN. CELL STRUCTURAL ANOMALIES DUE TO PREVIOUS CELL OVERFILLING.
79-73	07/23/1979	RAW WATER LEAK IN 241-C TANK FARM RESULTED IN LARGE PUDDLE WHICH PARTIALLY COVERED TANKS 111-C AND 112-C.	MECHANICAL FAILURE OF "STOP AND WASTE" VALVE SUPPLYING 241-C FARM.
79-75	06/09/1978	RADIATION ACTIVITY IN TANK 108-T DRY WELL INCREASED.	ASSUME INCREASED ACTIVITY DUE TO MIGRATION OF TANK 106-T LEAK PLUME.
79-80	08/17/1979	MISROUTING OF 13,000 GALLONS OF CROSS-COUNTRY LINE LEAK CHECK WATER TO TANK 103-S.	PERSONNEL ERROR. FAILURE TO REALIGN VALVE IN 241-SA VALVE PIT.
79-81	08/20/1979	BOXES IN BURIAL GROUND 3A-TRENCH 17 EXCEEDED CRITICALITY LIMITS.	PERSONNEL ERROR. IT APPEARS THAT THREE BOXES WERE PUT IN THE BURIAL TRENCH WITHOUT PROPER SPACING.
79-100	10/10/1979	LIQUID LEVEL IN TANK 102-S EXCEEDED LIMIT.	PERSONNEL ERROR. FAILURE TO MAINTAIN CONTROL WHILE 242-S EVAPORATOR STEAM TURBINE PRESSURE REGULATING VALVE WAS CYCLED.
79-104	10/21/1979	WASTE TRANSFER FROM TANK 106-SX TO 101-SX MISROUTED TO TANK 102-S.	PERSONNEL ERROR. VALVE ALIGNMENT IN 241-SA VALVE PIT FOR OTHER TRANSFER REROUTED THIS TRANSFER.
79-113	10/10/1979	INADVERTENT FLOW ROUTING TO INACTIVE CRIB 216-A-24.	PERSONNEL ERROR. TWO SETS OF ROUTING VALVES WERE MISALIGNED.
79-118	11/29/1979	LIQUID LEVEL IN TANK 103-A DECREASED 4 INCHES.	ASSUME LEVEL DECREASE DUE TO SLUMPING OF THE TANK SURFACE.
79-125	12/15/1979	LIQUID LEVEL IN TANK 105-SX DECREASED 2.3 INCHES.	ASSUME LEVEL DECREASE DUE TO PLUMMET/TANK MATERIAL INTERACTION.
79-126	12/18/1979	25-TON CRANE BOOM POSITIONED OVER WORKERS ON TOP OF 241-SA VALVE PIT AND TESTED, VIOLATING SAFE OPERATING PRACTICES.	PERSONNEL ERROR. WILLFUL VIOLATION OF CRANE OPERATION PROCEDURES.
80-4	01/13/1980	LIQUID LEVEL IN TANK 110-BX INCREASED 2.5 INCHES.	SNOW MELT CHANNELED INTO PUMP PIT AND DIRECTLY INTO TANK.
80-5	01/15/1980	LIQUID LEVEL IN TANK 108-BY INCREASED 3 INCHES.	RAPID SNOW MELT RAN INTO PUMP PIT THROUGH THE PIT DRAIN DIRECTLY INTO TANK.
80-6	01/15/1980	LIQUID LEVEL IN TANK 103-BY INCREASED 1.25 INCHES.	RAPID SNOW MELT RAN INTO PUMP PIT THROUGH THE PIT DRAIN DIRECTLY INTO TANK.
80-7	01/17/1980	LIQUID LEVEL IN TANK 103-SX DECREASED 1.1 INCHES.	ASSUME LEVEL DECREASE DUE TO FIC PLUMMET MEASURING IRREGULAR SURFACE.
80-8	01/18/1980	MISROUTED 2000 GALLONS INTO TANK 102-AY FROM TANK 103-A INSTEAD OF INTO TANK 101-AY.	PERSONNEL ERROR. MISVALVING THE SLURRY DISTRIBUTOR VALVE IN TANK 102-AY 02A VALVE PIT.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
80-9	01/16/1980	CROSS-COUNTRY TRANSFER LINE FROM TANK 107-S TO 105-BX PLUGGED DURING TRANSFER OF TERMINAL LIQUOR SOLUTION.	PLUG DUE TO INADEQUATE DILUTION OF WASTE, DILUTION WATER METER FAILED.
80-25	02/20/1980	UNUSUAL LIQUID LEVEL DECREASE IN TANK 103-SX FOLLOWING TRANSFER IN.	LEVEL DECREASE CAUSED BY MIXING LARGE AMOUNT OF LOW DENSITY LIQUID INTO TANK OF SOLIDS.
80-26	02/21/1980	LINE LEAK IN SLURRY LINE SL 126 BETWEEN 241-SD VALVE PIT AND TANK 107-S CROSS-SITE PUMP PIT.	ASSUME LINE LEAKS DUE TO UNANTICIPATED CORROSION.
80-32	03/05/1980	CASS TRANSMISSION CABLE FROM 241-A TANK FARM CRUSHED DURING REMOVAL OF A FLUME IN 241-AZ TANK FARM. NOTIFICATION TO TANK FARM OPERATIONS WAS NOT INITIATED IMMEDIATELY AS REQUIRED.	PERSONNEL ERRORS. DAMAGE DURING CONSTRUCTION ACTIVITIES.
80-36	03/14/1980	CRITICALITY PREVENTION SPECIFICATION VIOLATIONS IN ALPHA-1 CAISSON OCCURRED BETWEEN 1970 AND 1973.	PROCEDURE ERRORS.
80-37	04/03/1980	HIGH VACUUM (-4.0"W.G. FOR 3 1/2 DAYS WHEN SUPPLY FAN WAS OFF, COULD HAVE BEEN AS HIGH AS -6.25" W.G.) IN TANK 102-AY ANNULUS.	PERSONNEL AND DESIGN PROBLEMS. UNEXPECTED SHUTDOWN OF ANNULUS SUPPLY FAN COUPLED WITH THE LACK OF PRESSURE SWITCH TO SHUT DOWN EXHAUST FAN.
80-50	05/16/1980	PARTIAL MISTRANSFER OF 4125 GALLONS INTO TANK 101-AY FROM TANK 103-A. TRANSFER WAS TO GO TO TANK 102-AY.	MECHANICAL FAILURE. 3-WAY SDV VALVE IN 241-AY-02A VALVE PIT SPLIT FLOW BETWEEN TWO TANKS. BALL VALVE ORIENTATION WITHIN VALVE BODY DID NOT CORRESPOND TO PAINTED FLOW DIAGRAM ON PROCESS PIT COVER BLOCK
80-51	05/31/1980	4120 GALLONS MISROUTED TO TANKS 101-AY AND 102-AY FROM 244-A CATCH TANK. INTENDED RECEIVER TANK WAS 102-A.	PERSONNEL ERROR. INSTALLED JUMPER WAS MISALIGNED IN 241-A-02C PIT.
80-53	06/07/1980	LIQUID LEVEL IN TANK 201-T INCREASED 2.25 INCHES.	ASSUME LEVEL INCREASE INDICATION DUE TO SOLIDS MOVEMENT IN VICINITY OF PLUMMET.
80-58	05/12/1980	LIQUID LEVEL MEASUREMENT TAPE IN TANK 107-BY CUT AND REMOVED WITHOUT PERMISSION.	PERSONNEL ERROR. CONSTRUCTION EMPLOYEE REMOVED TAPE AND GAUGE WITHOUT PERMISSION.
80-60	05/08/1980	PHOTOGRAPHIC SURVEY OF TX-302-C CATCH TANK REVEALED LIQUID LEVEL ABOVE MAXIMUM LIMIT.	MANUAL TAPE READINGS INDICATED LEVEL WITHIN LIMITS. TANK RISER EXTENDED 3' PREVIOUSLY AND NO REFERENCE TO ELEVATION CHANGE MADE TO DRAWINGS.
80-64	07/11/1980	LIQUID LEVEL IN TANK 112-TX INCREASED 1.75 INCHES.	LEVEL INCREASE DUE TO INTRUSION FROM A STEAM LINE LOCATED IN AN ASSOCIATED VALVE PIT.
80-66	07/21/1980	PLUGGED DEENTRAINER MINIMIZED FLOW THROUGH 241-SY EXHAUSTER, CAUSING 102-SY ANNULUS EXHAUST SYSTEM TO PULL CONTAMINATED AIR THROUGH AIR SAMPLER FILTER.	PERSONNEL ERROR. DEENTRAINER dP INSTRUMENT INSTALLED BACKWARDS, GIVING FALSE INDICATION OF GOOD OPERATION.
80-73	07/10/1980	MISROUTED 2200 GALLONS TO TANK 103-TX FROM 118-TX, INTENDED RECEIVER TANK WAS 106-SX.	PERSONNEL ERROR. FAILURE TO CLOSE VALVE IN 241-152-TXR DIVERSION BOX.
80-80	07/23/1980	WHILE TRANSPORTING A SALT WELL PUMP FOR BURIAL THE PLASTIC COVERING THE PUMP WAS PUNCTURED AND TWO GALLONS OF RADIOACTIVE LIQUID SPILLED ON THE GROUND.	PERSONNEL ERROR. IMPROPER RIGGING OF PUMP FOR BURIAL.
80-81	08/26/1980	SPRAY LEAK IN 241-AW-05A CENTRAL PUMP PIT DURING SLURRY TRANSFER TO TANK 105-AW.	PERSONNEL AND DESIGN ERROR. WORKER UNABLE TO TIGHTEN CONNECTION BETWEEN JUMPER AND DISTRIBUTOR SUFFICIENTLY.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
80-82	09/04/1980	LIQUID LEVEL IN TANK 103-A DECREASED 3.3 INCHES.	ASSUME LEVEL DECREASE IS DUE TO MIXING OF DISSIMILAR SOLIDS WITHIN THE TANK.
80-84	09/08/1980	WORKER EXCEEDED WEEKLY EXPOSURE WHILE WORKING IN A TRENCH IN 241-SY FARM DURING WASTE TRANSFER.	PROCEDURE ERROR. TRANSFER NOT COMMUNICATED TO CONSTRUCTION WORKERS.
80-87	10/02/1980	5775 GALLONS MISTRANSFERRED INTO TANK 103-AX FROM TANK 101-AX. INTENDED RECEIVER TANK WAS 103-AW.	PERSONNEL ERROR. VALVE MISPOSITIONED IN AX-A VALVE PIT.
80-88	10/17/1980	9625 GALLONS MISTRANSFERRED TO TANK 102-AY FROM 101-A. INTENDED RECEIVER TANK WAS 102-A.	PERSONNEL ERROR. CORRECT TRANSFER ROUTE NOT SET UP.
80-90	11/11/1980	SLURRY LINE SL 176 LEAKED DURING TRANSFER FROM 242-S EVAPORATOR TO TANK 103-SY.	MECHANICAL FAILURE. ASSUME CORROSION OF CARBON STEEL TRANSFER LINE.
81-02	11/19/1980	LIQUID LEVEL IN TANK 106-SX INCREASED 3 INCHES.	MECHANICAL FAILURE. INTRUSION FROM A LEAKING STEAM COIL AND FAILURE OF A VALVE TO THE STEAM COIL.
81-03	01/13/1981	RADIATION ACTIVITY IN TANK 101-A DRY WELL INCREASED.	ACTIVITY INCREASE DUE TO LEACHING DOWN OF A PREVIOUS SOIL CONTAMINATION AROUND 241-A-01B PIT.
81-04	01/14/1981	LIQUID LEVEL IN TANK 110-BX INCREASED 1.25 INCHES.	LIQUID LEVEL INCREASE DUE TO INTRUSION OF RAINWATER.
81-24	03/02/1981	20-40 GALLONS/DAY LEAK IN 4" RAW WATER LINE FEEDING 244-UR PROCESS VAULT.	MECHANICAL FAILURE. RAW WATER LINE DEVELOPED LEAKS AND CLOSED DISCHARGE LINE VALVES LEAKED THROUGH.
81-25	03/30/1981	LIQUID LEVEL IN TANK 103-T EXCEEDED LIMIT.	ASSUME LEVEL INCREASE DUE TO PRECIPITATION ENTERING TANK VIA PUMP PITS.
81-36	05/20/1981	LIQUID LEVEL IN TANK 103-TY EXCEEDED LIMIT BY 5.1 INCHES.	LEVEL INCREASE CAUSED BY WATER INTRUSION VIA AN OPEN WATER LINE IN 103-TY WATER FLUSH PIT. WATER RAN INTO PIT AND INTO THE TANK VIA THE PIT DRAIN.
81-48	07/10/1981	FIC BOX NEAR 118-TX VALVE PIT DAMAGED BY CRANE BACKING UP.	APPARENT ACCIDENT CAUSED BY ERROR IN JUDGMENT BY FLAGMAN, CONGESTION IN TANK FARM, AND EXTREMELY ROUGH TERRAIN.
81-52	08/17/1981	WASTE TRANSFER FROM 101-AY TO 104-AW MISROUTED TO 102-AY.	MECHANICAL FAILURE. MISROUTING CAUSED BY FAILURE OF 3-WAY DISCHARGE VALVE IN TK-AY-102-02D TO BE POSITIONED AGAINST MECHANICAL STOP.
81-55	09/03/1981	CONTAMINATION RELEASE IN 204-S UNLOADING STATION WHILE HOOKING UP RAILROAD CAR FOR UNLOADING.	MECHANICAL FAILURE. FAULTY SPRAY RING VALVE ON TOP OF CAR.
81-58	09/15/1981	FIRE IN 241-AN TANK FARM K1-2-1 CABINET ELECTRIC BLAST HEATER POWER COMPONENTS.	PERSONNEL ERROR AND MECHANICAL FAILURE. CURRENT ALARM SWITCH SHORTED OUT, SWITCH WAS REDUNDANT AND SHOULD HAVE BEEN REMOVED DURING CONSTRUCTION.
81-61	09/08/1981	RADIOACTIVE FLUSH WATER PUMPED TO TANK 102-SY THROUGH TRANSFER LINE THAT GOES THROUGH S-FARM WHERE WORKERS WERE EXCAVATING.	PERSONNEL ERROR. COMMUNICATION FAILURE, AND FAILURE TO FOLLOW LOCK AND TAG PROCEDURE.
81-82	12/07/1981	LIQUID LEVEL IN 011-BXR TANK DECREASED 2.5 INCHES.	MECHANICAL FAILURE. LEVEL DECREASED WHEN TANK WALL BUCKLED WHICH CAUSED LEAKS.
82-01	01/06/1982	RADIATION ACTIVITY IN TANK 109-C DRY WELL INCREASED.	ASSUME ACTIVITY INCREASE IS CAUSED BY MIGRATION OF SOIL CONTAMINATION.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
82-02	01/05/1982	FAILURE OF PROCESS LINE V-402 DURING TX-FARM SALT WELL PUMPING.	MECHANICAL FAILURE. LINE FAILURE CONFIRMED BY PRESSURE TEST.
82-12	03/24/1982	LOSS OF EMERGENCY POWER TO 204-AR UNLOADING STATION AND 242-A EVAPORATOR.	MECHANICAL FAILURE. APPARENT LOSS OF BACK-UP POWER DUE TO DIRT IN RELAY CONTACTS, FAILURE OF MANUAL/AUTOMATIC SWITCH, AND FAILURE IN AUTOMATIC START CONTROL CIRCUIT MODULE.
82-21	05/15/1982	FAILURE OF PROCESS LINE BETWEEN 241-TX-155 AND 241-U-151, V-398.	MECHANICAL FAILURE OF INNER PROCESS LINE.
83-1	01/22/1983	FAILURE OF PUREX 36" CHEMICAL SEWER LINE DISCOVERED BY CRANE TIRE CAUSING CAVE-IN IN 241-AP TANK FARM.	MECHANICAL FAILURE. BELLS OF VITRIFIED CLAY PIPE WERE BROKEN AND LEAKING.
83-07	04/11/1983	WASTE TRANSFER INTO AY TANK WITHOUT VENTILATION ON RECEIVER TANK. NORMAL VENTILATION SYSTEM WAS OUT-OF-SERVICE, PORTABLE EXHAUSTER STARTED, BUT OPERATOR FAILED TO OPEN THE EXHAUSTER INLET VALVE.	PERSONNEL ERROR, FAILURE TO FOLLOW PROCEDURE. OPERATOR OPENED VALVE ONE QUARTER TURN INSTEAD OF 15 1/2 TURNS.
83-09	03/25/1983	WHILE CORE DRILLING IN 241-AX-152 DIVERTER STATION A 2" ENCASEMENT DRAIN LINE WAS HIT AND BREACHED.	DESIGN PROBLEM. ENCASEMENT DRAIN LINE WAS NOT ON CONSTRUCTION DRAWINGS OR DRILL PERMIT.
83-11	03/19/1983	LIQUID LEVEL IN TANK 201-T INCREASED 2.25 INCHES.	UNKNOWN.
83-16	07/11/1983	TANK 102-T LIQUID LEVEL INCREASE. TANK INTERIM STABILIZED, ASSUMED INTRUSION OF RAIN/SNOW MELT.	WEATHER. RAIN/SNOW MELT INTRUSION INTO TANK. 241-TR-153 BOOSTER PUMP PIT DRAINED WAS SEALED, LEVEL INCREASE HAS STOPPED.
83-22	11/16/1983	INCREASE IN ACTIVITY IN DRYWELL ADJACENT TO TANK 107-TX. APPARENT RAINFALL INTRUSION INTO INACTIVE, QUESTIONABLE INTEGRITY TANK CAUSED INCREASED ACTIVITY IN ASSOCIATED DRYWELL.	MECHANICAL/WEATHER. TANK INTEGRITY QUESTIONABLE, RAINFALL INTRUSION THROUGH COVERBLOCKS ASSUMED. TANK 107-TX PUMPED.
83-28	11/07/1983	STEAM RELEASE FROM 107-AN PUMP PIT. AN FARM VENT FAN SHUT DOWN DURING WASTE TRANSFER TO TANK 107-AN. TANK VACUUM LOST, STEAM ESCAPED FROM 107-AN PUMP PITS.	MECHANICAL. STACK SAMPLER MALFUNCTION CAUSED INTERLOCK TO SHUTDOWN VENT FAN, PRIOR TO TRANSFER BEING STOPPED.
83-31	11/16/1983	TANKS 102,101,104 AND 106-AW PRESSURIZED WHEN HOT WATER (123oF) DUMPED INTO TANK 102-AW FROM 242-A EVAPORATOR.	RAPID EXPANSION OF TANK VAPORS OVERWHELMED THE EXHAUST AIR FLOW.
83-33	11/06/1983	MULTIPLE PRESSURIZATIONS OF TANK 103-AW WHEN RECEIVING PUREX E-5 WASTE.	PRESSURIZATION DUE TO VAPORIZATION OF THE THERMALLY HOT WASTE AS IT IS DUMPED INTO A COOLER TANK.
83-34	12/12/1983	SMEARABLE CONTAMINATION IN 200-EAST ARE CLEAN OUT BOXES (COBs).	ASSUME DETERIORATION OF PLUG SEALS ON THE CENTER RISER OF THE COBs.
84-02	01/08/1984	50-70' BREACH IN B-POND DIKE BETWEEN EAST AND WEST EXPANSION PONDS.	APPARENT CAUSE OF DIKE BREACH IS EROSION UNDER THE FABRIFORM LINER OF THE SPILLWAY.
84-06	10/27/1983	RELEASE OF RADIOACTIVE EFFLUENT TO THE 216-A-8 CRIB IN EXCESS OF CONCENTRATION GUIDELINES.	APPARENT SOURCE OF CONTAMINATION WAS A DEACTIVATED 16" WASTE COOLING WATER LINE THAT ENTERS THE A-08 SAMPLE PIT.
84-17	04/13/1984	FAILURE OF THERMOCOUPLES NEAR AIR LIFT CIRCULATORS IN AGING WASTE TANK 101-AZ.	MECHANICAL FAILURE OF UNKNOWN TYPE.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
84-19	03/21/1984	FIRE IN FUEL DELIVERY TRUCK IN 200-WEST AREA.	PINHOLE LEAK IN POWER STEERING LINE CAUSED FLUID TO SPRAY ONTO THE MANIFOLD OF THE TRUCK. FLUID FLASHPOINT IS 375 °F, MANIFOLD TEMPERATURE WAS 800-900 °F.
84-21	03/28/1984	2800 GALLONS OF PUREX WASTE ROUTED TO TANK 102-AZ INSTEAD OF TANK 101-AZ.	PERSONNEL ERROR. DIVERTER VALVE IN 152-AX DIVERTER STATION NOT RETURNED TO NORMAL POSITION AFTER TRANSFER TO NEARBY WASTE TANK.
84-27	04/30/1984	SAMPLE OF GABLE MOUNTAIN POND FOUND HIGH LEVELS OF STRONTIUM 90 EXCEEDING LIMITS.	HIGH STRONTIUM LEVELS DUE TO ACCIDENTAL RELEASE IN 1964.
84-34	05/31/1984	LIQUID LEVEL IN TANK 203-C DECREASED 2 INCHES.	CAUSE OF TANK LEVEL DECREASE NOT REPORTED.
84-71	11/19/1984	TRANSFER LINE BETWEEN B-PLANT AND 244-A LIFT STATION (SN-233) LEAKED TO ENCASEMENT.	MECHANICAL FAILURE OF TRANSFER LINE.
84-81	12/18/1984	BACKUP EXHAUSTER FOR 241-AY AND AZ FARMS FAILED AFTER STARTING. AGING WASTE FARM TANKS WERE WITHOUT VENTILATION FOR 20 MINUTES.	MECHANICAL FAILURE. EXHAUSTER CIRCUIT BREAKER TRIPPED AT FAN START.
85-34	04/12/1985	UNNEUTRALIZED TANK F-18 (PUREX) TRANSFER RESULTED IN PIPE DAMAGE IN LINE BETWEEN 241-AW-A VALVE PIT AND 241-101-AW DISTRIBUTOR.	PERSONNEL ERROR.FAILURE TO NEUTRALIZE BATCH PRIOR TO TRANSFER.
85-48	05/23/1985	TRANSFER BETWEEN PUREX AND 101-AZ TANK RESULTED IN EXPOSURE TO PERSONNEL IN EXCAVATION NEAR 241-AY FARM.	PERSONNEL ERROR. FAILURE TO COMMUNICATE A DELAY IN TRANSFER TIME TO PERSONNEL IN EXCAVATION.
85-55	06/26/1985	FLASH FIRE IN 153-AX DIVERSION BOX.	FIRE CAUSED BY ACTUATING AN ELECTRIC TOOL IN DIVERSION BOX AFTER USING A CONTAMINATION SEALANT IN THE DIVERSION BOX FOLLOWED BY A METHYL ALCOHOL FLUSH.
85-98	12/18/1985	FAILURE TO REPLACE BREATHER FILTERS WHEN REQUIRED BY SAR FOR WASTE TANKS 102-BX, 103-C, AND 108-C.	PERSONNEL ERRORS. FILTERS NOT REPLACED IN TIME DUE TO MANPOWER PROBLEMS.
86-45	08/06/1986	FOUR OPERATIONAL SAFETY REQUIREMENTS NOT COMPLETED AS REQUIRED. PREVENTATIVE MAINTENANCE ACTIVITIES WERE NOT CARRIED OUT AS REQUIRED.	ADMINISTRATIVE. TANK FARM PROD CONTROL DID NOT SCHEDULE THE PMs. COVERED 241-A-702 AIR MONITOR, 241-AR-151 LEAK DETECTOR, AY & AZ LEAK DETECTOR, AREA EFFLUENT IN-LINE RADIATION MONITOR
RHO-UOR-87-04	03/13/1987	ALL OPERATIONAL SAFETY REQUIREMENTS REVIEWED, FOUND THAT FOR 9 OF THEM, POSITIVE COMPLIANCE COULD NOT BE VERIFIED.	ADMINISTRATIVE. SAFETY ANALYSIS REPORTS HAD TO BE CHANGED TO REFLECT THE REAL SITUATION.
87-05	03/30/1987	I-129 EMISSIONS FROM 241-AW FARM PRIMARY EXHAUSTER EXCEEDED OPERATIONS ADMINISTRATIVE CONTROL VALUE	OPERATIONAL. PUREX FLUSHED A SILVER REACTOR TO THE AW FARM IN JUNE, 1986. I-129 LEVELS WENT UP TO 4 TIMES THE LIMIT. LEVELS STARTED DECREASING IN JULY, BACK TO NORMAL IN DECEMBER.
WHC-UO-87-010-PUREX-01	08/30/1987	PUREX CLADDING REMOVAL IN PROGRESS, DISCHARGE MADE TO 216-A-36B CRIB. PUREX STACKS, CRIB, AND AW TANK FARM EXHAUST EXCEEDED LIMITS OF (AMMONIUM HYDROXIDE) NH4OH AND AMMONIA (NH3).	PROCEDURE/PERSONNEL ERROR. AMMONIA CONTAINING DISCHARGE SHOULD HAVE BEEN TO A WASTE TANK INSTEAD OF CRIB. INSUFFICIENT ATTENTION TO ENVIRONMENTAL DISCHARGE LIMITS.
WHC-UO-88-028-TF-03	07/13/1988	241-SX-104 EXCEEDED THE LEVEL DECREASE CRITERIA OF 0.3 FOOT DECREASE.	MECHANICAL. TANK ASSUMED TO LEAK. INITIATED STABILIZATION AND ISOLATION ACTIVITIES.

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WHC-UO-88-029-TF-04	07/26/1988	241-AX-102 EXCEEDED THE 1.00 INCH DECREASE CRITERIA.	MECHANICAL. TANK ASSUMED TO LEAK. PUMPED TANK OUT IN AUGUST, 1988.
WHC-UO-88-034-TF-05	10/11/1988	241-C-103 SHOWS DECREASING LEVEL TREND OF 0.5" SINCE DECEMBER, 1984. NO LIMITS EXCEEDED.	MECHANICAL. NO LIMITS EXCEEDED. TANK WILL BE STABILIZED ON SCHEDULE.
WHC-UO-89-03-TF-01	01/09/1989	OPERATING AGING WASTE FACILITY USING DOE UNAPPROVED SAFETY ANALYSIS REPORT (2 YEARS). REPORT WAS APPROVED BY CONTRACTOR AND "OFFICIALLY RELEASED". DOE HAD NOT APPROVED THE SAR REVISION.	ADMINISTRATIVE. SAR APPROVAL PROCESS BREAKDOWN.
WHC-UO-89-04-TF-02	01/06/1989	SURVEILLANCE NON-CONFORMANCE, FAILURE TO TAKE TEMPERATURE READINGS EVERY 45 DAYS ON HIGH-HEAT TANKS (101, 102, 103, 104, 105, AND 106-SX)	ADMINISTRATIVE/PERSONNEL ERROR. NO ADMINISTRATIVE PROCEDURE TO ENSURE ALL OSRs AND STATUS OF MONITORING. DATA TAKING REQUIREMENTS NOT FOLLOWED.
WHC-UO-89-009-TF-03	01/31/1989	LEVEL DECREASE IN 241-A-102. EXCEEDED THE 1.00 INCH LEVEL DECREASE CRITERIA.	MECHANICAL. TANK ASSUMED LEAKER. EXPEDITED PUMPING OF TANK.
WHC-UO-89-014-TF-04	03/07/1989	SURFACE LEVEL MEASUREMENT DECREASE IN 241-A-302-B CATCH TANK. LEVEL READINGS HAVE SHOWN WIDE FLUCTUATIONS.	MECHANICAL. MEASURING DEVICE SHORTING OUT. TANK INTERIM STABILIZED.
WHC-UO-89-023-TF-05	05/18/1989	LEVEL DECREASE IN 241-AX-102. LEVEL CONTINUED TO DECREASE AFTER TANK PUMP DOWN. EXCEEDED 1.00" LEVEL DECREASE CRITERIA.	LEVEL DECREASE ATTRIBUTED TO TANK CONTENTS SETTLING.
WHC-UO-89-030-SAHP-01	05/24/1989	RAILROAD WASTE TANK CAR SHIPPED FROM 340 FACILITY IN 300-AREA TO 204-AR FACILITY WITH SMEARABLE CONTAMINATION IN EXCESS OF LIMITS.	PERSONNEL ERROR. FAILURE TO COMMUNICATE THE REQUIREMENTS OF DEPT. OF TRANSPORTATION IN SAFETY ANALYSIS REPORT FOR PACKAGING (SARP) AND THE HEALTH PHYSICS PROCEDURE.
WHC-UO-89-043-TF-06	09/05/1989	TANK FARM AMMONIA RELEASES EXCEEDING CERCLA LIMITS.	TRAINING. THE REQUIREMENTS CHANGED FOR AMMONIA RELEASES, PLANT OPERATING AND ENGINEERING STAFF WERE NOT AWARE OF THE SIGNIFICANCE OF THESE CHANGES, PROCEDURES TO BE CHANGED.
WHC-UO-89-044-TF-07	08/16/1989	241-C TANK FARM VAPOR RELEASE INHALED BY EMPLOYEE.	OPERATION OF TANK FARM. SUSPECT AMMONIA SMELL FROM TANK 241-C-102 THROUGH BREATHER FILTER. INSTALLED ACTIVATED CARBON SYSTEM TO FILTERS.
WHC-UO-89-059-TF-08	11/28/1989	AUTOMATIC TRANSFER OF ELECTRIC POWER FAILED TO TRANSFER TO DIESEL GENERATED POWER ON LOSS OF NORMAL POWER TO 242-A EVAPORATOR.	MECHANICAL. MALFUNCTION OF AUTOMATIC EMERGENCY TRANSFER SWITCH.
WHC-UO-89-062-SSS-01	12/22/1989	ERROR FOUND IN COMPUTER CODE GENII USED TO CALCULATE ENVIRONMENTAL IMPACTS OF EMISSIONS ON HANFORD SITE.	PERSONNEL, PROCEDURE ERROR. WIND DIRECTIONS USED IN MODELLING ARE OFF BY 180 DEGREES.
WHC-UO-89-065-TF-09	12/25/1989	PORTABLE POWER TRANSFORMER FAILED WHILE NORMAL POWER OUT OF SERVICE FOR SCHEDULED MAINTENANCE, 200-EAST TANK FARMS.	MECHANICAL. PORTABLE TRANSFORMER FAILED DUE TO A BURNT CABLE.
RL-WHC-TANKFARM-1990-0014	09/04/1990	RELEASE OF RADIONUCLIDE MATERIAL FROM TANK 105-A PORTABLE EXHAUSTER SEAL POT AND ONTO SOIL. APPROX 3 SQUARE FEET OF THE SOIL SURFACE WAS CONTAMINATED.	ADMINISTRATIVE/MECHANICAL. FAULTY SEAL POT DISCOVERED APRIL, 1990, FAULTY SEAL POT NOT REPLACED, FAILED IN SEPTEMBER, 1990

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
RL-WHC-TANKFARM-1990-0056	09/16/1990	RELEASE OF RADIONUCLIDE MATERIAL FROM TANK 105-A PORTABLE EXHAUSTER FILTER HOUSING ONTO SOIL. TWO SPOTS WERE CONTAMINATED, 8000 D/M IN 1 FT IN DIAMETER AREA, 600 D/M IN AN 8 INCH IN DIAMETER AREA	ADMINISTRATIVE. LOCK AND TAG PROCEDURE FOR MAINTENANCE DID NOT LOCK OUT THE DRAIN VALVES DURING MAINTENANCE.
RL-WHC-TANKFARM-1990-0082	09/26/1990	OSR NON-CONFORMANCE ON ADMINISTRATIVE CONTROLS FOR UNDERGROUND STORAGE TANK 241-U-103. MAINTENANCE FAILED TO USE SPARK RESISTANT TOOLS DURING BREATHER FILTER MAINTENANCE.	ADMINISTRATIVE. WORK PACKAGE NOT PROPERLY PREPARED, NO PERSON-IN-CHARGE.
RL-WHC-TANKFARM-1990-0087	09/27/1990	UNCONTROLLED ACCESS TO HIGH RADIATION AREAS, IMPROPER ACCESS TO S/SX/SY FARMS DUE TO NO CONTROL BEING PROVIDED	PERSONNEL ERROR. NOT TRAINED PROPERLY IN ACCESS CONTROL REQUIREMENTS.
RL-WHC-TANKFARM-1990-0117	10/05/1990	LOSS OF 105-A PORTABLE EXHAUSTER EFFLUENT MONITORING CAPABILITIES. FAILURE OF CAM AND RECORD SAMPLER, WHILE EXHAUSTER WAS OPERATING.	MECHANICAL. KNIFE SWITCH NOT FULLY ENGAGED.
RL-WHC-TANKFARM-1990-0145	10/14/1990	LOSS OF POWER TO A SECTION OF HANFORD 230 KV LINE. LINE FAULT CAUSED POWER LOSS AT 100-B, 100-KE, 100-KW, AND 100-N.	MECHANICAL. CONTAMINATED INSULATOR CAUSED POWER POLE FIRE.
RL-WHC-TANKFARM-1990-0186	10/30/1990	241-A-105 UNEXPLAINED TEMPERATURE INCREASE DURING EXHAUSTER OPERATION AND FAILURE TO NOTIFY DOE IN A TIMELY MANNER. SOIL TEMPERATURE UNDER THE WASTE TANK READ 297oF, LIMIT IS 300oF. NO SPECIFICATIONS OR REQUIREMENTS WERE VIOLATED.	MECHANICAL/PERSONNEL ERROR. UNDERGROUND THERMOCOUPLE WIRE HAD DETERIORATED. OPERATIONS FAILED TO REPORT INCREASING TEMPERATURE AS REQUIRED.
RL-WHC-TANKFARM-1990-0319	12/12/1990	INADVERTENT SHUTDOWN OF 241-SY PRIMARY EXHAUSTER, OPERATOR OPENED INCORRECT CIRCUIT BREAKER.	PERSONNEL ERROR. BREAKERS WAS NOT LABELED, OPERATOR DID NOT VERIFY CORRECT CIRCUIT BREAKER.
RL-WHC-TANKFARM-1990-0386	12/26/1990	STEAM COIL LEAK AT 242-S EVAPORATOR RESULTS IN ACTIVATION OF FIRE SPRINKLER SYSTEM. SPRINKLER WAS LOCATED IN THE HVAC FILTER SYSTEM PLENUM.	MECHANICAL/ADMINISTRATIVE. FAILED STEAM COIL, ROOT CAUSE WAS FAILURE TO REPLACE COILS WHEN NOTIFIED OF REPLACEMENT NEED IN JUNE, 1989.
RL-WHC-TANKFARM-1991-0003	01/03/1991	DISABLING OF AUDIBLE ALARM ANNUNCIATOR, ALARM PANEL "A", 242-S EVAPORATOR. ALARM PANEL "ACKNOWLEDGE" BUTTON WAS HELD IN WITH WEDGED PAPER CLIP, PREVENTING SIX ALARMS FROM SOUNDING.	ADMINISTRATIVE. PROCEDURE VIOLATION.
RL-WHC-TANKFARM-1991-0011	01/06/1991	FREEZING OF 241-A-401 COOLING TOWER SPRAY LINE RESULTS IN UTILIZATION OF BACKUP SYSTEM.	PERSONNEL ERROR/WEATHER CONDITIONS. TWO VALVES HAD BEEN LEFT CLOSED PREVENTING THE COOLING TOWER PIPING FROM DRAINING. THE WATER FROZE AND RENDERED THE PIPING INOPERABLE.
RL-WHC-TANKFARM-1991-0061	01/18/1991	242-T ALPHA CONTINUOUS AIR MONITOR DISABLED, OSR VIOLATION. VACUUM PUMP WAS INTENTIONALLY UNPLUGGED BY A HEALTH PHYSICS TECHNICIAN.	PROCEDURE VIOLATION. EMPLOYEE INDICATED THE NOISE FROM THE PUMP RESULTED IN A HEADACHE.
RL-WHC-TANKFARM-1991-0079	01/25/1991	LOSS OF ACCOUNTABILITY OF RADIOACTIVE SOURCES.	ADMINISTRATIVE. SOURCE LOCATIONS NOT UPDATED, MULTIPLE SERIAL NUMBERS ON SOURCES, LACK OF TRAINING, REQUIREMENTS AND MANAGEMENT EXPECTATIONS NOT EASILY DERIVED.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
WHC-91-0096-TFARM	01/16/1991	ADDITION OF TWO TANKS, 241-T-107 AND 241-TY-104, TO THE LIST OF UNREVIEWED SAFETY QUESTION TANKS CONTAINING FERROCYANIDE.	FURTHER REVIEW OF HISTORICAL RECORDS INDICATED THESE TANKS SHOULD BE ADDED TO THE LIST OF 22 FERROCYANIDE TANKS.
RL-WHC-TANKFARM-1991-0099	01/31/1991	LOSS OF 244-CR RECORD SAMPLER, DUE TO LOW FLOW CAUSED BY A HIGH DIFFERENTIAL PRESSURE ACROSS THE PRE-FILTERS.	ADMINISTRATIVE. DATA SHEET SPECIFICATIONS DID NOT AGREE WITH OSD REQUIREMENTS. SYSTEM REACTED AS DESIGNED.
RL-WHC-TANKFARM-1991-0103	02/01/1991	DAMAGED HEAT TRACE LINE CAUSES ELECTRICAL SHOCK.	MECHANICAL. DAMAGED HEAT TRACE LINE ALLOWED DRAIN PIPE TO BE ENERGIZED. WORKED CONTACTED PIPE AND RECEIVED ELECTRICAL SHOCK.
RL-WHC-TANKFARM-1991-0192	03/06/1991	242-S PUMP ROOM FLOODED (7 FT) BY DAMAGED FIRE SYSTEM PIPING, CAUSED BY FREEZING CONDITIONS.	WEATHER CONDITIONS/PROCEDURE ERROR. FIRE SYSTEM OUT OF SERVICE FOR REPAIR, PROCEDURE DID NOT INCLUDE PUMP ROOM OR EVAPORATOR ROOM.
RL-WHC-TANKFARM-1991-0200	03/21/1991	POTENTIAL DISTURBANCE OF 241-SY-101 TANK CRUST. WHILE RAISING A RISER COVER TO INSTALL VAPOR SPACE PROBES, AN UNEXPECTED CABLE WAS DISCOVERED, ATTACHED TO THE RISER COVER. ASSUMED THE WORK DISTURBED THE CRUST.	ADMINISTRATIVE. CONFIGURATION CONTROL PROBLEM, SLUDGE WEIGHT CABLE LOCATION WAS UNKNOWN PRIOR TO WORK.
RL-WHC-TANKFARM-1991-1001	04/01/1991	LOSS OF TANK PRESS. INDICATION IN 241-SY TANK FARM, OPERATIONAL SAFETY REQUIREMENT VIOLATION. RELAY FAILURE CAUSED LOSS OF BOTH AIR COMPRESSORS, AIR MONITORING AND ALARM CAPABILITIES.	MECHANICAL/ADMINISTRATIVE. RELAY FAILURE. AIR DRYER IN 242-S OUT OF SERVICE FOR TWO YEARS, LOSS OF AIR COMPRESSORS ALLOWED MOISTURE IN LINES CAUSING FLUCTUATING READINGS AND WATER IN ROTAMETERS.
RL-WHC-TANKFARM-1991-1002	04/04/1991	MISSED PROGRAMMATIC MILESTONE FOR 242-A EVAPORATOR RE-START.	ADMINISTRATIVE. ADDITIONAL WORK TAKEN ON WITHOUT CHANGING THE MILESTONE DATE. FAILURE TO USE A FORMALIZED CHANGE CONTROL SYSTEM.
RL-WHC-TANKFARM-1991-1008	04/18/1991	DIESEL FUEL SPILL FROM THE EMERGENCY GENERATOR AT 241-SY TANK FARM.	PERSONNEL ERROR. THE FUEL TANK WAS OVERFILLED, WHEN HEATED UP DO TO WARM WEATHER, THE FUEL EXPANDED AND OVERFLOWED.
RL-WHC-TANKFARM-1991-1012	05/05/1991	244-AR VAULT PORTABLE COMPRESSOR FUEL LEAK DUE TO FUEL FILTER SEAL RUPTURE.	ADMINISTRATIVE. MAINTENANCE NOTED THAT THE SEAL NEEDED TO BE CHANGED BUT TWO COMPRESSORS HAD BEEN OUT OF SERVICE FOR A YEAR, IT COULD NOT BE SHUT DOWN.
RL-WHC-TANKFARM-1991-1021	06/21/1991	TANK 241-C-104 CORE SAMPLE EXCEEDED CRITICALITY SPECIFICATIONS. THIS INFRACTION WAS DECLARED FIVE YEARS AFTER THE SAMPLE WAS TAKEN, AN ERROR IN THE LABORATORY DATA TRANSMITTAL WAS DISCOVERED. NO INFRACTION ACTUALLY OCCURRED.	ADMINISTRATIVE. LACK OF ADMINISTRATIVE CONTROL IN REVIEWING DATA.
RL-WHC-TANKFARM-1991-1030	07/24/1991	POTENTIAL LOCK AND TAG PROCEDURE VIOLATION AT 216-A 29-A DIVERSION BOX. CHAIN WHICH HAD LOCKED VALVE 216-A-29-A-1, APPEARED TO HAVE BEEN CUT AND THE VALVE PARTIALLY OPENED.	MALICIOUS OR CRIMINAL INTENT.
RL-WHC-TANKFARM-1991-1050	10/02/1991	UNPLANNED LIQUID LEVEL INCREASE IN TANK 241-AW-102. LEVEL INCREASED ONE INCH OVER ONE SHIFT. EYEWASH UNIT WAS LEFT ON, OR LEAKED, AND DRAINED INTO TANK.	MANAGEMENT PROBLEM, IMPROPER RESOURCE ALLOCATION.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
RL-WHC-TANKFARM-1991-1053	10/18/1991	241-TX LOCK AND TAG VIOLATION, A BREAKER WAS IN THE ON POSITION WITH A TAG INDICATING IT WAS LOCKED IN THE OFF POSITION.	ADMINISTRATIVE/PERSONNEL ERROR. PROCEDURE DID NOT INDICATE THE BREAKER COULD BE CHANGED, CUSTODIAN DID NOT TELL TAG INSTALLER TO CHANGE POSITION.
RL-WHC-TANKFARM-1991-1056	10/25/1991	SUSPECT SINGLE SHELL TANK pH LEVELS. INFORMATION WAS PRESENTED AT A DNFSB MEETING WHICH INDICATED pH LEVELS OF SIX TO EIGHT IN THE 1940s AND 1950s.	MANAGEMENT DECISION. IN CONSIDERATION OF TANK SPACE PRESERVATION.
RL-WHC-TANKFARM-1991-1058	11/07/1991	LOSS OF 241-AN VENTILATION SYSTEM. THE PRIMARY EXHAUSTER TRIPPED ON LOW DIFFERENTIAL PRESSURE DURING A PRE-FILTER INSPECTION, THE BACKUP SYSTEM WAS TAGGED OUT FOR MAINTENANCE. NO VENTILATION SYSTEM FOR 12 MINUTES.	PLANNING DEFICIENCY. POTENTIAL FOR SYSTEM SHUTDOWN DURING PRE-FILTER INSPECTION, NO BACKUP SYSTEM AVAILABLE.
RL-WHC-TANKFARM-1991-1063	11/16/1991	LOSS OF POWER TO 200 WEST TANK FARMS. LOST VENTILATION TO 241-SY FARM AND 242-T EVAPORATOR. POWER OFF FOR ONE MINUTE.	SUSPECT THAT A SMALL ANIMAL CAUSED THE OUTAGE.
RL-WHC-TANKFARM-1991-1064	11/22/1991	LOSS OF 241-AY/AZ TANK FARM BACKUP VENTILATION SYSTEM CLASS A EQUIPMENT DURING TROUBLESHOOTING.	MECHANICAL/PERSONNEL ERROR. MOTOR RESET CIRCUIT FAULT TRIGGERED AN ELECTRICAL CHAIN REACTION. RESET BUTTON SHOULD NOT HAVE BEEN PRESSED.
RL-WHC-TANKFARM-1991-1073	05/24/1991	MISSED PROGRAMMATIC MILESTONE FOR 242-A EVAPORATOR RE-START.	WORK STOPPAGE DUE TO FUNDING LIMITATIONS. LACK OF ABILITY TO HOLD THE CONSTRUCTION CONTRACTOR ACCOUNTABLE.
RL-WHC-TANKFARM-1991-1076	12/16/1991	LOCK AND TAG VIOLATION AT 241-C TANK FARM, WORK WAS DONE ON A HEAT TRACE LINE WITH NO LOCK AND TAG IN PLACE.	ADMINISTRATIVE. LOCK AND TAG CLEARED WITHOUT TESTING, PAPERWORK NOT COMPLETED.
RL-WHC-TANKFARM-1991-1079	12/23/1991	MISSED TRI-PARTY AGREEMENT MILESTONE M-05-03 FOR INTERIM STABILIZATION. COULD NOT PUMP THE TANKS AS ASSIGNED.	ADMINISTRATIVE. FAILURE TO GET OFFICIAL DETERMINATION OF IMPACTS OF INTERIM STABILIZATION ACTIVITIES.
RL-WHC-TANKFARM-1992-0007	01/22/1992	TANK FARM INTERNAL ASSESSMENTS UNCOVERED DEFICIENCIES IN SOLID WASTE COMPLIANCE ISSUES DUE TO LACK OF PROGRAMMATIC DIRECTION.	INSUFFICIENT STAFFING, TRAINING, INADEQUATE IMPLEMENTATION OF INTERNAL ENVIRONMENTAL COMPLIANCE OVERSIGHT PROGRAMS.
RL-WHC-TANKFARM-1992-0011	01/28/1992	PERSONNEL EXPOSURE TO UNKNOWN VAPORS AT B-COMPLEX RESULT IN SYMPTOMS REQUIRING MEDICAL EVALUATION.	BATTERY BOILED OVER INSIDE RADIOLOGICAL CONTROLLED AREA.
RL-WHC-TANKFARM-1992-0012	01/31/1992	OPERATIONAL SAFETY REQUIREMENT NONCONFORMANCE. DAILY READINGS COULD NOT BE OBTAINED DUE TO TANK FARM ENTRY LIMITATIONS AFTER BATTERY BOILOVER.	ADMINISTRATIVE. APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT NOT AVAILABLE TO MAKE TANK FARM ENTRIES FOR SURVEILLANCE.
RL-WHC-TANKFARM-1992-0019	02/29/1992	LOSS OF PRIMARY VENTILATION IN AP-FARM. THE PRIMARY FAN TRIPPED DUE TO DIFFERENTIAL PRESSURE PROBLEMS, AND THE BACKUP FAN ATTEMPTER, BUT FAILED, TO START.	MECHANICAL.
RL-WHC-TANKFARM-1992-0022	02/28/1992	LOSS OF CONFIGURATION CONTROL IN THE 241-SY PRIMARY LEAK DETECTION SYSTEM DUE TO AN INACCURATE PROCEDURE. CONDUCTIVITY PROBE SETTINGS INCORRECT FOR 101-SY AND 103-SY.	ADMINISTRATIVE. PROCEDURES HAD NOT BEEN UPDATED TO REFLECT MODIFICATIONS IN LEAK DETECTION CONFIGURATION.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
RL-WHC-TANKFARM-1992-0028	03/16/1992	200 EAST/200 WEST POWER OUTAGE. TWO BACKUP POWER SYSTEMS FAILED TO START DURING OUTAGE.	MECHANICAL. 204-AR DIESEL GENERATOR AND 241-SY TANK FARM DIESEL GENERATOR FAILED TO START WHEN REQUIRED.
RL-WHC-TANKFARM-1992-0033	04/23/1992	OSR SURVEILLANCE REQUIREMENT NOT MET, EQUIPMENT OUT OF CALIBRATION DUE TO LACK OF ADMINISTRATIVE CONTROL.	ADMINISTRATIVE. CALIBRATION CARDS FOR LOW FLOW ALARMS AT AY AND AZ TANKS WERE INACTIVATED IN 1989. CHANGES TO PISCES SYSTEM NOW REQUIRES OUTSIDE REVIEW.
RL-WHC-TANKFARM-1992-0037	04/30/1992	UNREVIEWED SAFETY QUESTION REGARDING CRITICALITY SAFETY OF TANK FARMS. SARs STATE A CRITICALITY IN WASTE TANKS IS INCREDIBLE. WE CAN NOT PROVE THIS.	ADMINISTRATIVE. INADEQUATE CHARACTERIZATION, AND LACK OF DATA ON MATERIAL DISTRIBUTION IN THE TANKS.
RL-WHC-TANKFARM-1992-0038	05/02/1992	241-A-702 STACK CONTINUOUS AIR MONITOR FAILURE.	MECHANICAL.
RL-WHC-TANKFARM-1992-0051	06/28/1992	ELECTRICAL STORM DISRUPTS 200 WEST POWER.	WEATHER CONDITIONS.
RL-WHC-TANKFARM-1992-0055	07/20/1992	15 MINUTE LOSS OF VENTILATION IN 241-AP TANK FARM DUE TO PLUGGED SENSING LINE LEADING TO DIFFERENTIAL PRESSURE INDICATING SWITCH. BACKUP FAN ATTEMPTED TO START BUT TRIPPED DUE TO VALVE FAILING TO OPEN.	MECHANICAL. SENSING LINE PLUG AND INLET VALVE FAILURE.
RL-WHC-TANKFARM-1992-0066	09/15/1992	BOMB THREAT RESULTS IN 241-SY EVACUATION.	MALICIOUS INTENT OR PART OF A TRAINING EXERCISE. UNKNOWN.
RL-WHC-TANKFARM-1992-0069	09/21/1992	FLOATING LIQUID ORGANIC LAYER IN 241-C-103 DETERMINED TO BE AN UNREVIEWED SAFETY QUESTION.	ADMINISTRATIVE. FLOATING ORGANIC LAYER IS NOT ADDRESSED IN THE SAFETY ANALYSIS REPORT.
RL-WHC-TANKFARM-1992-0073	09/18/1992	DECREASE IN LIQUID LEVEL IN TANK 241-T-101. ASSUMED LEAKER.	DEFECTIVE OR FAILED MATERIAL.
RL-WHC-TANKFARM-1992-0074	10/01/1992	LEAKAGE FROM CONTAINMENT CASK CONTAINING AN AIR LANCE TAKEN FROM TANK 241-SY-101. SOIL CONTAMINATED.	DEFECTIVE OR INADEQUATE DESIGN. NEEDED A GASKET IN THE LOCKING ASSEMBLY.
RL-WHC-TANKFARM-1992-0082	11/04/1992	LOSS OF LEAK DETECTION CAPABILITIES FOR TANK 241-SY-102. ANNULUS FLAKE BOX LEAK DETECTOR PROBE FAILED. ANNULUS CAM WAS NOT FUNCTIONAL DUE TO PREVIOUS FAILURE. RESULTING LCO NONCONFORMANCE.	MECHANICAL. LEAK DETECTOR FAILURE, CAM OUT OF SERVICE DUE TO VACUUM PUMP FAILURE.
RL-WHC-TANKFARM-1993-0005	01/12/1993	MISSED SURVEILLANCE ON TK-105-C AND TK-106-C RESULT IN OSR NONCONFORMANCE.	WEATHER CONDITION. SNOW DRIFTS WAIST HIGH AND HIGH WINDS CAUSED READINGS TO BE 12 HOURS BEYOND THE LIMIT.
RL-WHC-TANKFARM-1993-0009	01/18/1993	LOSS OF PRIMARY TANK VENTILATION IN 241-AN TANK FARM. VENTILATION FAN SHUT OFF FOR UNKNOWN REASON. BACKUP FAN FAILED TO START DUE TO INCORRECT SWITCH POSITION SETTING THE FAN IN STANDBY.	MECHANICAL/PERSONNEL ERROR. SUSPECT INSTRUMENT NOISE CAUSED PRIMARY FAN FAILURE, SWITCH MISPOSITION CAUSED BACKUP FAN FAILURE TO START.

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OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
RL-WHC-TANKFARM-1993-0011	01/21/1993	TEMPORARY LOSS OF 241-AY/AZ PRIMARY TANK VENTILATION DUE TO PERSONNEL ERROR. THE TWO BACKUP FANS WERE OUT FOR MAINTENANCE.	PERSONNEL ERROR. INATTENTION TO DETAIL, ELECTRICIAN BUMPED MAGNETIC MOTOR STARTER FOR ISOLATED FAN, TRIPPING THE OPERATING FAN.
RL-WHC-TANKFARM-1993-0012	01/22/1993	AMMONIA-LIKE ODOR AFTER REMOVING 1" DRAIN PLUG FROM AIR LANCE RECEIVER.	WEATHER CONDITIONS. TEMPERATURE WARMING CONTRIBUTED TO PRESSURIZATION OF AIR IN AIR LANCE PACKAGE, WHEN PLUG WAS REMOVED, PRESSURE WAS RELIEVED.
RL-WHC-TANKFARM-1993-0023	02/11/1993	ALPHA CAM VACUUM PUMP FAILED ON EXHAUST STACK MONITOR AT 242-T EVAPORATOR. PUMP WAS UNPLUGGED FOR ROUTINE TESTING OF FLOW ALARM, PUMP FAILED TO RE-START WHEN PLUGGED BACK IN.	MECHANICAL. DEFECTIVE OR FAILED COMPONENT.
RL-WHC-TANKFARM-1993-0027	03/05/1993	TANK 101-AN LIQUID INDICATING TRANSMITTER FAILURE, SURVEILLANCE MISSED. OSR VIOLATION.	MECHANICAL/TRAINING. COMPONENT FAILURE. DELAY IN SURVEILLANCE DUE TO MAINTENANCE STAFF UNFAMILIAR WITH JOB.
RL-WHC-TANKFARM-1993-0028	03/05/1993	WASTE TRANSFER STOPPED DUE TO FAULTY AIR VALVE, LEAK BY ON BALL VALVE ALLOWED 700 GALLON TRANSFER TO 102-SY.	MECHANICAL. AIR VALVE FAILURE, BALL VALVE LEAK BY, LEAK DETECTORS FAILED TO ALARM.
RL-WHC-TANKFARM-1993-0035	03/23/1993	SINGLE SHELL TANK 241-BX-111 ASSUMED LEAKER. LEVEL DECREASE IN TANK CHANGED FROM 0.5 INCH DECREASE OVER 7 YEARS, TO ONE INCH DECREASE IN THREE MONTHS.	MECHANICAL/ADMINISTRATIVE. ASSUMED CORROSION CAUSED LEAK. TANK SERVICE LONG PAST DESIGN LIFE.
RL-WHC-TANKFARM-1993-0043	03/05/1993	NON-CONFORMANCE TO STATE REQUIREMENTS CONCERNING STORING HAZARDOUS WASTE CONTAINERS.	ADMINISTRATIVE/FAILURE TO FOLLOW PROCEDURE. RESULTED IN A BACKLOG OF WASTE CONTAINERS ACCUMULATED.
RL-WHC-TANKFARM-1993-0044	05/06/1993	LIQUID OBSERVATION WELL IN TANK 241-SX-102 INDICATES LIQUID LEVEL DECREASE OF 0.4 FEET. ASSUMED LEAKER.	DEFECTIVE OR FAILED MATERIAL.
RL-WHC-TANKFARM-1993-0045	05/08/1993	WASTE CONTAINERS FOUND WITHOUT CORRECT PAPERWORK. INVENTORY OF TANK FARMS FOUND 26 OUT OF COMPLIANCE WASTE CONTAINERS (NO ACCUMULATION DATES, NO INVENTORIES, OR IMPROPER STORAGE)	ADMINISTRATIVE. LACK OF EFFECTIVE PROCEDURE TO CONTROL WASTE CONTAINERS ACCORDING TO POLICIES AND REGULATIONS.
RL-WHC-TANKFARM-1993-0057	06/22/1993	CRANE ACTIVITIES IN 241-SY TANK FARM, WIRE ROPE SEVERED, BLOCK FALLING TO GROUND.	PERSONNEL ERROR/LACK OF PROPER EQUIPMENT. INATTENTION BY CRANE OPERATOR, LACK OF ANTI TWO-BLOCKING ALARM ON CRANE MAIN HOIST.
RL-WHC-TANKFARM-1993-0063	07/15/1993	PACKAGING DISCREPANCIES OF SOLID WASTE CONTAINERS AT 241-SX FARM. LOW LEVEL WASTE BOXES CONTAINED DANGEROUS WASTE.	PROCEDURE VIOLATION.
RL-WHC-TANKFARM-1993-0069	08/04/1993	INADVERTENT START OF 241-SY-101 HYDROGEN MITIGATION PUMP.	LACK OF TRAINING, INFORMATION TAG INFORMATION INCOMPLETE.
RL-WHC-TANKFARM-1993-0072	08/11/1993	LOSS OF POWER TO AP, AW, AND AN TANK FARMS RESULTING IN LOSS OF PRIMARY EXHAUST FANS IN AP, AW, AN, AND C TANK FARMS.	POWER LOSS DUE TO LARGE BIRD LANDING ON POWER POLE AT GABLE MOUNTAIN.

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RL-WHC-TANKFARM-1993-0090	10/08/1993	CALCULATION ERROR FOR AMMONIA RELEASE MECHANISM AT 241-SY-101, GENERATES USQ.	PERSONNEL ERROR IN COMPUTER INPUT FOR TANK BURN ACCIDENT CALCULATION.
RL-WHC-TANKFARM-1993-0105	12/02/1993	METHANE GAS IN SY-101 DISCOVERED TO ADD 10% MORE ENERGY TO THE BURN ANALYSIS RESULTS. NEW DATA ANALYSIS METHOD DISCOVERED DISCREPANCY.	LESS THAN EFFECTIVE MANAGEMENT METHODS. LACK OF FORMAL REPORTING METHODS BETWEEN LOS ALAMOS NATIONAL LAB AND WHC.
RL-WHC-TANKFARM-1993-0107	12/04/1993	241-SY TANK FARM ENTRANCE DURING MIXER PUMP OPERATION.	PROCEDURE VIOLATION. OPERATORS REMOVED EXCLUSION AREA BARRIERS AND ENTERED AREA WITHOUT VERIFYING PUMP TEST COMPLETION.
RL-WHC-TANKFARM-1993-0117	12/15/1993	INCORRECT SAFETY PRECAUTIONS USED DURING MAINTENANCE ACTIVITIES ON EXHAUSTER SYSTEM OF FLAMMABLE WATCHLIST TANK.	PERSONNEL ERROR. ERRONEOUS INFORMATION ON DRAWING AND INCORRECT INTERPRETATION OF DRAWING.
RL-WHC-TANKFARM-1994-0002	01/11/1994	SOIL COVER DEPTH OVER 241-SY TANKFARM TANKS EXCEEDS SPECIFICATIONS.	ROOT CAUSE ANALYSIS TO BE PERFORMED.
RL-WHC-TANKFARM-1994-0009	02/23/1994	DECREASE IN LIQUID LEVEL IN TANK 241-T-111. DECLARED ASSUMED LEAKER IN 1984.	TANK ASSUMED TO LEAK, FAILED MATERIAL, PROBABLY DUE TO CORROSION.
RL-WHC-TANKFARM-1994-0035	06/14/1994	POTENTIAL VIOLATION OF 241-AP TANKFARM DOME LOADING REQUIREMENTS. ENGINEERING REVIEW OF CONSTRUCTION DOCUMENTATION FOUND THAT DOME LOADING WAS BASED ON 110 LBS. PER CUBIC FOOT, WETTED SOIL DENSITY IS 121 LBS. PER CUBIC FOOT.	ROOT CAUSE ANALYSIS TO BE PERFORMED.
RL-WHC-TANKFARM-1994-0036	07/01/1994	SURVEILLANCE ANOMALY IN 241-C-106. CYCLIC TEMPERATURE VARIATIONS OCCURRED ON ONE OF TWO THERMOCOUPLE TREES IN TANK. INCONSISTENT DATA WITH HISTORICAL DATA. EXCEEDED OPERATING SPECIFICATION OF 20 DEGREES PER DAY VARIATION.	DESIGN PROBLEM. ENERGY BUILDUP DURING TESTING WAS NOT DETECTED UNTIL AFTER THE TEST WHEN WATER ADDITION TO TANK PUSHED HOT SLUDGE UP AGAINST THE THERMOCOUPLE.
RL-WHC-TANKFARM-1994-0063	11/14/1994	MISSED SURVEILLANCE REQUIREMENTS DURING WASTE TRANSFER. COVERS ON CLEAN-OUT BOXES, PITS, AND BOXES ARE TO BE VERIFIED IN POSITION ONCE EVERY 72 HOURS DURING TRANSFER.	PERSONNEL ERROR, VIOLATION OF PROCEDURE. COVER BLOCKS WERE NOT INSPECTED AS REQUIRED.
RL-WHC-TANKFARM-1994-0070	12/12/1994	SPILL OF ONE GALLON OF WASTE AT C-110 SALTWELL AFTER FLUSH OF C-110 AND C-107.	PROCEDURE PROBLEM/MECHANICAL. SALTWELL FLUSH WATER BACKPRESSURE CAUSED WASTE WATER INTO RAW WATER FEED LINE WHERE IT LEAKED OUT OF DEFECTIVE QUICK DISCONNECTS.
RL-WHC-TANKFARM-1995-0010	01/26/1995	PERSONAL CLOTHING CONTAMINATION AT W-030 PROJECT CHANGE TRAILER. KEH PIPEFITTER HAD CONTAMINATED OVERALLS. NUCLEAR PROCESS OPERATOR BAGGED THE CLOTHING AND RELEASED THE PIPEFITTER TO GO HOME. MANAGEMENT NOT NOTIFIED.	MANAGEMENT PROBLEM. NUCLEAR PROCESS OPERATOR DID NOT NOTIFY RADIOLOGICAL CONTROL OR SHIFT MANAGER.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
RL-WHC-TANKFARM-1995-0063	07/25/1995	FAILURE TO COMPLY WITH WATCHLIST CONTROLS WHEN SAMPLES FROM C-105, C-202, AND C-204, WERE TAKEN AND FORWARDED TO OPERATIONS WITHOUT HAVING WATCHLIST CONTROLS IMPOSED.	PROCEDURE VIOLATION. SHIFT MANAGER DID NOT IMPOSE WATCHLIST CONTROLS FOR SAMPLES.
RL-WHC-TANKFARM-1995-0088	10/16/1995	RECENT STUDY INDICATES 23 TANKS SHOULD BE ADDED TO FLAMMABLE GAS UNREVIEWED SAFETY QUESTION. PNL IDENTIFIED 59 TANKS WITH POSSIBLE TRAPPED GAS, BASED ON LEVEL FLUCTUATIONS. 21 OF THESE TANKS ARE MONITORED AND CONTROLLED AS WATCHLIST TANKS.	TO BE DETERMINED.
RL-WHC-TANKFARM-1996-0007	01/16/1996	OSD VIOLATION, 244-TX DCRT HYDROXIDE LEVELS NOT SUFFICIENT. SHOULD HAVE HAD 0.1178 MOLES/LITER, ONLY HAD 0.0025 MOLES/LITER. HYDROXIDE LEVEL NOT ADJUSTED AFTER SALTWELL WASTE AND FLUSH WATER TRANSFER FROM SST T-107.	IMPROPER CHEMICAL ADJUSTMENT AFTER WASTE TRANSFER.
WHC-TANKFARM-1996-0026	03/15/1996	HELICOPTER OPERATED BY BECHTEL NEVADA CORPORATION PERFORMING AERIAL RADIOLOGICAL SURVEYS FLEW OVER 241-A, AX, AY, AW, AND C TANK FARM AND WAS NOT AUTHORIZED.	ALTHOUGH FLIGHTS DIRECTLY OVER TANKFARMS IS PROHIBITED, IT WAS NOT RECOGNIZED BY PERSONNEL THAT THIS WAS TRUE. PERSONNEL ERROR.
WHC-TANKFARM-1996-0029	03/26/1996	COVER BLOCK INSPECTIONS NOT SPECIFIED FOR PUMP PIT 241-S-107-A WHICH HAD WASTE TRANSFER PASSING THROUGH IT.	INADEQUATE PROCEDURE. IT DID NOT CALL FOR COVER BLOCK INSPECTION OF THIS PIT.
WHC-TANKFARM-1996-0032	04/08/1996	AN UNPLANNED SHUTDOWN OF THE 241-SY-K1-4-1 PRIMARY TANK EXHAUSTER OCCURRED. EXHAUSTER WAS RESTARTED AFTER INVESTIGATION OF CAUSE.	NO CAUSE WAS FOUND.
WHC-TANKFARM-1996-0038	06/04/1996	AN ASSESSMENT TEAM REVIEWING THE "DOUBLE-SHELL TANK COMPOSITION STATUS - QUARTERLY REPORT" DISCOVERED A POTENTIAL LOW HYDROXIDE CONCERN WITH TANK 101-AZ.	THE ROOT CAUSE AND DIRECT CAUSE OF THIS EVENT WAS PROCEDURE PROBLEM/DEFECTIVE OR INADEQUATE PROCEDURE.
WHC-TANKFARM-1996-0044	07/01/1996	ELECTRICAL POWER WAS LOST AT 241-AN/AW/AP/AZ, 272-AW, AND 244-AR.	A PIECE OF FOIL BACKED PAPER, CAUGHT IN A WHIRLWIND SHORTED 2 PHASES ON THE POWER LINE WEST OF AY FARM.
WHC-TANKFARM-1996-0047	07/07/1996	LOCK AND TAG PLACED ON WRONG VALVE ON CROSS-SITE TRANSFER LINE. VALVE WAS IN 153-ER AND THE CORRECT VALVE WAS IN 152-ER.	NO MENTION IN PROCEDURE WAS MADE TO GEOGRAPHICAL LOCATION AND NO MENTION OF LOCATION WAS DISCUSSED DURING THE PRE-JOB BRIEFING PRIOR TO INSTALLING THE LOCK OUT. HUMAN ERROR
WHC-TANKFARM-1996-0050	07/15/1996	DURING EXCAVATION OF TANK C-104, RISER #14, IT WAS FOUND THAT NO FLANGE WAS COVERING ACCESS TO TANK. INSTEAD, A PIECE OF LEAD SHIELDING WAS COVERING THE OPENING.	THE EXACT CAUSE OF THIS EVENT CANNOT BE DETERMINED. IT IS EVIDENT THAT THE RISER DID NOT HAVE A COVER FLANGE INSTALLED WHEN IT WAS BACKFILLED.
WHC-TANKFARM-1996-0056	08/02/1996	DURING PREPARATION TO INSTALL VIDEO CAMERA IN TANK 241-A-101 A SPARK OCCURRED WHEN THE ELECTRICIAN ATTACHED THE BONDING WIRE TO THE BONDING BUS BAR.	A DEFICIENCY EXISTED IN THE TANK 241-A-101 AIR LIFT CIRCULATOR BUILDING ELECTRICAL SYSTEM. THE CAUSE OF THE SPARK WAS TRACED TO WIRING IN THE RECEPTACLES USED TO SUPPLY 120 VAC POWER DUE TO CROSS-CONNECTED GROUND AND NEUTRAL WIRES.
WHC-TANKFARM-1996-0066	09/04/1996	TANK C-106 DUMMY JUMPER DROPPED DURING REMOVAL FROM PUMP PIT.	THE GRAPPLE ASSEMBLY CONTROL BOX FELL OFF CABINET RESULTING IN GRAPPLE ASSEMBLY OPENING AND THE JUMPER TWISTING AND TILTING OVER.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
WHC-TANKFARM-1996-0067	09/17/1996	NINETY SEVEN GALLONS OF WATER SPILLED INTO CONTAINMENT TENT AT TANK C-106 PUMP PIT.	OPERATOR COMMENCED WATER ADDITION WITHOUT VERIFYING THE LINEUP AND WITHOUT CONNECTING THE FILL HOSE TO THE FILL ADAPTER AS REQUIRED BY PROCEDURE.
WHC-TANKFARM-1996-0072	09/24/1996	UNSAFE USE OF NON-SPARKING TOOLS DURING TANK INTRUSIVE WORK. USE OF CRESCENT WRENCH COMBINATION RESULTED IN POTENTIAL FOR WORKER INJURY AND SPARK CREATION.	CORRECT TOOLS NOT AVAILABLE AT THE JOB SITE CAUSED BY SCHEDULE PRESSURES. THIS CAUSED THE CRAFT PERSONNEL TO IMPROVISE.
PHMC-TANKFARM-1996-0002	10/08/1996	LOSS OF VENTILATION IN AN TANK FARM.	DURING CHECKING PHASE ROTATION OF THE SHMS SAMPLE PUMP THE WRONG BREAKERS WERE OPENED. THE BREAKERS FOR THE VENTILATION FANS AND THE SHMS ARE DIRECTLY ABOVE EACH OTHER.
PHMC-TANKFARM-1996-0006	10/18/1996	241-A-A INTRINSICALLY SAFE LEAK DETECTOR DOES NOT MEET DESIGN REQUIREMENTS OF THE AUTHORIZATION BASIS.	PERSONNEL ERROR DUE TO INATTENTION TO DETAIL.
PHMC-TANKFARM-1996-0010	10/29/1996	DISCOVERY DECLARED ON AUTHORIZATION BASIS DEFICIENCY AT 209-E FACILITY. NO AUTHORIZATION BASIS WAS FOUND TO INCLUDE THE 209-E FACILITY.	INADEQUATE ADMINISTRATIVE CONTROL.
PHMC-TANKFARM-1996-0016	11/26/1996	DUMP TRUCK BED CONTACTED AND BROKE OVERHEAD LOCAL AREA NETWORK CABLE.	PROCEDURE NOT USED. HUMAN ERROR.
PHMC-TANKFARM-1996-0018	12/11/1996	PROCEDURE MISINTERPRETATION DISCOVERED IN TANKFARM OPERATING SPECIFICATION DOCUMENT. REQUIREMENT WAS INTERPRETED THAT THERE WAS NO REPLACEMENT TIME LIMIT FOR FILTER REPLACEMENT ON A CASCADED TANK IF ITS HEPA FILTER FAILED ITS AEROSOL TEST. THE REQUIREMENT ACTUALLY SPECIFIES THAT A 7 DAY PERIOD IS PERMITTED FOR REPLACEMENT.	PERSONNEL ERROR IN INTERPRETING THIS REQUIREMENT.
PHMC-TANKFARM-1997-0001	01/03/97	LIQUID LEVEL IN 244-AR SUMP #1 INCREASED FROM 3% TO 51.5%.	DURING THE WEEKS LEADING UP; TO THE LEVEL INCREASE, AN UNUSUAL INCREASE IN THE OUTSIDE TEMPERATURE RESULTED IN A SUDDEN AND LARGE AMOUNT OF SNOW MELT. IN ADDITION TO THE SNOW MELT, AN ABOVE AVERAGE AMOUNT OF PRECIPITATION FELL DURING THIS TIME PERIOD. TWO PATHS ARE AVAILABLE TO CELL1. ONE IS THE DRAIN LINE ON THE CONCRETE ENCASEMENT LINE FROM 151-AR DIVERSION BOX. THE OTHER IS THE DRAIN LINE LOCATED AT THE BOTTOM OF THE FAILED EQUIPMENT STORAGE CONTAINERS.
PHMC-TANKFARM-1997-0002	01/07/97	RUPTURED SANITARY WATER LINE CAUSES FLOODING IN WET GROUT FACILITY, MODULE G3.	THE FACILITY WAS LEFT IN AN "ABANDON AS IS" CONDITION AND THE SANITARY WATER WAS NOT SECURED TO THE EYE WASH STATION. NO FREEZE PROTECTION WAS PROVIDED AND THE LINE FROZE AND BROKE WHEN THE OUTSIDE TEMPERATURE WENT BELOW FREEZING. THE ROOT CAUSE IS FAILURE TO RECOGNIZE HAZARDS FOR ABANDONED FACILITIES.
PHMC-TANKFARM-1997-0003	12/27/1996	241-SY PRIMARY EXHAUSTER UNEXPECTEDLY SHUT DOWN.	FROZEN PRESSURE SENSOR LINE DUE TO WATER ACCUMULATION COUPLED WITH LOW AMBIENT TEMPERATURES. INADEQUATE DESIGN OF THE SENSOR LINE.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
PHMC-TANKFARM-1997-0004	12/30/1996	UNPLANNED LOSS OF VENTILATION AT 242-S BUILDING.	AN ELECTRICAL SHORT DUE TO MOTOR BEARING FAILURE PERMITTING ARMATURE TO CONTACT STATOR WINDING CAUSED THE EXHAUSTER MOTOR TO FAIL.
PHMC-TANKFARM-1997-0006	01/09/1997	102-AZ PRIMARY TANK PRESSURIZATION ALARM RECEIVED AFTER MAINTENANCE ON THE SERVICE WATER SYSTEM IN AZ TANKFARM.	A WORKER LEFT A WRONG VALVE OPEN DURING TESTING OF A REPAIR OF AN INSTRUMENT LINE LEAK. THIS RESULTED IN THE TANK VENTILATION SYSTEM SEAL LOOP FILLING. THE VALVE WAS MISLABELED.
PHMC-TANKFARM-1997-0007	01/17/1997	106-AN TRANSFER PUMP OPERATED FOR 4 HOURS WITH THE TANKFARM MASTER PUMP SHUTDOWN (MPS) ALARM ACTIVATED.	MULTIPLE PERSONNEL ERRORS IN COMMUNICATION AND RECOGNITION OF AN UNDESIRABLE CONDITION. PROCEDURES NOT USED OR USED INCORRECTLY. INATTENTION TO DETAIL. GROUND IN ADJACENT FUSED GROUNDING PANEL ALLOWED PUMP RELAY TO REMAIN ENERGIZED EVEN THOUGH THE MPS WAS TRIPPED.
PHMC-TANKFARM-1997-0008	01/19/1997	241-SY PRIMARY EXHAUSTER SHUT DOWN DURING TROUBLESHOOTING ACTIVITIES. (BACKUP P-28 EXHAUSTER MANUALLY STARTED)	INADVERTENT CYCLING OF THE MAIN BREAKER TO THE CAM CABINET RESULTED IN CAM HIGH RADIATION ALARM RELAY BEING DE-ENERGIZED IMMEDIATELY CAUSING EXHAUSTER SHUTDOWN. PROCEDURE NOT USED OR USED INCORRECTLY. VIOLATION OF ADMINISTRATIVE PROCEDURE.
PHMC-TANKFARM-1997-0009	01/23/1997	241-SY TANK FARM PRIMARY EXHAUSTER SHUTDOWN RESULTING IN ACTIVATION OF PRESSURIZATION ALARM. EXHAUSTER WAS RESTARTED WITHIN 1 MINUTE OF SHUTTING DOWN.	INADEQUATE DESIGN RESULTED IN AN ERRONEOUS SIGNAL OF HIGH VACUUM IN HEADER TO OCCUR WHEN PANEL DOOR WAS SHUT.
PHMC-TANKFARM-1997-0011	01/23/1997	244-AR SUMP #2 WATER INTRUSION DUE TO RUPTURED SANITARY WATER LINE OUTSIDE THE FACILITY.	TWO WATER LINES BROKE OUTSIDE THE 244-AR FACILITY. WATER FLOWED TOWARD THE FACILITY, ENTERED THE CONTROL ROOM, FLOWED AROUND THE NORTH EAST SIDE OF THE FACILITY AND ENTERED THE GROUND NEAR THE SEAL POT MANHOLE. CURRENT DRAWINGS DO NOT SHOW A POTENTIAL LEAK PATH, BUT THE RAPID RISE IN SUMP LEVEL WAS CONCURRENT WITH THE WATER LINE BREAKAGE.
PHMC-TANKFARM-1997-0013	01/28/1997	LIQUID LEVELS IN 240-S-302 CATCH TANK AND 240-S-151 DIVERSION BOX SHOWED A MARKED INCREASE IN LIQUID LEVEL.	RAIN WATER AND SNOW MELT ACCUMULATED IN AN AREA THAT PERMITS DRAINAGE TO THE DIVERSION BOX. THE TAPE USED TO AUGMENT THE COVER BLOCK SEALS HAD DETERIORATED FROM EXPOSURE TO THE ELEMENTS. THE COVER BLOCK SEALS DO NOT MAKE A WATER TIGHT SEAL.
PHMC-TANKFARM-1997-0023	02/20/1997	LOSS OF AW TANKFARM VENTILATION SYSTEM RESULTS IN A PRESSURIZATION ALARM.	ELECTRICIAN WAS INSTALLING THE COVER ON EDS-DP-203 WHEN IT SLIPPED DOWN CAUSING THE MAIN BREAKER AND ADJACENT BREAKER TO TURN OFF. PER WORK PACKAGE, THE CREW DID NOT ATTEMPT TO RESET THE BREAKERS, BUT FINISHED THE PANEL INSTALLATION. HUMAN ERROR.
PHMC-TANKFARM-1997-0029	03/17/1997	ELECTRICAL LINE SEVERED DURING EXCAVATION. A BURIED ELECTRICAL CONDUIT WAS SEVERED BY A BACKHOE DURING EXCAVATION ACTIVITIES FOR THE W-058 CROSS SITE TRANSFER LINE PROJECT.	THE EXCAVATION PERMIT ISSUED FOR THIS WORK WAS LESS THAN ADEQUATE. A RECENT PROJECT HAD INSTALLED PERIMETER LIGHTING AROUND THE 241-SY TANK FARM. THE AS-BUILT DRAWINGS FOR THIS INSTALLATION WERE NOT REVIEWED DURING THE PREPARATION STAGE OF THE EXCAVATION PERMIT.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
PHMC-TANKFARM-1997-0033	03/27/1997	UNANTICIPATED SHUTDOWN OF THE P-28 BACKUP EXHAUSTER FOR THE 241-SY TANK FARM. SHUTDOWN WAS DISCOVERED WHEN PERSONNEL RESPONDED TO TANK FARM HIGH PRESSURE ALARM. 45 MINUTES LATER THE PRIMARY EXHAUSTER WAS STARTED.	CAUSE IS UNKNOWN.
PHMC-TANKFARM-1997-0035	04/02/1997	UNEXPECTED LOSS OF 242-S K1-5-3 EXHAUSTER. APPROXIMATELY ONE HALF HOUR LATER THE EXHAUSTER WAS RESTARTED.	AN ELECTRICIAN PERFORMING DE-WINTERIZATION OPENED CIRCUIT BREAKER #5 INSIDE THE K1-5-3 CAM ENCLOSURE. WHEN THE BREAKER WAS OPENED THE EXHAUSTER SHUTDOWN. THE WINTERIZATION PROCEDURE WAS INADEQUATE IN PROVIDING DIRECTION ON HOW HEAT TRACE WAS TO BE SHUTOFF.
PHMC-TANKFARM-0036	04/06/1997	TANK 105-AN EXPERIENCED A GAS RELEASE EVENT (GRE)	GAS GENERATION IN TANK COUPLED WITH CHANGING WEATHER CONDITIONS.
PHMC-TANKFARM-0037	04/07/1997	UNEXPLAINED DECREASE IN 244-AR SUMP #2 LEVEL. THE SURFACE LEVEL IN THE 244-AR DECREASED 2.57 INCHES IN THE PRIOR 4 WEEKS.	CAUSE UNKNOWN.
PHMC-TANKFARM-0048	05/30/1997	AN APOLLO-OWNED GROVE 30 TON HYDRAULIC CRANE TIPPED WHILE LIFTING TRENCH BOX COMPONENTS.	OPERATOR FAILED TO EXTEND ALL OUTRIGGERS. OPERATOR MIS-ESTIMATED ACTUAL LOAD AND CRANE CAPACITY. HUMAN ERROR.
PHMC-TANKFARM-1997-0049	05/31/1997	MOMENTARY POWER LOSS AT 200 WEST TANK FARMS CAUSES EXHAUSTER TO UNEXPECTEDLY SHUTDOWN.	UNEXPLAINED MOMENTARY POWER LOSS.
PHMC-TANKFARM-1997-0055	06/29/1997	MOMENTARY POWER LOSS AT 200 WEST TANK FARMS CAUSES EXHAUSTER TO UNEXPECTEDLY SHUTDOWN.	MOMENTARY POWER LOSS MAY BE CONNECTED WITH DUST DEVIL ACTIVITY.
PHMC-TANKFARM-1997-0064	08/06/1997	LOSS OF TANK FARM VENTILATION POWER TO 241-SY, 244-TX, 242-T, 241-SX EXHAUSTERS, AND THE S AND T CASS SUBSTATIONS. THE POWER SURGE ALSO CAUSED THE 204-AR BACKUP GENERATOR TO START AND COME ON LINE.	TANK & TOILET SERVICE CONTRACTOR INADVERTENTLY CAUGHT CRANE HOOK ON UTILITY POLE GUY WIRE AND CAUSED POLE TO BE PULLED TO THE GROUND BREAKING THE WIRE. HUMAN ERROR.
PHMC-TANKFARM-1997-00065	08/10/1997	UNPLANNED SHUTDOWN OF THE 296-S-15 "SLUDGE COOLER" EXHAUSTER IN THE 241-SX TANK FARM. AT 0050 HRS CASS OPERATOR REPORTED A 241-SX LOSS OF VENTILATION ALARM. EXHAUSTER RESTARTED AT 0110 HRS AND SHUTDOWN AFTER 5 MINUTES. OPERATORS SWITCHED TO SOUTH FAN AND RESTARTED AT 0120 HRS. FAN SHUTDOWN AT 0154 HRS AND TROUBLE SHOOTING WENT ON FOR 90 MINUTES UNSUCCESSFULLY. ELECTRICIANS WERE DISPATCHED FOR TROUBLE SHOOTING AND COULD FIND NOTHING WRONG. EXHAUSTER WAS STARTED AND OPERATED NORMALLY.	THE DIRECT CAUSE WAS DETERMINED TO BE ELECTRICAL OR INSTRUMENT SIGNAL NOISE.
PHMC-TANKFARM-1997-0070	08/22/1997	UNEXPECTED SHUTDOWN OF THE 241-SY P-28 PORTABLE EXHAUSTER.	THE DIRECT CAUSE WAS DETERMINED TO BE ELECTRICAL OR INSTRUMENT SIGNAL NOISE.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
PHMC-TANKFARM-1997-0072	08/26/1997	101-SY MIXER PUMP COMPUTER SYSTEM NOT UPDATING TEMPERATURE DATA. ON AUGUST 25, 1997 IT WAS CONFIRMED THAT TANK 101-SY TEMPERATURE DATA HAD NOT BEEN UPDATING THE DACS SYSTEM SINCE AUGUST 6, 1997.	THE CAUSE OF THIS EVENT WAS A DESIGN PROBLEM. THERE WAS AN INADEQUATE MAN-MACHINE INTERFACE. THE ORIGINAL DESIGN OF THE DACS SOFTWARE DID NOT INCLUDE A METHOD OF ALERTING OPERATORS THAT THE THERMOCOUPLES HAD LOST COMMUNICATIONS WITH THE DACS.
PHMC-TANKFARM-1997-0073	09/08/1997	WHILE TRANSFERRING WASTE FROM TANK 101-AY TO TANK 102-AW, A LEVEL INCREASE WAS DETECTED IN TANK 102-AY.	A THREE WAY VALVE ON THE TRANSFER ROUTE LOCATED IN THE 102-AY, 02A PIT WAS ALLOWING WASTE TO LEAK BY THE VALVE AND THROUGH A DROP LEG INTO TANK 102-AY. THE LEAKING VALVE WAS PART OF A JUMPER ASSEMBLY THAT HAD RECENTLY BEEN INSTALLED BY PROJECT W-320. ALTHOUGH A HYDROSTATIC TEST HAD BEEN PERFORMED ON THE JUMPER TO TEST WELDS AND PIPING INTEGRITY, NO TESTING HAD BEEN DONE ON THE VALVES TO ENSURE THEY DID NOT LEAK THROUGH.
PHMC-TANKFARM-1997-0074	09/11/1997	APPROXIMATELY 250 GALLONS OF WATER WHICH CONTAINED 20 GALLONS OF DILUTE CITRIC ACID WATER WAS POTENTIALLY SPILLED FROM 241-BY TRANSFER LINE SN-200. THE LINE IS A DIRECT BURIED PIPE WHICH IS FOAM ENCAPSULATED. THE ADDITION OF THE LIQUID WAS PART OF AN ATTEMPT TO CLEAR A BLOCKAGE IN THE LINE.	THE BLOCKAGE OCCURRED DUE TO THE LINE BEING INACTIVE FOR AN EXTENDED PERIOD OF TIME. CORROSION OF THE LINE CAUSED THE LEAK.
PHMC-TANKFARM-1997-0079	10/06/1997	LOSS OF COMPRESSED AIR TO 244-TX DIP TUBES. THE DIP TUBE SYSTEM IS UTILIZED TO DETERMINE LEVEL AND SPECIFIC GRAVITY IN THE DCRT. IT ALSO PROVIDES PURGE AIR TO MINIMIZE THE POTENTIAL FOR FLAMMABLE GAS BUILDUP IN THE DCRT.	AN AIR LEAK DEVELOPED IN THE AIR SYSTEM CAUSING THE COMPRESSOR TO RUN CONTINUOUSLY, WHICH EVENTUALLY LED TO A TRIPPED BREAKER.
PHMC-TANKFARM-1997-0083	10/08/1997	LOSS OF 241-SY 296-S-15 "SLUDGE COOLER" EXHAUSTER.	THE DIRECT AND ROOT CAUSES OF THIS EVENT HAVE BEEN DETERMINED TO BE ELECTRICAL/INSTRUMENT NOISE.
PHMC-TANKFARM-1997-0086	10/30/1997	THE 241-SY TANK FARM PRIMARY VENTILATION SYSTEM UNEXPECTEDLY SHUT DOWN.	INADEQUATE/DEFECTIVE DESIGN CAUSED EVENT. HIGH WINDS EXPERIENCED ON THE HANFORD SITE CAUSED THE 2400 VAC REGULATED LINE TO COME IN CONTACT WITH THE 13.8 KV LINE RESULTING IN A MOMENTARY POWER LOSS.
PHMC-TANKFARM-1997-0092	11/17/1997	NON-INTRINSICALLY SAFE LEAK DETECTORS WERE DISCOVERED NOT TO BE ISOLATED FROM TANK 101-AN. THE PIT DRAIN AND DRAIN SEAL DESIGNS DID NOT ADEQUATELY ISOLATE THE PIT FROM THE TANK DOME SPACE DURING A TIME WASTE DISTURBING OPERATIONS WERE OCCURRING.	THE ROOT CAUSE OF THIS EVENT WAS DETERMINED TO BE PERSONNEL ERROR/INATTENTION TO DETAIL. THE DESIGN OF THE DRAIN SEAL WAS NOT ADEQUATE TO IDENTIFY THAT IT DID NOT PROVIDE ADEQUATE ISOLATION FROM THE TANK DOME.
PHMC-TANKFARM-1997-0095	11/20/1997	THE 241-SY PRIMARY EXHAUSTER SHUTDOWN CAUSING THE SY FARM PRESSURIZATION ALARM TO ACTIVATE.	MAINTENANCE PROCEDURE NOT USED OR USED INCORRECTLY RESULTED IN CAM SET POINT NOT BEING CHANGED AS PRESCRIBED BY PROCEDURE, ALLOWING A CHECK SOURCE TO ACTIVATE THE CAM'S INTERLOCK SHUTTING DOWN THE EXHAUSTER.
PHMC-TANKFARM-1997-0108	12/31/1997	THE 241-T-104 WASTE TRANSFER PUMP SHUT DOWN DUE TO ACTIVATION OF A SERVICE WATER SYSTEM HIGH PRESSURE SWITCH.	THE WASTE TRANSFER LINE PLUGGED DURING TRANSFER AND THE WASTE SOLUTION LEAKED BY A 3-WAY VALVE INTO THE SERVICE WATER (FLUSH) SYSTEM. THE VALVE FAILED TO REMAIN LEAK TIGHT AT THE PRESSURE OF THE DEADHEADED SYSTEM. DEFECTIVE COMPONENT.

Table B-2. Summary of Occurrences. (37 sheets)

OCCURRENCE NUMBER	DISCOVERY DATE	DESCRIPTION OF EVENT	EVENT CAUSE
PHMC-TANKFARM-1998-0009	01/24/1998	A PRESSURIZATION ALARM WAS RECEIVED AT THE CASS INDICATING THE 241-SY DOUBLE-SHELL TANK'S PRIMARY EXHAUSTER HAD SHUTDOWN.	NO ABNORMAL CONDITIONS WERE DISCOVERED TO INDICATE WHAT CAUSED THE SHUTDOWN. EVALUATION OF CHANGES IN DESIGN WILL BE CONSIDERED TO PREVENT HIGH WINDS FROM AFFECTING EXHAUSTER OPERATION.
PHMC-TANKFARM-1998-0020	03/05/1998	WHEN NOZZLE E WAS LOOSENED TO DRAIN A RIGID JUMPER IN 241-A-A VALVE PIT TO PERMIT REMOVAL AN UNEXPECTED AMOUNT OF WATER DRAINED TO A-350 CATCH TANK. THE LEVEL IN THE TANK EXCEEDED 77 INCHES, BEYOND THE RANGE OF THE INSTRUMENTATION.	THE WORK PACKAGE USED TO ACCOMPLISH THE WORK DID NOT HAVE PROPER DETAILS DESCRIBING HOW MUCH WATER, IF ANY, SHOULD BE ALLOWED TO DRAIN TO THE A-A VALVE PIT. THIS WAS A RESULT OF PERSONNEL ERROR/INATTENTION TO DETAIL AS THE COGNIZANT ENGINEER DID NOT TAKE INTO ACCOUNT SEVERAL ASPECTS OF THE JOB.
PHMC-TANKFARM-1998-0032	03/27/1998	WORKER IN AREA AROUND 241-AZ EVAPORATIVE COOLING TOWERS NOTICED ODOR OF CHLORINE.	CAUSE NOT SPECIFIED
PHMC-TANKFARM-1998-0034	03/29/1998	UNSCHEDULED SHUTDOWN OF C-106 EXHAUST FAN.	PERSONNEL PERFORMING ROUTINE EFFICIENCY CHECKS OF THE CAM CAUSED FAN SHUTDOWN ON HIGH RADIATION ALARM WHILE PERFORMING THE CAM EFFICIENCY CHECK.
PHMC-TANKFARM-1998-0036	03/31/1998	INADVERTENT SHUTDOWN OF 241-SX EXHAUSTER.	PERSONNEL PERFORMING MAINTENANCE ON THE EXHAUSTER CAM INADVERTENTLY MOVED THE INTERLOCK SET POINT CONTROL KNOB, CAUSING THE EXHAUSTER TO SHUT DOWN.
PHMC-TANKFARM-1998-0037	04/01/1998	LOSS OF VENTILATION IN TANK 101-AZ.	VALVE K1-2 WAS FOUND SHUT. CAUSE UNSPECIFIED.
PHMC-TANKFARM-1998-0038	04/02/1998	ADDITION OF SOIL TO CATCH TANK EXCLUSION AREA RESULTS IN NEAR MISS VIOLATION OF TECHNICAL SAFETY REQUIREMENTS ADMINISTRATIVE C ONTROL. CLEAN BACKFILL WAS SPREAD IN THE AREA ABOVE AN SST UNDERGROUND TANK JUST EAST OF 221-U. ADMINISTRATIVE CONTROLS FOR THE CATCH TANK AREA ASSOCIATED WITH TANK DOME LOADING PROHIBIT ANY ADDITIONAL LOADS TO BE ADDED TO THE CATCH TANK DOME WITHOUT ENGINEERING CONCURRENCE.	INTERFACE REQUIREMENTS BETWEEN CONTRACTORS INADEQUATE TO PREVENT THIS EVENT.

CAM = continuous air monitor.
CASS = Computerized-Automated Surveillance System.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
COB = cleanout box.
DCRT = double-contained receiver tank.
Dept. = department.
DNFSB = Defense Nuclear Facilities Safety Board.
DOE = U.S. Department of Energy.
dP = differential pressure.
FIC = Food Instrument Corporation.
H = hydrogen.
HVAC = heating, ventilation, and air conditioning.
KEH = Kaiser Engineers Hanford.
LCO = Limiting Condition for Operations.
MCC = motor control center.
OSD = operating specification document.
OSR = Operational Safety Requirement.
PAS = PUREX acidified sludge.
PM = preventive maintenance (activities).
PNL = Pacific Northwest Laboratory.
psig = pounds per square inch (gauge).
PUREX = Plutonium Uranium Extraction (Facility).
REDOX = Reduction Oxidation (Facility).
SAR = safety analysis report.
SARP = Safety Analysis Report for Packaging.
SOV = solenoid-operated valve.
SST = single-shell tank.
TFO = tank farm operator.
USQ = Unreviewed Safety Question.

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APPENDIX C
REPRESENTATIVE ACCIDENTS

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APPENDIX C
REPRESENTATIVE ACCIDENTS

LIST OF TABLES

C-1 Analyzed Accidents TC1-1

C-2 Analyzed Accidents and the Represented Hazardous Conditions TC2-1

LIST OF TERMS

COB	cleanout box
CPS	criticality prevention specification
DCRT	double-contained receiver tank
diff.	differential
DST	double-shell tank
EPDM	ethylene-propylene diene monomer
GRE	gas release event
H2	hydrogen
HEPA	high-efficiency particulate air (filter)
ID	identification
LFL	Lower Flammability Limit
MISF	miscellaneous inactive storage facility
NaOH	sodium hydroxide
NC	no controls
OGT	overground transfer
PFP	Plutonium Finishing Plant
PUREX	Plutonium Uranium Extraction (Facility)
SST	single-shell tank
TRU	transuranic
TWRS	Tank Waste Remediation System
W058	existing cross site transfer (historical/applicable information from previous PHA)

KEY TO TABLE HEADINGS IN APPENDIX C

BIN—A code that describes the release attributes for a specific type of Hazardous Condition. This code identifies the initial location, form, and energy level of the release or the code identifies an occupational safety or radiation protection condition. (The codes used to identify bins are described in Table 3.3.1.4-1 of Chapter 3.0).

ID—This field contains a unique alpha/numeric identification code for each Hazardous Condition identified during the TWRS hazard evaluations activities. In general, these codes, derived from the name of the evaluation and the node numbering used in the evaluation, can be used to identify the analysis they came from.

Material at Risk—description of the type and quantity of material that may be affected by the occurrence of a Hazardous Condition.

Hazardous Condition—A description of the Hazardous Condition associated with the unique ID code. In general, Hazardous Conditions are related to uncontrolled releases of hazardous or radioactive material, however there are occurrences of Hazardous Conditions listed that are not specific to release events that can be identified by the BIN code. (This appendix contains only S2 and S3 release events).

Cause—A description of the factors that could cause the identified Hazardous Condition.

Initial Freq NC—Frequency/No Controls - The frequency of Hazardous Condition occurrence assuming no controls are present for a specific Hazardous Condition. (Qualitatively assessed before performance of the accident analysis).

Initial Safety Cons NC—Safety Consequence/No Controls - The resultant effect on individuals impacted by a release or exposure associated with a specific Hazardous Condition assuming no controls are present.

Cause Grp—Cause Group - An alpha/numeric code used to sort data by type of Cause of a Hazardous Condition.

Rep Acc—Representative Accident - An alpha/numeric code used to specify the analyzed accident by which the specified Hazardous Condition is represented. The code is used in the Database in two forms, alpha/numeric with and without an X. The X identifies that the hazardous condition is represented by the analyzed accident. Hazardous conditions that were chosen as the analyzed accident have no X designator.

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APPENDIX C
REPRESENTATIVE ACCIDENTS

Appendix C contains the results of the accident selection process and identifies which of the hazardous conditions with S3 and S2 consequences are represented by the 29 representative accidents that are analyzed in Chapter 3.0.

The tables in this appendix have been produced using a relational data base tool, which is used to manage the hazard analysis data base. The data contained in the tables appears as it is stored in the data base. No attempts have been made to reformat the information.

This appendix consists of two tables:

- Table C-1, "Analyzed Accidents," identifies the 29 representative accidents that are analyzed in Chapter 3.0 and provides the hazard analysis information that served as the basis for each accident analyzed. This information includes material at risk, hazardous condition and cause plus qualitative frequency and consequence estimates.

- Table C-2, "Analyzed Accidents and the Represented Hazardous Conditions," includes the 29 representative accidents found in Table C-1 plus all of the S3 and S2 hazardous conditions represented by each of those accidents. Each represented hazardous condition is accompanied by information on material at risk, hazardous condition and cause plus qualitative frequency and consequence estimates.

This appendix contains two tables which show the end point of the accident selection process. Table C-1 lists the hazardous conditions and associated accident titles for the final set of representative accidents analyzed in Chapter 3.0. Table C-2 lists all the hazardous conditions with postulated significant offsite or onsite consequences by representative accident to show that they are all covered by the accidents analyzed in Chapter 3.0.

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Table C-1. Analyzed Accidents. (6 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Nuclear Criticality								
A-1-a	I-PFP-1-AGT-A	Fission product gases and aerosols from receiver tank.	Release of fission product gases and aerosols from receiver tank due to: Potential solids collection in Tk-D-5. If mixed later, potential for composition of next batch to exceed Criticality Prevention Specifications (CPS). Potential "Criticality Issue."	Human Error or Agitator fails results in criticality	F3	S2	A05	01
ANALYZED ACCIDENT: In-Tank Fuel Fire/Deflagration								
A-1-a	EE-05-a	Contents of SST tank, fires and possible explosions	Release of radioactive or hazardous materials from SST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	S3	B25	02A
A-1-a	EE-05-b	Contents of DST tank, fires and possible explosions	Release of radioactive or hazardous materials from DST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	S3	B25	02B
ANALYZED ACCIDENT: Mixing of Incompatible Material - Tank Pressurization								
B-1-a	I-222S-1-RXN-A	Aerosols and/or toxic vapors from receiver tank	Release of aerosols and/or toxic vapors from receiver tank due to adverse chemical reactions caused by incompatible waste.	Transfer of incompatible waste	F3	S2	D01	03
ANALYZED ACCIDENT: Flammable Gas Deflagrations - DST								
A-1-a	ITK-10-b	DST tank contents	Release of radioactive material from in-tank fire or explosion due to intrusive activity (Dome Collapse)	Spark from equipment or tools	F3	S3	B04	04
ANALYZED ACCIDENT: Flammable Gas Deflagrations - SST								
A-1-a	XS-01-FLOW03	SST and DCRT tank contents	Release of liquids, solids, and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas explosion/fire propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	S3	B07	05

Table C-1. Analyzed Accidents. (6 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: HEPA Filter Failure - Exposure to High Temperature or Pressure								
A-1-a	106C-10J	Tank atmosphere and surface contamination on HEPA filters	Release of radioactive and/or hazardous material from Tk-106-C due to tank structural damage, HEPA damage caused by high temperature	Fire in or around ventilation system	F2	S2	B09	06
ANALYZED ACCIDENT: Fire in Contaminated Area								
A-1-a	CRN-05	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Human error in positioning crane load	F3	S2	B26	07
ANALYZED ACCIDENT: Waste Transport Vehicle Accident								
A-1-a	VEH-03	Sample transport cask	Release of radioactive or toxic material from cask due to damage to transport casks during a high wind/tornado	High wind/tornado	F2	S2	D20	08
ANALYZED ACCIDENT: Organic Solvent Fire/Organic Salt-Nitrate Reaction								
A-1-a	I-222S-1-CMP-E	Aerosols from receiver tank or 244-S	Release of radioactive aerosols to the atmosphere from 244-S-DCRT or receiver tank due to over pressurization of tank caused by organic fire.	Human Error - Upset of 222-S Lab operations	F3	S3	B01	09
ANALYZED ACCIDENT: Natural Phenomena - High Wind								
A-1-a	CRN-13-a	Tank inventory	Release of radioactive or toxic material from tank/equipment damage and dome collapse due to boom failure	High wind	F3	S3	D20	10
ANALYZED ACCIDENT: Natural Phenomena - Lightning								
A-1-a	NP-03	Head space inventories and combustion products from tank fire	Release of radioactive and hazardous material from tanks due to fire in tanks	Lightning strikes riser in tank farm	F2	S2	B21	11

Table C-1. Analyzed Accidents. (6 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Tank Failure Due to Excessive Loads								
B-1-a	CRN-03	Tank inventory	Release of radioactive and/or toxic materials from tank due to dome collapse	Human error results in excessive weight on dome	F3	S3	C10	12A
B-1-a	CRN-04	Tank inventory.	Release of radioactive and/or toxic materials from tank due to dome collapse	Crane or rigging failures drop load resulting in large impact to dome	F3	S3	C10	12B
B-1-a	CRN-11	Tank inventory	Release of radioactive or toxic material from tank due to boom failure and tank/equipment damage and dome collapse	Human error: improper load assembly, rigging, crane overloaded	F3	S3	C10	12C
ANALYZED ACCIDENT: Tank Failure Due to Vacuum or Degradation								
B-1-a	114SX-06.a.3	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tk-114-SX waste to the atmosphere due to dome collapse caused by loss of strength with aging	Long term aging Resulting in tank degradation	F1	S3	C12	13
ANALYZED ACCIDENT: Natural Phenomena - Seismic								
B-1-a	NP-07	Multiple tanks and ventilation systems inventories, 204-AR tanker spill	Release of radioactive and hazardous material from tanks and ventilation systems due to seismic event	Earthquake collapses domes	F1	S3	D18	14
ANALYZED ACCIDENT: Spray Leak in Structure or from Overground Waste Transfer Lines								
B-1-a	XS-06-FLOW02	DCRT waste being transferred to 102-SY	Release of liquid radioactive waste from DCRT transfer piping to Tk-102-SY due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	S3	D12	15

Table C-1. Analyzed Accidents. (6 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Spray Leak from Underground Waste Transfer Lines								
B-1-a	EE-16	Material leaked from transfer line	Release of radioactive and hazardous material from transfer line due to spray leak caused by excavation error	Excavation into waste transfer line during a transfer	F3	S3	D22	16
ANALYZED ACCIDENT: Caustic Spray Leak								
B-1-a	107AN-02-PRES	Contents of caustic truck	Release of caustic aerosol from caustic truck transfer piping due to spray leak	Piping/hose leak initiated by various causes	F3	S2	D12	17
ANALYZED ACCIDENT: Tank Bump								
B-1-a	102AW-02-TEMP02	DST tank vapors/aerosols	Release of radioactive aerosols from Tk-102-AW due to tank bump	High heat waste combined with loss of ventilation contributes to tank bump	F2	S2	D01	18A
ANALYZED ACCIDENT: Unfiltered Release								
B-1-a	114SX-04.c.2.a	Radioactive aerosols contained in tank head space	Release of radioactive aerosols from Tk-114-SX head space to atmosphere due to exhauster HEPA filter seal failure	HEPA filter seal failure	F3	S2	D07	18B
ANALYZED ACCIDENT: Subsurface Leak Resulting in Pool								
B-3-b	XS-07-FLOW02	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer piping out of DCRT due to leak in primary pipe and encasement	Corrosion of inner and outer pipe	F3	S2	D16	21A
B-3-b	XS-07-FLOW06	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer pipe out of DCRT due to leak in primary pipe and encasement	Water hammer causes failure of primary pipe and encasement	F3	S2	D17	21B
ANALYZED ACCIDENT: Evaporator Dump								
C-1-a	102AW-02-PRES 102AW-02-TEMP	DCRT tank vapor/aerosols	Release of radioactive aerosols from Tk-102-AW due to pressurization	Evaporator dump when intrusive activity is occurring which causes pressurization	F3	S2	D01	22

Table C-1. Analyzed Accidents. (6 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Mixing of Incompatible Material - Toxic Vapor Generation								
C-1-a	XS-26-PRES XS-26-TEMP	DST tank vapors/aerosols	Release of toxic vapors from Tk-102-SY due to chemical reaction	Mistransfer of incompatible waste causes chemical reaction	F3	S2	E06	23
ANALYZED ACCIDENT: Leak from Railcar/Tank Trailer								
B-2-b	204AR-01H	20,000 gallons of liquid radioactive waste from the rail car	Release of airborne and waterborne contaminates outside building on track spur, and potential contamination in unloader room from railcar due to spilling railcar contents	Rail car rupture due to collision with other or a derailment	F2	S2	D25	25
ANALYZED ACCIDENT: Surface Leak Resulting in Pool								
C-2-b	W058-PRES01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (Pool)	Water hammer plus mitigative features failure	F3	S2	D17	26
ANALYZED ACCIDENT: Unplanned Excavation/Drilling in Crib/Ditch/Pond								
C-2-c	CDP-10	Portion of radioactive material present in crib, ditch, or pond	Release of radioactive contamination to soil surface from cribs, ditches, or ponds due to excavation or drilling	Excavation or drilling	F3	S2	D22	28
ANALYZED ACCIDENT: Subsurface Leak Remaining Subsurface								
B-3-b	102S-01.b3	Radioactive/ hazardous material contained in pumpable liquids from S-102.	Release of radioactive liquid to the soil subsurface from leaks in transfer lines SL-140, SN-242 (Plume) due to leak in line caused by corrosion	Line leak during saltwell pumping (corrosion)	F3	S2	D12	29
ANALYZED ACCIDENT: Sodium Fire								
A-1-a	2727W-06	Building inventory	Release of hazardous materials from 2727-W due to sodium-water reactions	High wind or tornado destroys building with rain/snow	F2	S2	D20	30

Table C-1. Analyzed Accidents. (6 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Aboveground Structure Failure								
B-1-a	ITK-FR-08	DST & SST tank liquid held in flex receiver	Release of radioactive aerosols/vapors from flex receiver due to structural failure	High winds tear flex receiver bag	F3	S2	D20	31
ANALYZED ACCIDENT: Steam Intrusion from Interfacing Systems								
B-1-a	I-242A-6-CMP-A	Aerosols and particulates entrained in steam from feed tank TK-AW-102.	Release (steam) of aerosols from feed Tk-102-AW to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank.	Human error - Steam block valve inadvertently left opened.	F3	S3	E01	32

CPS = criticality prevention specification.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
NC = no controls.
SST = single-shell tank.

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Nuclear Criticality								
A-1-a	I-PFP-1-AGT-A	Fission product gases and aerosols from receiver tank	Release of fission product gases and aerosols from receiver tank due to potential for solids to collect in D-5, If mixed later, potential for composition of next batch to exceed Criticality Prevention Specifications (CPS); potential "Criticality Issue"	Human error or agitator fails results in criticality	F3	S2	A05	01
HAZARDOUS CONDITIONS								
A-1-a	102AW-08-COMP02	DST tank contents	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Misrouting of waste creates critical mass	F1	S2	A06	01X
A-1-a	102AW-08-COMP02A	DST tank contents	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Human error - addition of excess fissile material to Tank 241-AW-102 creates critical mass	F1	S2	A01	01X
A-1-a	102AW-08-COMP03	DST tank contents	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Non-uniform distribution of fissile material (horizontally) creates critical mass	F1	S2	A02	01X
A-1-a	102AW-08-COMP04	DST tank contents	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Non-uniform distribution of fissile material (vertically) due to addition of "rich" layer	F1	S2	A02	01X
A-1-a	102AW-08-COMP05	DST tank contents	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Over concentration of waste creates critical mass	F0	S2	A03	01X
A-1-a	102S-04.e4	Tank waste/vapor space	Release of radioactive gases and aerosols from Tank 241-S-102 vapor space to atmosphere due to criticality	Criticality (misrouting)	F1	S2	A06	01X
A-1-a	106C-01N	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 to atmosphere due to criticality	Criticality in waste tank from high temperature	F1	S2	A05	01X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	114SX-05.c.2c	Radioactive aerosols created by criticality event	Release pf radioactive gases and aerosols as well as direct radiation from Tank 241-SX-114 due to criticality	Criticality (difficult to achieve concentration needed and difficult to obtain configuration required)	F1	S2	A05	01X
A-1-a	244AR-03.a.09	Fission product gases generated by the criticality	Release of radioactive aerosols created by criticality to the cell atmosphere	Criticality in waste	F1	S2	A05	01X
A-1-a	I-PFP-1-CMP-B	Fission product gases and aerosols from receiver tank	Release of fission product gases and aerosols from receiver tank due to, potential for localized concentration of fissile materials in receiver tank from failure to add ferric nitrates; potential "Criticality Issue"	Failure to add ferric nitrates, results in criticality	F3	S2	A01	01X
A-1-a	I-PFP-1-CMP-D	Fission product gases and aerosols from receiver tank	Release of fission product gases and aerosols from receiver tank due to excess fissile material in waste, potential to exceed criticality prevention specification requirements for shipment; potential "Criticality Issue"	Excess fissile content added to waste results in criticality	F3	S2	A01	01X
B-1-a	I-PUREX-3-CMP-E	Fission product gases and aerosols from receiver tank	Release of fission product gases and aerosols from receiver tank due to criticality caused by exceeding Criticality Prevention Specifications for shipment from PUREX	Transfer of L Cell sump water to Tank F-18 and eventually to the Tank Farms	F3	S2	A01	01X
A-1-a	ITK-06	Radionuclides from criticality plus tank wastes	Release of radioactive and/or hazardous material from point of in-tank access (non-fire, non-explosion) due to criticality	Intrusive activity causes critical mass	F1	S2	A04	01X
A-1-a	ITK-06-I	Material inside MISF	Release of radioactive and/or hazardous material from point of in-facility access due to criticality within the in-facility waste during intrusive activity (non-fire, non-explosion)	Criticality from intrusive activity	F1	S2	A04	01X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	RCSTS-01-FLOW02	Fissile material in waste Tank 241-SY-102	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality	Mistransfer of material containing organic extractant from east area via the supernate piping route	F1	S2	A01	01X
A-1-a	W030-43	Radiological and toxicological material in the ventilation ducting	Release of radioactive material from ventilation ducting to atmosphere due to criticality	Buildup of fissile material in ventilation ducting until criticality occurs	F0	S3	A03	01X
B-1-a	W151-31	Tank inventory	Criticality	Release of radioactive/ hazardous material from tank to the atmosphere due to criticality	F1	S3	A05	01X
A-1-a	W320-BCD-TRANS01	Tank 241-C-106 plutonium inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank pump vortices	Accumulation of material in the pump vortices until critical mass condition are met	F1	S2	A04	01X
A-1-a	W320-BCD-TRANS02a	Tank 241-C-106 plutonium inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Flushing valve misposition	F0	S2	A06	01X
A-1-a	W320-BCD-TRANS02b	Tank 241-C-106 plutonium inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Excessive solids in slurry flow	F0	S2	A06	01X
A-1-a	W320-BCD-TRANS03	Tank 241-C-106 plutonium inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Primary failure of distributor	F0	S2	A02	01X
A-1-a	W320-BCD-TRANS04	Tank 241-C-106 plutonium inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation during sluicing activities	F1	S2	A04	01X
A-1-a	W320-D-TERM01	Tank 241-C-106 and 241-AY-102 plutonium inventory	Release of ionizing radiation and radioactive gas from Tank 241-AY-102 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation in tank due to natural conditions	F1	S2	A02	01X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	XS-03-LEVE02 XS-21-LEVE (244-S DCRT)	DCRT tank contents	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Evaporation of DCRT contents with increased solids settling on DCRT bottom creates critical mass	F3	S2	A02	01X
A-1-a	XS-03-TEMP02 XS-21-TEMP (244-S-DCRT)	DCRT tank contents	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Transfer of material into tank that violates criticality specification	F3	S2	A01	01X
A-1-a	XS-06-FLOW01	DCRT tank contents	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Transfer of inadequately recirculated waste from tank due to failure to appropriately balance flow between recirculation and transfer line causing buildup of solids creating critical mass	F3	S2	A06	01X
A-1-a	XS-13-PRES04	Catch tank contents	Release of fission product gases and aerosols from catch Tank 241-U-301B due to criticality	Transfer of excess fissile material to catch tank creates critical mass	F1	S2	A01	01X
A-1-a	XS-20-FLOW05	Catch tank/DCRT tank contents	Release of fission product gases and aerosols from 244 S DCRT (not designated solids receiver) due to criticality	Transfer of waste from 244-TX DCRT due to improper valve lineup creates critical mass	F1	S2	A06	01X
A-1-a	XS-26-PRES XS-26-TEMP 102-AW-TEMP (FOR TK-102-AW)	DST tank contents	Release of fission product gases and aerosols from Tank 241-SY-102 due to criticality	Transfer of critical mass of fissile material and achievement of critical geometry	F1	S2	A01	01X
ANALYZED ACCIDENT: In-Tank Fuel Fire/Deflagration								
A-1-a	EE-05-a	Contents of SST tank, fires and possible explosions	Release of radioactive or hazardous materials from SST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	S3	B25	02A

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	EE-05-b	Contents of DST tank, fires and possible explosions	Release of radioactive or hazardous materials from DST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	S3	B25	02B
HAZARDOUS CONDITIONS								
A-1-a	102AW-03-TEMP01	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by an fire/explosion in the annulus	Fire/Explosion of flammable liquid spilled into annulus via a riser	F2	S3	B09	02X
A-1-a	102AW-03-TEMP02	DST tank contents	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus damaging primary tank	Flammable concentration of gases in annulus vapor space due to spill of fuel into annulus and spark source	F2	S2	B09	02X
A-1-a	102AW-09-COMP02	DST tank contents	Release of radioactive waste aerosols from Tank 241-AW-102 due to fire in fuel spilled in waste tank causing dome collapse	Spill of fuel from external source plus fuel reaching flash point or being aerosolized plus ignition source	F2	S3	B09	02X
A-1-a	102S-03.b3	Tank contents	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into waste tank due to ignition of fuel from ruptured gas tank.	Vehicle drives into open riser puncturing gas tank + Ignition	F2	S2	B25	02X
A-1-a	102S-03.b4	Tank contents	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into waste tank causing dome collapse	Vehicle drives into open riser puncturing gas tank + Ignition + Flammable organic vapors in tank	F3	S3	B25	02X
A-1-a	EE-04-a	SST tank contents	Release of radioactive and hazardous materials from SST tank due to external fires	Vehicle accident involving propane, diesel or gasoline delivery	F2	S3	B25	02X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	EE-04-b	DST tank contents	Release of radioactive and hazardous materials from DST tank due to external fires	Vehicle accident involving propane, diesel or gasoline delivery	F2	S3	B25	02X
A-1-a	LDUA 2-2	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of hydraulic fluid	Structural failure of hydraulic system	F2	S3	B09	02X
A-1-a	PB-D07.04	10,000 gallons of fuel oil and radioactive material in double shell tank	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to in-tank fuel fire	F2	S3	B25	02X
A-1-a	PB-J01a	10,000 gallons of fuel oil and radioactive material in double shell tank	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to in-tank fuel fire	F1	S3	B25	02X
A-1-a	PB-J01b	10,000 gallons of fuel oil and radioactive material in double shell tank	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tanks in 241-AW to atmosphere due to in-tank fuel fire involving multiple tanks	F0	S3	B25	02X
A-1-a	VEH-07-I	Material in MISF	Release of radioactive or toxic material from MISF due to riser being sheared off and possibly vehicle gas tank ruptured and fire	Vehicle moving near facility risers	F3	S2	B25	02X
A-1-a	W320-D-CHILL01	Tank inventory and filter burden	Release of radioactive aerosols from damaged Tank 241-C-106 to the atmosphere due to propylene glycol fire/deflagration	Piping or tubing leak of propylene glycol from pit chiller into tank with ignition source	F0	S3	B01	02X
A-1-a	W320-D-CHILL02	Tank inventory and filter burden	Release of radioactive aerosols from damaged Tank 241-C-106 to the atmosphere due to propylene glycol fire/deflagration	Piping or tubing leak of propylene glycol from pit chiller into tank with ignition source	F0	S3	B01	02X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Mixing of Incompatible Material - Tank Pressurization								
B-1-a	I-222S-1-RXN-A	Aerosols and/or toxic vapors from receiver tank	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste	Transfer of incompatible waste	F3	S2	D01	03
HAZARDOUS CONDITIONS								
C-1-a	102AW-02-TEMP 102AW-08-TEMP	DST tank vapor/aerosols	Release of radioactive aerosols from Tank 241-AW-102 due to positive pressure	Chemical reaction heating up and/or agitating tank causes positive pressure in tank	F2	S2	E15	03X
B-1-a	102AW-02-TEMP01	DST tank vapor/aerosols	Release of radioactive aerosols from Tank 241-AW-102 due to boiling waste	High heat waste causing boiling	F2	S2	D01	03X
B-1-a	106C-01G	Tank atmosphere	Release of radioactive and/or hazardous material from Tank 241-C-106 tank, due to waste reaction causing local discharge of contamination through blown HEPAs or out cover blocks	Addition of acid to tank	F2	S2	E01	03X
C-1-a	106C-01H	Tank atmosphere, residual filter surface contamination	Release of radioactive and/or hazardous material from Tank 241-C-106, through blown HEPAs or out cover blocks due to tank boiling with vent path blocked or failed	Tank boiling with lack of vent path	F2	S2	D07	03X
B-1-a	106C-01M	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, due to high temperature in the waste tank	Exothermic, chemical reaction in tank due to inadvertent addition to tank	F2	S2	E01	03X
C-1-a	106C-12F	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 tank due to waste reaction in tank	Added chemicals to tank instead of normal water addition	F2	S2	E01	03X
C-1-a	107AN-02-FLOW01	Contents of DST	Release of radioactive aerosols from Tank 241-AN-107 due to surface chemical reaction	Transfer of incompatible chemical to tank via chemical addition system due to vendor or paperwork error	F3	S2	E01	03X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	107AN-02-FLOW02	Contents of DST	Release of toxic vapors from Tank 241-AN-107 due to surface chemical reaction	Transfer of incompatible chemical to tank via chemical addition system due to vendor or paperwork error	F3	S2	E01	03X
B-1-a	CCF-01	Head space inventories from actively ventilated tanks	Radioactive and hazardous release from tanks due to extended loss of ventilation (over 6 months)	Sustained loss of offsite power	F1	S2	D07	03X
B-1-a	CCF-20	Contents of two tanks	Release of radioactive and hazardous aerosols/vapors from tanks due to chemical reactions between waste and added materials	Reactive chemical additions to two tanks	F2	S2	D01	03X
B-1-a	I-222S-2-FLW-C	Aerosols and/or toxic vapors from receiver tank	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste	Human error - incorrect valve line up	F2	S2	E06	03X
B-1-a	I-BPLANT-2-FLW-D	Receiver tank waste	Release of aerosols and/or toxic vapors from receiver tank due to transfer of incompatible waste from B Plant	Human error - communication error between B Plant and TWRS causes transfer of incompatible waste	F3	S2	E01	03X
A-1-a	RCSTS-01-FLOW04	Amount of reactive chemicals in waste transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible material from east area via the supernate piping route	F2	S3	D01	03X
C-1-a	XS-02-FLOW03	DCRT tank vapors/aerosols	Release of toxic gases (oxides of nitrogen) from DCRT due to chemical reaction	Chemical reaction between sodium nitrite (DCRT) and nitric acid (PFP transfer) due to failure to adjust waste pH prior to transfer	F2	S2	E01	03X
B-1-a	XS-03-TEMP01	DCRT tank contents	Release of radioactive aerosols from 244 TX DCRT headspace due to positive pressure	Chemical reaction in DCRT causes positive pressure	F2	S2	D01	03X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	XS-13-PRES01	Liquid radioactive waste contents of catch tank	Release of radioactive aerosols from 241-U-301B catch tank due to chemical reaction	Draining of incompatible chemicals to catch tank	F3	S2	D01	03X
C-1-a	XS-20-FLOW01	DCRT tank vapor/aerosols	Release of radioactive aerosols from 244 TX DCRT due to chemical reaction	Transfer of incompatible waste to 244-TX DCRT due to improper valve lineup	F3	S2	E06	03X
B-1-a	XS-20-FLOW03	DCRT tank contents	Release of radioactive aerosols from 244 TX DCRT due to positive pressure caused by chemical reaction	Chemical reaction of 244-S material with contents of 244-TX caused by misrouting	F2	S2	B06	03X
C-1-a	XS-26-PRES01	DST tank vapor/aerosols	Release of radioactive aerosols from Tank 241-SY-102 due to chemical reaction	Mis-transfer of incompatible waste causes chemical reaction	F3	S2	E06	03X
ANALYZED ACCIDENT: Flammable Gas Deflagrations - DST								
A-1-a	ITK-10-b	DST tank inventory	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	F3	S3	B04	04
HAZARDOUS CONDITIONS								
A-1-a	102AW-02-PRES01	DST tank contents	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in waste tank (Dome Collapse)	Flammable concentration of gases in tank vapor space with spark source	F2	S3	B08	04X
A-1-a	102AW-03-LEVE01	DST tank contents	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus	Flammable concentration of gases in annulus vapor space due to waste leak into annulus and spark source	F2	S2	B12	04X
A-1-a	102AW-03-LEVE02	Liquid radioactive waste leaked into Tank 241-AW-102 annulus	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus	Flammable concentration of gases in annulus vapor space due to waste mis-transfer into annulus and spark source	F2	S2	B06	04X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	I-242A-1-FLW-A	Aerosols and other radioactive material from Tank 241-AW-102	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from dead heading	Valves fail to regulate (closed position) which fails pump and creates ignition source, sufficient hydrogen accumulation for fire/explosion.	F2	S3	B08	04X
A-1-a	I-242A-1-FLW-B	Aerosols and other radioactive material from Tank 241-AW-102	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source	Feed pump fails and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	S3	B08	04X
A-1-a	I-242A-1-FLW-C	Aerosols and other radioactive material from Tank 241-AW-102	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from dead heading	Plugged line which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	S3	B08	04X
A-1-a	I-242A-1-FLW-D	Aerosols and other radioactive material from Tank 241-AW-102	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source	Pump plugged which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	S3	B08	04X
A-1-a	I-242A-1-FLW-E	Aerosols and other radioactive material from Tank 241-AW-102	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from pump cavitation	Empty feed tank which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	S3	B08	04X
A-1-a	ITK-11	Tank Inventory	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Lightning, range fire, or seismic event ignites tank vapors	F2	S3	B09	04X
A-1-a	ITK-FR-13	DST & SST tank liquid held in flex receiver	Release of radioactive aerosols/vapors from flex receiver due to buildup and ignition of flammable gas in receiver	Hydrogen gas buildup in tank/riser that travels into receiver with ignition source (spark from herculite or equipment)	F1	S2	B08	04X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W030-33	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank headspace to atmosphere due to dome collapse/damage caused by flammable gas deflagration	Accumulation of flammable gas from steady state generation with ignition source present resulting in fire/deflagration	F3	S3	B08	04X
A-1-a	W030-34	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank headspace to atmosphere due to dome collapse/damage caused by flammable gas deflagration	Accumulation of flammable gas from a gas release event (GRE) with ignition source present resulting in fire/deflagration	F3	S3	B08	04X
A-1-a	W151-07	Tank headspace and contaminated material in filter	Release of radioactive material to the atmosphere	Release of radioactive/ hazardous material from failed HEPA filter to the atmosphere due to flammable gas deflagration	F1	S2	B08	04X
A-1-a	W151-08	Tank headspace and contaminated material in filter	Release of radioactive material to the atmosphere	Release of radioactive/ hazardous material from failed HEPA filter to the atmosphere due to flammable gas deflagration	F1	S2	B08	04X
A-1-a	W151-12	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank headspace to atmosphere due to flammable gas ignition	F2	S2	B08	04X
A-1-a	W151-17	Tank headspace	Unfiltered release from pit	Release of radioactive/ hazardous material from tank inlet station or pit to the atmosphere due to flammable gas release with ignition	F1	S2	B08	04X
A-1-a	W151-19	Tank inventory	Release to the environment	Release of radioactive/ hazardous material from tank to atmosphere and leak to soil due to flammable gas deflagration	F2	S3	B08	04X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W151-26	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank to the atmosphere through failed HEPA filter due to flammable gas deflagration	F2	S2	B08	04X
A-1-a	W151-28	Tank inventory	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere due to flammable gas deflagration	F1	S2	B01	04X
A-1-a	W151-36	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F2	S2	B07	04X
C-1-a	W151-40	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F0	S2	B07	04X
A-1-a	W151-44	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F1	S2	B18	04X
A-1-a	W151-48	Tank inventory and contaminated material in stack	Release of radioactive/hazardous material in tank and contaminated material plugging stack	Release of radioactive/ hazardous material from tank to soil subsurface and contaminated material from stack to atmosphere due to flammable gas deflagration	F1	S3	B08	04X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W151-49	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to atmosphere through failed filters due to flammable gas deflagration	F2	S2	B07	04X
A-1-a	W320-ABCDF-ALL01*	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration in pit	Flammable gas generation from tank waste builds up in pit drain pipe and is ignited	F1	S3	B08	04X
A-1-a	W320-B-ALL08a	Tank inventory	Large release of radioactive aerosols from Tank 241-AY-102 due to flammable gas fire/deflagration	Raw water leak causes a large water intrusion that induces a flammable gas release event which is ignited resulting in a dome space fire	F0	S3	B08	04X
A-1-a	W320-B-ALL08b	Tank inventory	Large release of radioactive aerosols from Tank 241-AY-102 due to flammable gas fire/deflagration	Surface water flood causes a large water intrusion that induces a flammable gas release event which is ignited resulting in a dome space fire	F0	S3	B08	04X
A-1-a	W320-B-TRANS14	Tank inventory	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Low slurry flow to distributor resulting in solids piling up, flammable gas generation, LFL being reached and ignition occurs resulting in a dome space fire	F0	S3	B08	04X
A-1-a	W320-B-TRANS15	Tank inventory	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Air is injected into the waste from the startup of slurry flow from the distributor, gas is scrubbed from the waste, LFL is reached in dome space and ignition occurs resulting in dome space fire	F0	S3	B08	04X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-B-TRANS16	Tank inventory	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Distributor nozzle breaks off causing solids to pile up generating significant amounts of flammable gas, LFL is reached and an ignition source is present resulting in a dome space fire	F0	S3	B08	04X
A-1-a	W320-BCD-PUMP03	Tank 241-AY-102 inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Submersible pump raised to high in tank, winch lifting strap fails, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	S2	B08	04X
A-1-a	W320-BCD-PUMP04	Tank 241-AY-102 inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Submersible pump raised too high in tank, winch lifting strap fails, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	S3	B08	04X
A-1-a	W320-D-ALL08	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Human error or activation of ALCs during high temperature condition causes GRE above LFL	F1	S3	E02	04X
A-1-a	W320-D-PUMP04	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Pumping of more solids than anticipated, annulus cooling mod not completed, waste is overheated causing a tank bump that results in large flammable gas release/ignition	F0	S3	B08	04X
A-1-a	W320-D-TRANS05	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	GRE causes head space gas concentration above LFL in tank and start of pumping ignites	F1	S3	B08	04X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-TRANS07	Tank 241-AY-102 inventory	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Sluice water transfer rate is excessive causing the level of waste to be lowered quickly with the waste temperature too high resulting in a large steam bump and flammable gas release/ignition	F1	S3	B08	04X
A-1-a	W320-D-VENT13	Tank inventory	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable fire/deflagration	Influx of cold water spray into tank causing excessive vacuum with a large flammable gas release as a result of slurry distribution; gas is ignited causing dome fire	F0	S3	B08	04X
A-1-a	W320-D-VENT14	Pit radionuclide inventory	Small release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due flammable gas fire/deflagration in the annulus	Loss of primary or annulus ventilation for an extended period resulting in a gradual rise in waste temperature, leak of flammable gas into annulus and ignition resulting in the annulus being breached	F0	S2	B08	04X
A-1-a	W320-D-VENT16	Tank 241-AY-102 inventory	Large release of aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration in the dome space	Loss of primary or annulus ventilation for an extended period resulting in a gradual rise in waste temperature, buildup of flammable gas to the LFL and ignition resulting in a dome space fire	F0	S3	B08	04X
A-1-a	W320-D-VENT17	Tank 241-AY-102 inventory	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Ice storm prevents air inflow into tank causing excessive tank vacuum, flammable gas release with ignition source resulting in fire/deflagration	F1	S3	B08	04X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-VENT18	Tank 241-AY-102 inventory	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration in the tank dome space	Volcanic event causes buildup up of ash on top of tank preventing air inflow, excessive vacuum develops and flammable gas is released to the dome space which is ignited resulting in dome space fire	F0	S3	B18	04X
A-1-a	W320-E-TERM03	Tank inventory	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Lack of controls on operation of tank after it has been turned into a FG group 1 tank, ignition occurs from lightning strike or other event resulting in a dome space fire	F0	S3	B08	04X
A-1-a	XS-26-PRES02	DST tank contents	Release of radioactive aerosols from Tank 241-SY-102 due to flammable gas fire/explosion (dome collapse)	Accumulation of flammable gases in vapor space and spark source	F2	S3	B08	04X
ANALYZED ACCIDENT: Flammable Gas Deflagrations - SST								
A-1-a	XS-01-FLOW03	SST and DCRT tank contents	Release of liquids, solids and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	S3	B07	05
HAZARDOUS CONDITIONS								
A-1-a	102AW-01-FLOW 102AW-02-PRES	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by chemical reaction of incompatible wastes	Misrouting to destination other than intended creates chemical incompatibility	F0	S3	B06	05X
A-1-a	102S-04.e3	Tank contents	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to generation of excessive heat leading	Addition of incompatible waste/chemical (misroute)	F0	S3	B06	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	106C-01I	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to possible dome collapse caused by tank high pressure	Fire in waste tank	F2	S3	B08	05X
A-1-a	106C-01J	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to high pressure in tank and possible dome collapse	Fire/explosion in waste tank	F2	S3	B08	05X
A-1-a	106C-01Ma	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to flammable gas fire/explosion in tank caused by high temperature (dome collapse)	Chemical reaction in tank	F2	S3	B01	05X
A-1-a	106C-02A	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to dome collapse caused by ignition of high flammable gas content in tank	High waste temperature	F2	S3	B08	05X
A-1-a	106C-02B	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to ignition of high flammable gas content in tank and possible dome collapse	Ventilation system failure	F2	S3	B07	05X
A-1-a	106C-02C	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to dome collapse caused by ignition of high flammable gas content in tank	Tank burp, release of trapped gas	F2	S3	B08	05X
A-1-a	106C-04A	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to tank damage caused by flammable gas fire/explosion because of high flammable gas content in the tank (dome collapse)	High flammable gas content due to chemical reaction in sludge layer	F2	S3	B01	05X
A-1-a	106C-04Aa	Tank atmosphere	Release of radioactive and/or hazardous material from Tank 241-C-106 due to flammable gas content of the waste causing an exothermic reaction in waste tank	High flammable gas content in tank sludge layer due to chemical reaction	F2	S2	B08	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	106C-04B	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to fire/explosion caused by ignition of flammable gas released from radiolysis in tank sludge	Radiolysis in sludge layer allows release of trapped gas to vapor space	F2	S3	B08	05X
A-1-a	106C-13A	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106 due to possible dome collapse, tank damage caused by high temperature	Fire in Tank 241-C-105 propagates into Tank 241-C-106	F2	S3	B09	05X
A-1-a	114SX-04.b.3b	Radioactive aerosols contained in tank head space	Release of radioactive aerosols from head space of Tank 241-SX-114 to atmosphere through exhaust HEPA filter due to flammable gas ignition in the headspace (dome collapse)	Flammable gas fire/explosion in Tank 241-SX-114 {Note: Tank 241-SX-114 is NOT currently identified as a Flammable Gas Watch List Tank} Requires spark to be present	F1	S3	B08	05X
A-1-a	114SX-05.b.1	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to flammable gas ignition resulting in dome collapse	Radiolysis creating bubbles of gases in waste	F2	S3	B08	05X
A-1-a	114SX-05.d	Radioactive material contained in tank head space	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to localized fire/explosion of flammable gas	Core Sampling through a pocket of gas large enough to exceed local LFL with ignition source (spark) creates local fire/explosion	F3	S2	B08	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	114SX-06.a.1b	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere as a result of a dome collapse	Deflagration of H2 (Implies gas generation with spark)	F1	S3	B08	05X
A-1-a	244AR-01.c.09	Radioactive and toxic material contained in tank	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to flammable gas ignition	Ignition of flammable gas that has collected in piping and tank dome	F2	S2	B08	05X
A-1-a	244AR-02.a.03	Radioactive material contained in vessel	Release of radioactive liquid in the form of aerosols contained in a cell to the exterior of the 244-AR facility due to ignition of flammable gas	Fire/explosion from hydrogen buildup	F1	S2	B08	05X
A-1-a	244AR-03.a.04	Radioactive material contained in the tank	Release of radioactive aerosols into cell due to ignition of flammable gas in 244-AR Vault tank headspace	Fire/explosion due to ignition of accumulated flammable gas	F2	S2	B08	05X
A-1-a	BND-02	Surface contamination in pits and risers	Release of radioactive aerosols from tank due to ignition of combustibles during preparation for bonding	Drilling holes for bonding attachments causes sparks when flammable gases or materials are present	F2	S2	B04	05X
A-1-a	CP-MSP-05	Tank inventory	Release of radioactive or toxic material to atmosphere from waste tank due to flammable gas deflagration	Human error AND Flammable gas is present in tank AND Mechanical failure of the pipe and probe (ignition source)	F1	S3	B09	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	CP-MSP-06	Tank inventory	Release of radioactive or toxic material to atmosphere due to flammable gas deflagration caused by puncture and ignition of flammable gas in transfer line which propagates to the waste tank	Human error AND Flammable gas is present in transfer pipe AND Spark from probe tip (ignition source)	F1	S3	B09	05X
A-1-a	CP-MSP-08	Material remaining in MISF from past activity	Release of radioactive or toxic material to atmosphere from MISF Miscellaneous Inactive Storage Facilities due to flammable gas deflagration	Human error AND Mechanical failure of probe	F2	S2	B09	05X
A-1-a	ITK-08	Tank inventory	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Exothermic reaction of incompatible materials in tank	F3	S3	B04	05X
A-1-a	ITK-08-I	Material inside MISF	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Exothermic reaction of incompatible materials in facility	F2	S2	B04	05X
A-1-a	ITK-09	Tank inventory	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Failure to bond components or incorrect bonding	F3	S3	B08	05X
A-1-a	ITK-09-I	Material inside MISF	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Failure to bond components or incorrect bonding	F2	S2	B08	05X
A-1-a	ITK-10-I	Material inside MISF	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Spark from equipment or tools provide an ignition source	F3	S2	B04	05X
A-1-a	ITK-10-a	SST tank inventory	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	F3	S3	B04	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	LDUA 1-25	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Fire (electrical, lighting)	F2	S3	B04	05X
A-1-a	LDUA 1-32	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	During planned intrusive activities, sampling triggers GRE	F3	S3	B04	05X
A-1-a	LDUA 1-33	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Non-arm end effectors (OVS, OSVS) dropped down riser	F2	S3	B04	05X
A-1-a	LDUA 2-20	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Combustible source of gas located near the compressor intake.	F3	S3	B04	05X
A-1-a	LDUA 2-51	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Supervisor error - arm in wrong mode, Electric remains on after air purge fault, flammable gas enters arm, spark ignites gas	F1	S3	B04	05X
A-1-a	LDUA 5-45	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Helicopter/airplane crash	F1	S3	B23	05X
A-1-a	LDUA 6-24	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Wrong setting on safety interlock for electric shutdown on loss of purge air	F3	S3	B09	05X
A-1-a	LDUA/EREE 1-22	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Electrical Short in LDUA Lighting short	F2	S3	B04	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	LDUA/EREE 1-28	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Electrical Short in LDUA/EREE Lighting short	F3	S3	B04	05X
A-1-a	NP-15	Inventory in isolated or abandoned equipment	Radioactive and hazardous material release from isolated or abandoned equipment due to fire	Hydrogen producing chemical reactions in isolated or abandoned equipment	F3	S2	B08	05X
B-1-a	RCSTS-03-INTEG01	Aerosol fraction of supernate or slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	F2	S2	B08	05X
B-1-a	RCSTS-03-INTEG02	Aerosol fraction of slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	S2	B08	05X
A-1-a	RCSTS-08-INTEG12	Aerosol fraction of supernate spill	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	F2	S3	B08	05X
B-1-a	RCSTS-09-INTEG06	Aerosol fraction of supernate spill	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	F2	S2	B08	05X
B-1-a	RCSTS-24-INTEG03	Aerosol fraction of supernate or slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	F2	S2	B08	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	RSR-06-I	Material inside MISF	Release of radioactive or toxic material from facility due to in-facility fire or explosion during riser removal activity	Failure to bond components or incorrect bonding allows electrostatic spark	F2	S2	B08	05X
A-1-a	W320-A-TRANS04	Tank inventory	Large release of radioactive aerosols from Tank 241-C-106 due to flammable gas fire/deflagration in dome space	High waste temperature during slurry transfer causing a steam bump which induces a flammable gas release/ignition resulting in dome fire	F0	S2	B08	05X
A-1-a	W320-A-TRANS05	Tank 241-C-106 inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Temperature out of specification causing a steam bump when level is lowered resulting in release/ignition of a flammable gas	F0	S3	D02	05X
A-1-a	W320-B-FLUSH01	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through breached filters due to ignition of flammable gas plume	Ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank	F0	S2	B08	05X
A-1-a	W320-B-TRANS17	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due flammable gas fire/deflagration	The sluicer hose breaks impinging into the solids releasing a region of retained flammable gas which is then ignited	F0	S2	B08	05X
A-1-a	W320-B-TRANS18	Tank inventory	Large release of radioactive aerosols from Tank 241-C-106 to the atmosphere due flammable gas fire/deflagration	Sluice water transfer rate being excessive causing waste level to be lowered quickly with waste temperature too high resulting in a large steam bump, flammable gas release and plume burn	F0	S2	B08	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-BCD-ALL05	Transfer line inventory	Small release of radioactive aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	F0	S2	B08	05X
A-1-a	W320-BCD-ALL06	Transfer line inventory	Small release of radioactive aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	F0	S2	B08	05X
A-1-a	W320-BCD-PUMP05	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Immersible pump raised too high in tank, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables	F1	S2	B08	05X
A-1-a	W320-BCD-PUMP09	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Immersible pump raised too high in tank, winch lifting strap breaks, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	S2	B08	05X
A-1-a	W320-D-TRANS06	Tank inventory	Large release of radioactive aerosols from Tank 241-C-106 to the atmosphere due to flammable gas fire/deflagration	Slurry transfer rate being excessive causing a rapid reduction in the hydrostatic pressure in tank resulting in flammable gas release	F0	S2	B01	05X
A-1-a	XS-01-FLOW01	DCRT tank contents	Release of radioactive aerosols from 244 TX DCRT due to ignition of flammable gas atmosphere	Pressure drop in transfer line releases flammable gas into DCRT atmosphere and ignition source causes deflagration	F2	S2	B01	05X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	XS-01-FLOW02	SST tank contents	Release of liquids, solids and/or vapors from single shell tank due to dome collapse caused by flammable gas burn	Loss of pump prime results in overheated pump that ignites flammable gas	F2	S3	B08	05X
A-1-a	XS-03-LEVE01 XS-21-LEVE (244-S DCRT)	DCRT tank contents	Release of combustion products from 244 TX DCRT due to flammable gas burn in tank atmosphere	Evaporation of DCRT contents causing decreased ability of waste to retain flammable gases and spark source	F2	S2	B08	05X
A-1-a	XS-03-PRES01 XS-21-PRES (244-S DCRT)	DCRT tank contents	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn in tank atmosphere	Loss of ventilation flow with accumulation of flammable gas and spark source	F2	S2	B07	05X
A-1-a	XS-03-TEMP03 XS-21-TEMP (244-S-DCRT)	DCRT tank contents	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn-fire/explosion in tank atmosphere	Buildup of gases, loss of ventilation, and spark source	F2	S2	B07	05X
A-1-a	XS-13-PRES02	Catch tank contents	Release of radioactive aerosols from 241-U-301B catch tank due to fire/explosion of flammable gas	Buildup of flammable gas in catch tank and spark source	F2	S3	B08	05X
A-1-a	XS-41B-LEVE01	Vent station catch tank contents	Release of radioactive aerosols from vent station catch tank due to flammable gas fire/explosion in nozzle pit	Failure to empty catch tank with buildup of flammable gas in nozzle pit plus ignition source	F2	S2	B08	05X
A-1-a	XS-41C-LEVE01	Vent station catch tank inventory	Release of radioactive aerosols from vent station catch tank due to flammable gas fire/explosion in catch tank pit	Leak of catch tank with buildup of flammable gas in catch tank pit plus ignition source	F2	S2	B08	05X
ANALYZED ACCIDENT: HEPA Filter Failure - Exposure to High Temperature or Pressure								
A-1-a	106C-10J	Tank atmosphere and surface contamination on HEPA filters	Release of radioactive and/or hazardous material from Tank 241-C-106 due to tank structural damage, HEPA damage caused by high temperature	Fire in or around ventilation system	F2	S2	B09	06

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITIONS								
A-1-a	102S-04.c	Tank waste/vapor space	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to ignition of flammable gas in tank causing HEPA failure	Concentration of H2 or Ammonia (or other flammable gasses) above LFL + Ignition source	F1	S3	B08	06X
A-1-a	102S-04.e1b	Vapor space gases	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to due to ignition of flammable gas in tank causing HEPA failure	Concentration of H2 or Ammonia (or other flammable gasses) above LFL + Ignition source	F2	S2	B08	06X
B-1-a	106C-01F	Tank atmosphere	Release of radioactive and/or hazardous material from Tank 241-C-106, blown out HEPA filters and/or discharge out cover blocks due to high tank pressure	Blockage of inlet, outlet and cascade lines	F2	S2	D07	06X
B-1-a	106C-11J	Tank atmosphere, residual filter surface contamination	Release of radioactive and/or hazardous material from Tank 241-C-106 due to HEPA damage, beyond 200 F design	Exhauster heater overheat	F3	S2	D07	06X
A-1-a	106C-11K	Tank atmosphere and surface contamination on HEPA filters	Release of radioactive and/or hazardous material from Tank 241-C-106 due to HEPA filter damage, spread of contamination caused by high temperature in ventilation system	Fire in exhauster duct work	F2	S2	B07	06X
B-1-a	106C-11M	Tank atmosphere, residual filter surface contamination	Release of radioactive and/or hazardous material from Tank 241-C-106 due to damaged HEPA filters	Event that damages HEPAs	F3	S2	D07	06X
B-1-a	106C-11O	Tank atmosphere	Release of radioactive and/or hazardous material from Tank 241-C-106 due to loss of filtration	HEPA filter blowout	F2	S2	D07	06X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	114SX-04.c.2.c	Radioactive aerosols contained in the tank headspace	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter deterioration	Deteriorated HEPA filter	F3	S2	D07	06X
A-1-a	204AR-11F	Unloader room environment/airborne contaminants	Release of airborne radiological contamination through the ventilation stack from the unloader room atmosphere due to fire in ventilation ducting	Fire in ventilation ducting resulting in damage to the HEPA filters and release to the atmosphere	F2	S2	B07	06X
B-1-a	244AR-01.b.04	Material trapped in filter	Release of radioactive aerosols from the facility exhaust stack due to filter failure	HEPA filter fails	F3	S2	D07	06X
B-1-a	CRN-19	Contaminates on above ground equipment	Release of radioactive or toxic material from above ground tank equipment due to dropping crane load	Mechanical failure: corrosion, faulty materials (filter crush)	F3	S2	D10	06X
B-1-a	CRN-20	Surface contamination in pit or riser	Radioactive or toxic material release from pit or riser due to dropping crane load onto above ground tank equipment	High wind or seismic event (filter crush)	F3	S2	D05	06X
A-1-a	NP-02	Head space inventory in actively ventilated tanks, ventilation system inventory	Radioactive and hazardous material releases from tanks and ventilation systems due to fire	Lightning strikes ventilation system	F2	S2	B21	06X
B-1-a	W151-01	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank to atmosphere due to filter failure	F3	S2	D07	06X
B-1-a	W151-03	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank to atmosphere due to unfiltered release through failed filter	F0	S2	D05	06X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W151-10	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F3	S2	D07	06X
B-1-a	W151-22	Filter materials and tank headspace	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F2	S2	E15	06X
B-1-a	W151-24	Filter materials and tank headspace	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F3	S2	E15	06X
B-1-a	W151-25	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank to the atmosphere through failed HEPA filter due to material rollover	F0	S2	D02	06X
B-1-a	W151-27	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank to the atmosphere through failed HEPA filter due to high temperatures	F3	S2	D15	06X
B-1-a	W151-30	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere through failed filters due to waste redistribution	F3	S2	D02	06X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W151-37	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere through failed filters due to high pressure	F3	S2	D14	06X
B-1-a	W151-41	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere through failed filters due to high pressure	F0	S2	D07	06X
B-1-a	W151-45	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere through failed filters due to high pressure	F1	S2	D18	06X
B-1-a	W151-50	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to atmosphere through failed filters due to fan overspeed	F3	S2	D07	06X
B-1-a	W151-52	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to atmosphere through failed filters due to excessive moisture buildup	F3	S2	D14	06X
C-1-a	W320-ALL-TRANS01	Duct and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to moisture buildup	Moisture buildup on filters from natural causes	F2	S2	D14	06X
B-1-a	W320-B-TRANS01	Tank 241-AY-102 inventory	Release of radioactive aerosols from the annulus of Tank 241-AY-102 through failed filters due to steam pulses from boiling waste	Corrosion of primary tank due to new waste composition causes leak into annulus, steam pulses from boiling waste in annulus region resulting in failure of annulus filters	F0	S2	D16	06X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-B-TRANS06	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive slurry flow	Excessive slurry flow resulting in increased aerosol generation and errant flow release (assumes filter failure)	F2	S2	D06	06X
C-1-a	W320-B-TRANS07	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to release of vapor from waste	Startup of slurry flow to distributor resulting in air being bubbled through waste and release of vapor (assumes filter failure)	F2	S2	D04	06X
C-1-a	W320-B-TRANS08	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to equipment failure	Distributor breaks off resulting in excessive aerosol generation in head space and release through HEPAs	F1	S2	D07	06X
C-1-a	W320-B-TRANS10	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to equipment failure	Distributor breaks off resulting in excessive aerosol generation in head space and release through HEPAs	F1	S2	D04	06X
C-1-a	W320-B-TRANS11	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive heat loading	Excessive corrosion and heat loading from new waste cause aerosol release (assumes HEPA plugging)	F2	S2	D16	06X
C-1-a	W320-B-TRANS12	Tank dome space inventory	Release of radioactive aerosols from interconnected tanks to atmosphere due to increased heat loading of Tank 241-AY-102	Increased heat loading of Tank 241-AY-102 and loss of vacuum due to inadequate ventilation or waste behavior prediction (assumes HEPA plugging)	F2	S2	D01	06X
C-1-a	W320-D-TRANS02	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive sluicer flow	Excessive sluicer flow resulting in radioactive aerosols release through HEPAs	F2	S2	D04	06X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-VENT01	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 ventilation system to atmosphere due to filter breach from in tank fire/deflagration	Filter breach due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc	F1	S2	B09	06X
B-1-a	XS-05-FLOW01	Radioactive material entrained in DCRT HEPA filter - DCRT aerosols	Release of aerosols and filter media from DCRT ventilation system due to HEPA filter damage	Replacement of exhaust fan with larger capacity fan causes HEPA filter damage	F2	S2	E13	06X
A-1-a	XS-05-TEMP01	Material holdup on DCRT ventilation filters	Release to atmosphere of materials from DCRT ventilation filters and tank due to fire	Fire in ventilation system due to failure of ventilation heater controls	F3	S2	B07	06X
A-1-a	XS-05-TEMP02	Material holdup on DCRT ventilation filters	Release to atmosphere of materials from DCRT ventilation filters and tank due to filter degradation	Fire in ventilation system due to flammable gas buildup and ignition	F3	S2	B08	06X
ANALYZED ACCIDENT: Fire in Contaminated Area								
A-1-a	CRN-05	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Human error in positioning crane load	F3	S2	B26	07
HAZARDOUS CONDITIONS								
B-1-a	102AW-04-STRU03	Residual contamination in pump pit	Release of radioactive particulate from Tank 241-AW-102 central pump pit due to re-suspension	Equipment drop during crane work	F2	S2	D10	07X
A-1-a	102AW-04-TEMP	Residual contamination in central pump pit	Release of radioactive particulate from Tank 241-AW-102 central pump pit due to fire	Pump motor electrical fire	F1	S2	B08	07X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	102S-02.b1	Material leaked into the tank pump pit during saltwell pumping.	Release of radioactive aerosols to atmosphere from Tank 241-S-102 pump pit due to flammable gas generated in pump pit igniting and burning paint off pump pit walls	Jumper leak + H2 evolution (or ammonia) + Spark	F2	S2	B12	07X
A-1-a	102S-02.b2	Residual contamination in tank pump pit	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to flammable gas from tank igniting in pump pit and burning paint off pump pit	H2 /Ammonia production migrates into pump pit + Spark (pumps not operating)	F2	S2	B08	07X
A-1-a	102S-02.d2	Residual contamination in tank pump pit	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into pit ignited from ruptured gas tank.	Vehicle drives into pit cover puncturing gas tank + Ignition	F3	S2	B25	07X
A-1-a	106C-06D	Residual pump pit contamination	Release of contamination from Tank 241-C-106 pump pit and potential worker injury due to fire	Fire in or near pump pit due to vehicle fuel spill and burn	F2	S2	B25	07X
A-1-a	106C-06L	Residual pump pit contamination	Release of contamination from Tank 241-C-106 pump pit due to fire/explosion affecting the structural integrity	Fire/explosion in pump pit	F2	S2	B09	07X
A-1-a	CRN-06	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Mechanical failure in positioning crane load	F3	S2	B26	07X
A-1-a	CRN-07	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Crane hits electrical lines/supplies	F3	S2	B26	07X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	CRN-08	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Lightning	F3	S2	B21	07X
A-1-a	CVR-05	Contamination in the pit.	Release of radioactive or hazardous material through combustion or fire/explosion of materials in pit due to human error	Failure to sniff or improper sniffing	F3	S2	B09	07X
B-1-a	CVR-15-I	Material in the pit from which a cover block is being removed	Release of radioactive or hazardous material from pit upon dropping or falling coverblocks or pieces of coverblocks	Coverblock hooks fail or pieces of degraded coverblock fall into pit	F3	S2	D10	07X
B-1-a	RCSTS-03-TEMP01*	Residual contamination in valve pit	Release of radioactive material to the atmosphere from the SY valve pit due to fire in pit	Fire in the pit caused by maintenance or electrical problem	F2	S2	D09	07X
A-1-a	VEH-01	Material available on vehicle.	Release of radioactive or toxic materials from cask due to fire caused by vehicle operation	Vehicle catches on fire	F3	S2	B09	07X
A-1-a	VEH-01-I	Material in samples from MISFs, material on equipment from inside MISFs, fuel in vehicle gas tank	Release of radioactive or toxic materials from vehicle carrying MISF samples or contaminated equipment due to vehicle fire	Vehicle catches on fire	F2	S2	B09	07X
A-1-a	W320-ABCD-CHILL02	Pit radionuclide inventory	Release of radioactive aerosols from covered pit or deadened pipe to atmosphere due to propylene glycol fire	Piping or tubing leak causes propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome	F1	S2	B01	07X
A-1-a	W320-BCD-ALL01	Pit radionuclide inventory	Release of radioactive aerosols from covered pit on Tank 241-C-106 to atmosphere due to propylene glycol fire	Piping or tubing leak	F1	S2	B01	07X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-VENT15	Pit radionuclide inventory	Small release of radioactive aerosols from standpipes in Tank 241-AY-102 due to flammable gas fire/deflagration in pipe	Natural occurrence of flammable gas generation and collection under proper conditions with ignition source present	F2	S2	B08	07X
A-1-a	XS-12-FLOW02	Residual contamination in Diversion Box 241-U-152	Release of aerosols from Diversion Box 241-U-152 due to flammable gas deflagration	Chemical reaction of catch tank material with backflow of vapors via diversion box drain line	F1	S2	B01	07X
A-1-a	XS-12-FLOW03	Residual contamination in Diversion Box 241-U-152	Release of aerosols from Diversion Box 241-U-152 due to hydrogen deflagration	Radiolysis of catch tank material with backflow of vapors via diversion box drain line and ignition source	F1	S2	B01	07X
ANALYZED ACCIDENT: Waste Transport Vehicle Accident								
A-1-a	VEH-03	Sample transport cask	Release of radioactive or toxic material from cask due to damage to transport casks during a high wind/tornado	High wind/tornado	F2	S2	D20	08
HAZARDOUS CONDITIONS								
B-1-a	VEH-02	Sample transport cask	Release of radioactive or toxic material from cask due to damage to transport casks during seismic event	Seismic event	F1	S2	D18	08X
B-1-a	VEH-02-I	Material in samples from MISFs	Release of radioactive or toxic material from MISF samples in transport casks due to seismic damage	Seismic event	F1	S2	D18	08X
NP	VEH-03-I	Material in samples from MISFs	Release of radioactive or toxic material from MISF samples in transport casks due to high wind/tornado damage	High wind/tornado	F2	S2	D20	08X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Organic Solvent Fire/Organic Salt-Nitrate Reaction								
A-1-a	I-222S-1-CMP-E	Aerosols from receiver tank or 244-S	Release of radioactive aerosols to the atmosphere from 244 S or receiver tank due to over pressurization of tank caused by organic fire	Human error - upset of 222-S Lab operations	F3	S3	B01	09
HAZARDOUS CONDITIONS								
A-1-a	102AW-09-COMP01	DST tank contents	Release of combustion product aerosols from Tank 241-AW-102 due to fire in separable organic layer in waste tank causing dome collapse	Organic reaching flash point or being aerosolized plus ignition source	F2	S3	B08	09X
A-1-a	I-242A-4-TMP-A	Aerosols and other radioactive material from Tank 241-AW-102	Release of radioactive material from Tank 241-AW-102 caused by ignition of organics in Tank C-100 which pressurizes the drain line and propagates the fire down the line to Feed Tank 241-AW-102	Faulty control of vacuum to CA-1 vessel causing pot to boil with organic layer available	F0	S3	B08	09X
A-1-a	I-BPLANT-1-CMP-E	Receiver tank waste	Release of tank waste due to fire in receiver tank from transferring organics from B Plant	Human error - tank containing organics in B Plant rupture and spills organics to the drains which eventually end up in Tank 24-1 and an inadvertent transfer to tank farms	F1	S3	B01	09X
A-1-a	I-PFP-1-CMP-E	High level waste in the receiver tank	Release of high level waste from receiver tank due to fire from organics transferred from PFP	Excess organic material added to waste results in fire	F2	S3	B01	09X
A-1-a	RSR-07-I	Material inside MISF	Release of radioactive or toxic material from facility due to in-facility fire or explosion during riser removal activity (chosen to represent all organic nitrate tanks)	Spark from failure to use non-sparking tools or sparks from welding, cutting, grinding, etc.	F3	S2	B09	09X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-A-TRANS06	Tank Inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Waste temperature out of specification during start of slurry transfer in tank and subsequent ignition of organics	F0	S3	B08	09X
A-1-a	W320-B-ALL09	Tank inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to organic waste fire	Formation of organic layer in tank during slurry distribution and subsequent ignition of organics	F1	S3	B04	09X
A-1-a	W320-B-ALL10	Tank inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Formation of organic layer in tank during sluicing and subsequent ignition of organics	F1	S3	B04	09X
A-1-a	W320-B-VENT08	Tank inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	F0	S3	B07	09X
A-1-a	W320-B-VENT09*	Tank inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	F0	S3	B07	09X
ANALYZED ACCIDENT: Natural Phenomena - High Wind								
A-1-a	CRN-13-a	Tank Inventory	Release of radioactive or toxic material from tank/equipment damage and dome collapse due to boom failure	High wind	F3	S3	D20	10
HAZARDOUS CONDITIONS								
B-1-a	CRN-13-IA	Contents of facility	Release of radioactive and/or toxic materials from below ground facility due to containment top collapse or equipment damage by boom failure	High wind or seismic event	F2	S2	D05	10X
NP	CRN-13-IC	Contents of facility	Release of radioactive and/or toxic materials from facility due to containment top collapse damage by boom failure	High wind or seismic event	F2	S2	D05	10X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-3-b	CRN-23	Tank Inventory	Release of radioactive or toxic materials from tank due to loss of vertical load control, dropping crane load into tank, onto tank bottom (subsurface leak)	High wind or seismic event	F3	S2	D05	10X
B-3-b	CRN-23-IA	Contents of facility	Release of radioactive or toxic materials from underground facility bottom due to loss of vertical load control, dropping crane load into facility (subsurface leak)	High wind or seismic event	F2	S2	D05	10X
C-2-b	PB-D07.07	40,000 gallons of fuel oil	Release of toxic materials to the environment	Release of fuel oil from package boiler storage tank to the soil surface due to high winds, no ignition source present	F1	S0	D20	10X
A-1-a	PB-D07.08	Radioactive material in double shell tank	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to high winds	F1	S3	B20	10X
ANALYZED ACCIDENT: Natural Phenomena - Lightning								
A-1-a	NP-03	Head space inventories and combustion products from tank fire	Radioactive and hazardous material releases from tanks due to fire in tanks	Lightning strikes riser in tank farm	F2	S2	B21	11
HAZARDOUS CONDITIONS								
A-1-a	EE-01	Contents of tanks in one tank farm	Release of radioactive and toxic materials from tanks due to external force and fire	Aircraft crash	F1	S3	B23	11X
NP	ITK-11-I	Material inside MISF	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Lightning, range fire, or seismic event ignites facility vapors	F1	S2	B09	11X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	LDUA 5-43	Aerosols and other radioactive material in single shell tank	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Lightning strikes VPM in raised position	F2	S3	B09	11X
A-1-a	NP-11	Tank inventories	Radioactive and hazardous material releases from tank farms due to lava flow	Eruption of molten lava from fissures	F0	S3	D18	11X
ANALYZED ACCIDENT: Tank Failure Due to Excessive Loads								
B-1-a	CRN-03	Tank inventory	Release of radioactive and/or toxic materials from tank due to dome collapse	Human error results in excessive weight on dome	F3	S3	C10	12A
B-1-a	CRN-04	Tank inventory	Release of radioactive and/or toxic materials from tank due to dome collapse	Crane or rigging failures drop load resulting in large impact to dome	F3	S3	C10	12B
B-1-a	CRN-11	Tank inventory	Radioactive or toxic material release from tank due to boom failure and tank/equipment damage and dome collapse	Human error: improper load assembly, rigging, crane overloaded	F3	S3	C10	12C
HAZARDOUS CONDITIONS								
B-1-a	102AW-04-STRU01A	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive dome loading	Equipment drop during crane work causes excessive dome loading	F3	S3	C10	12X
B-1-a	102AW-04-STRU02	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive dome loading	Violation of limits on dome loading	F3	S3	C10	12X
B-1-a	102S-05.a1a	Tank contents	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Excess gravel overburden	F3	S3	C10	12X
B-1-a	102S-05.a1aa	Tank contents	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Large vehicle traffic over tank	F3	S3	C10	12X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	106C-01X	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, dome structural damage and/or personnel injury due to overload of tank dome	Overweight vehicles over top of tank	F3	S3	C10	12X
B-1-a	106C-01Y	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, dome structural damage and/or personnel injury due to overload of tank dome	Flooding over top of tank	F2	S3	C19	12X
B-1-a	114SX-06.a.1a	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Gravel overburden Large vehicle	F3	S3	C10	12X
B-1-a	CP-SET-04	Tank inventory	Release of radioactive or toxic material from waste tank due to dome collapse	Excessive weight on tank dome (static load of platform)	F2	S3	C10	12X
B-1-a	CP-SET-05	Tank inventory	Release of radioactive or toxic material from waste tank due to dome collapse caused by load drop	Mechanical failure of equipment causes load drop	F2	S3	C10	12X
B-1-a	CP-SET-06	Tank inventory	Release of radioactive or toxic material from waste tank due to dome collapse caused by load drop	Human error causes load drop	F3	S3	C10	12X
B-1-a	CRN-03-IA	Contents of facility	Release of radioactive and/or toxic materials from facility due to containment top collapse	Human error results in excessive weight on top of containment	F3	S2	E10	12X
B-1-a	CRN-04-IA	Contents of facility	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Crane or rigging failures drop load resulting in large impact to top of containment	F2	S2	D10	12X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	CRN-09	Contamination emanating from tank headspace and material contained in ventilation system.	Release of radioactive and/or toxic materials from ventilation system due to crane damage	Human error in positioning crane load	F3	S2	E26	12X
B-1-a	CRN-10	Material emanating from tank headspace and the material contained in the ventilation system.	Release of radioactive and/or toxic materials from ventilation system due to crane damage	Mechanical failure in positioning crane load	F3	S2	D26	12X
B-1-a	CRN-11-IA	Contents of facility or equipment	Release of radioactive and/or toxic materials from facility due to containment top collapse or equipment damage by boom failure	Human error: improper load assembly, rigging, crane overloaded	F3	S2	E10	12X
B-1-a	CRN-12	Tank inventory	Radioactive or toxic material release from tank due to boom failure and tank/equipment damage and dome collapse	Mechanical failure: corrosion, faulty materials	F3	S3	C10	12X
B-1-a	CRN-12-IA	Contents of facility or equipment	Release of radioactive and/or toxic materials from facility due to containment top collapse or equipment damage by boom failure	Mechanical failure: corrosion, faulty materials	F2	S2	D10	12X
B-1-a	ITK-FR-04	DST & SST tank inventory	Release of radioactive aerosols from tank due to tank collapse	Equipment becomes lodged in riser, efforts to remove pull riser out of tank causing loss of structural integrity leading to tank collapse	F1	S3	C26	12X
B-1-a	ITK-FR-19	DST & SST tank inventory	Release of radioactive aerosols from tank due to dome collapse	Hydraulic jacks on assembly stand are operated while assembly is bolted to flange tearing out riser and destroying tank integrity leading to dome collapse	F1	S3	C26	12X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	PB-J01c	Radioactive material in double shell tank	Release of radioactive and/or toxic materials in double shell tank	Release of radioactive and/or toxic materials from double shell tanks in 241-AW to atmosphere due to dome collapse	FO	S3	E25	12X
C-3-b	W151-14	Tank inventory	Leak to soil surface and release to atmosphere	Release of radioactive/ hazardous material from tank to soil surface due to load drop	F1	S3	D10	12X
B-1-a	W151-32	Tank inventory	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere due to dome overload resulting in collapse	F2	S3	D10	12X
A-1-a	W320-ABCD-ALL01a	Tank Inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	S3	C19	12X
A-1-a	W320-ABCD-ALL01b	Tank Inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	S3	C10	12X
A-1-a	W320-ABCD-ALL02a	Tank Inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	S3	C19	12X
A-1-a	W320-ABCD-ALL02b	Tank Inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	S3	C10	12X
A-1-a	W320-ABCD-ALL03a	Tank Inventory	Release of radioactive aerosols from tank to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	S3	C19	12X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-ABCD-ALL03b	Tank Inventory	Release of radioactive aerosols from tank to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	S3	C10	12X
A-1-a	W320-B-ALL01	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Volcanic event results in buildup of ashfall on top of tank; weight of ash exceeds design limit and causes dome collapse	F0	S3	C10	12X
A-1-a	W320-B-ALL02	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Volcanic event results in buildup of ashfall on top of tank; weight of ash exceeds design limit and causes dome collapse	F0	S3	C10	12X
A-1-a	W320-B-ALL03	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Extreme snow fall results in large amounts of snow accumulating on top of tank; weight of snow on tank exceeds design limits and causes dome collapse	F0	S3	C10	12X
A-1-a	W320-B-ALL04	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Extreme snow fall results in large amounts of snow accumulating on top of tank; weight of snow on tank exceeds design limits and causes dome collapse	F0	S3	C10	12X
A-1-a	W320-B-ALL05	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Maintenance error or procedure violation result in overloading tank dome past design limits resulting in dome collapse	F0	S3	C10	12X
A-1-a	W320-B-ALL06	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Maintenance error or procedure violation result in overloading tank dome past design limits resulting in dome collapse	F0	S3	C10	12X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-E-TERM01	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to tank structural damage	Excessive fluffing of waste resulting in tank structural damage	F0	S2	D02	12X
ANALYZED ACCIDENT: Tank Failure Due to Vacuum or Degradation								
B-1-a	114SX-06.a.3	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 waste to the atmosphere due to dome collapse caused by loss of strength due to aging	Long term aging resulting in tank degradation	F1	S3	C12	13
HAZARDOUS CONDITIONS								
B-1-a	102AW-02-PRES03	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Blocked ventilation inlet causes excessive vacuum leading to dome collapse	F0	S3	C07	13X
B-1-a	102AW-02-PRES04	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Condensation of vapors causes excessive vacuum leading to dome collapse	F0	S3	C11	13X
B-1-a	102AW-02-PRES05	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Sub-cooling of vapor during equipment flushing causes excessive vacuum leading to dome collapse	F0	S3	C11	13X
B-1-a	102AW-02-PRES06	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Ventilation imbalance causes excessive vacuum leading to dome collapse	F0	S3	C07	13X
B-1-a	102AW-02-PRES07	DST tank contents	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Wrong size portable ventilator chosen for support work causes excessive vacuum leading to dome collapse	F0	S3	C13	13X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	102AW-03-LEVE03	Radioactive waste in DST annulus	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by floating the primary tank within the annulus	Misrouting of liquid waste to the annulus causes floating of primary tank and subsequent dome collapse	F1	S3	C06	13X
B-1-a	102S-04.d1	Tank waste/vapor space	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to the atmosphere due to low pressure causing dome collapse	Misoperation of exhauster during saltwell pumping	F0	S3	C07	13X
B-1-a	102S-05.a3	Tank contents	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Past thermocycling of tank	F1	S3	C12	13X
B-1-a	102S-05.a3a	Tank contents	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Long term aging	F1	S3	C12	13X
B-1-a	106C-01A	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Air inlet plugged due to icing/dust	F0	S3	C07	13X
B-1-a	106C-01B	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Inlet air valve closed	F0	S3	C07	13X
B-1-a	106C-01C	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage, and dome collapse due to tank low pressure	Exhauster damper positioned incorrectly	F0	S3	C07	13X
B-1-a	106C-01D	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Wrong sized portable exhauster	F0	S3	C13	13X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	106C-01E	Tank inventory	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Subcooling of tank vapor space due to water addition of flushing	F2	S3	C11	13X
B-1-a	114SX-04.a.2	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Radioactive aerosols released from failed tank dome due to vacuum produced by valving error.	Human error: Valve out flammable watch list (Tank 241-SX-109) butterfly valve	F0	S3	C07	13X
B-1-a	114SX-04.a.3	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 to atmosphere due to high temperatures causing dome concrete strength loss	No ventilation flow High ambient temperature conditions Resulting in tank degradation	F1	S3	C12	13X
B-1-a	114SX-04.b.1.a.2	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive material from Tank 241-SX-114 to atmosphere due to high temperature in the dome leading to dome collapse (long term closure of butterfly valve)	Human error: Closure of Tank 241-SX-114 exhaust butterfly valve isolating tank from exhaust plenum Resulting in tank degradation	F1	S3	C07	13X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	114SX-04.b.1.b.2a	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to heat induced tank dome collapse	Ducting failure due to bad welds	F1	S3	C12	13X
B-1-a	114SX-04.b.1.c.2	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to dome collapse	Exhauster failure Fan failure Filter rupture (low differential pressure shutdown) Resulting in tank degradation	F0	S3	C07	13X
B-1-a	114SX-04.b.1.d.2	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Filter plugging results in lack of heat removal with high temperatures degrading dome strength	F1	S3	C07	13X
B-1-a	114SX-05.b.3	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse caused by sudden vacuum in tank	Quenching (adding cold liquid to hot tank contents) creating a vacuum	F0	S3	C11	13X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	114SX-05.c.2b	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Chemical reaction caused by addition of chemical/solution. Resulting in tank degradation	F1	S3	C01	13X
B-1-a	CCF-17	Contents of tank	Release of radioactive and hazardous materials from tank due to dome collapse	Corrosion of rebar in concrete SST domes	F1	S3	C12	13X
B-1-a	W030-35A	Radioactive and toxic materials confined in head space	Release of radioactive material from Tank 241-AZ-101 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	S3	C11	13X
B-1-a	W030-35B	Radioactive and toxic materials confined in head space	Release of radioactive material from Tank 241-AZ-102 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	S3	C11	13X
B-1-a	W030-35C	Radioactive and toxic materials confined in head space	Release of radioactive material from Tank 241-AY-101 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	S3	C11	13X
B-1-a	W030-35D	Radioactive and toxic materials confined in head space	Release of radioactive material from Tank 241-AY-102 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	S3	C11	13X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W030-36	Radioactive and toxic materials confined in head space	Release of radioactive material from tank to atmosphere due to dome failure or collapse caused by excessive vacuum	Ventilation imbalance causes excessive vacuum resulting in dome failure/collapse	F0	S3	C11	13X
B-1-a	W030-37	Radioactive and toxic materials confined in head space	Release of radioactive material from tank to atmosphere due to dome collapse caused by excessive pressure	Excessive air supply to air lift circulators causes excessive pressure in tank causing dome collapse/damage	F0	S3	C13	13X
A-1-a	W320-ABCD-CHILL03	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Excessive cooling from process chiller restricts inflow, loop seal fails to operate and vacuum is formed which damages tank structure	F0	S3	D11	13X
C-1-a	W320-B-FLUSH04	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Flushing water spray through sluice nozzle resulting in excessive tank vacuum damaging tank	F0	S3	D11	13X
C-1-a	W320-B-FLUSH05	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Flushing water spray thru antisiphon holes resulting in excessive tank vacuum and tank breach	F0	S2	D11	13X
C-1-a	W320-B-VENT01	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Volcanic ashfall prevents air intake through existing ventilation and W030 ventilation upgrade system resulting in excessive vacuum and tank breach	F0	S2	D18	13X
C-1-a	W320-B-VENT02	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Volcanic ashfall which prevents air intake through W030 ventilation upgrade system resulting in excessive vacuum and tank breach	F0	S2	D18	13X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-B-VENT03	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through W030 ventilation upgrade and results in excessive vacuum causing tank damage	F0	S2	D24	13X
C-1-a	W320-B-VENT04	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through existing exhaust system with W030 intake and results in excessive vacuum	F0	S2	D24	13X
C-1-a	W320-B-VENT05	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Cold water spray into tank which results in excessive vacuum and tank breach, possible result of slurry distribution	F0	S2	D11	13X
C-1-a	W320-B-VENT06	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through existing ventilation system and results in excessive vacuum	F0	S2	D11	13X
C-1-a	W320-B-VENT07	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Volcanic ashfall prevents air inflow into tank through existing ventilation system resulting in excessive vacuum and tank breach	F0	S2	D18	13X
A-1-a	W320-BCD-ALL02	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Closing of W030 ventilation system inlet damper, build up of excessive vacuum with PCV failure resulting in tank damage	F0	S3	D11	13X
B-1-a	W320-BCD-ALL03	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Ventilation system fan overspeed with failure of tank loop seal failure results in excessive vacuum and tank damage	F0	S3	D11	13X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-BCD-ALL04	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Fan controller failure resulting in excessive vacuum in tank, loop seal actuation and tank damage	F0	S2	D11	13X
A-1-a	W320-D-VENT12	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure and tank collapse	F0	S3	C11	13X
A-1-a	W320-D-VENT20	Tank inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure	F0	S3	E07	13X
ANALYZED ACCIDENT: Natural Phenomena - Seismic								
B-1-a	NP-07	Multiple tanks and ventilation systems inventories, 204-AR tanker spill	Radioactive and hazardous material releases from tanks and ventilation systems due to seismic event	Seismic event collapses domes	F1	S3	D18	14
HAZARDOUS CONDITIONS								
B-1-a	102S-05.a2	Tank contents	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Seismic event (common mode failure)	F1	S3	D18	14X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	114SX-04.b.1.b.2b	Radioactive material contained in the tank (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to heat induced tank dome collapse	Ducting failure due to seismic activity coupled with failure to respond Resulting in tank degradation	F1	S3	D18	14X
B-1-a	244AR-02.a.14	Radioactive material contained in the four tanks and facility	Release of radioactive aerosols from waste contained in tanks (4) and building due to earthquake	Seismic event collapses building and four tanks	F1	S3	D18	14X
B-1-a	244AR-05.a.02	Total amount of radioactive material contained in facility	Release of radioactive material from facility due to seismic event which causes building collapse without cell collapse	Seismic event damages facility structure	F2	S2	D18	14X
B-1-a	CCF-18	Contents of tanks, products of combustion	Release of radioactive and hazardous materials from tanks due to dome collapses	Fire in tank propagates to connecting tank and both tanks collapse during cool down from negative tank pressure	F0	S3	C11	14X
B-1-a	CCF-19	Contents of tanks, products of combustion	Release of radioactive and hazardous materials from tanks due to dome collapses	Fire in tank causes pressure transient that leads to GRE in connecting tank with subsequent fire and tank collapses from negative tank pressure	F0	S3	C11	14X
B-1-a	CRN-13-b	Tank Inventory	Release of radioactive or toxic material from tank/equipment damage and dome collapse due to boom failure	Seismic event	F1	S3	D18	14X
B-1-a	NP-13	Tank head space inventories and splash from dome collapse	Radioactive and hazardous material releases from tanks due to excessive weight on dome	Accumulations of heavy snow followed by heavy rain	F2	S3	C10	14X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-03-INTEG04	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	S3	D18	14X
C-2-b	RCSTS-03-INTEG06	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	S2	D18	14X
C-2-b	RCSTS-03-INTEG08	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Seismic event	F1	S2	D18	14X
B-1-a	RCSTS-03-INTEG10	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	S3	D18	14X
C-2-b	RCSTS-04/05-INTEG05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	S2	D18	14X
C-2-b	RCSTS-08-INTEG06	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Seismic event	F1	S2	D18	14X
C-2-b	RCSTS-08-INTEG07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Seismic event	F1	S2	D18	14X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-08-INTEG15	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Seismic event	F1	S3	D18	14X
B-1-a	RCSTS-08-INTEG16	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Seismic event	F1	S3	D18	14X
C-2-b	RCSTS-09-INTEG09	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Seismic event	F1	S2	D18	14X
C-2-b	RCSTS-09-INTEG10	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Seismic event	F1	S2	D18	14X
B-1-a	RCSTS-09-INTEG16	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Seismic event	F1	S3	D18	14X
B-1-a	RCSTS-09-INTEG17	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Seismic event	F1	S3	D18	14X
C-3-b	RCSTS-10/11-INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	S2	D18	14X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-3-b	RCSTS-12/13-INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	S2	D18	14X
C-2-b	RCSTS-15/16-INTEG04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	S2	D18	14X
C-3-b	RCSTS-18/19-INTEG07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	S2	D18	14X
C-2-b	RCSTS-24-INTEG04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Seismic event	F1	S2	D18	14X
C-2-b	RCSTS-24-INTEG05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Seismic event	F1	S2	D18	14X
B-1-a	RCSTS-24-INTEG09	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Seismic event	F1	S3	D18	14X
B-1-a	RCSTS-24-INTEG10	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Seismic event	F1	S3	D18	14X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-ALL07	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Seismic event releases flammable gas from the waste and after shocks cause mechanical sparks which ignite the flammable gas mixture	F2	S3	B18	14X
B-1-a	W320-D-TRANS11	Transfer line inventory	Release of radioactive aerosols from transfer line to the atmosphere due spray leak	Seismic event damages transfer line by ground motion resulting in spray release	F1	S3	D18	14X
ANALYZED ACCIDENT: Spray Leak in Structure or from Over Ground Waste Transfer Lines								
B-1-a	XS-06-FLOW02	DCRT waste being transferred to Tank 241-SY-102	Release of liquid radioactive waste from DCRT transfer piping to Tank 241-SY-102 due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	S3	D12	15
HAZARDOUS CONDITIONS								
B-1-a	102AW-01-FLOW 102AW-04-PRES	Liquid radioactive waste being transferred to DST from DCRT	Release of radioactive aerosol from transfer pipe which runs from DCRT to Tank 241-AW-102 due to spray leak into open underground structure	Piping leak due to thermal stress of transferring hot solution in cold pipe	F3	S3	D01	15X
B-1-a	102AW-01-FLOW01	Liquid radioactive waste being transferred to DST from DCRT	Release of liquid radioactive waste aerosols from transfer pipe to Tank 241-AW-102 due to spray leak into open underground structure	Piping leak due to corrosion caused by transferring high temperature waste	F2	S3	D01	15X
B-1-a	102AW-13-FLOW01	Radioactive waste being pumped from SST to DCRT	Release of radioactive waste aerosols due to spray leak of waste from flush pit	Backflow of waste to flush pit with valve or pipe leak and cover block off	F1	S3	D12	15X
B-1-a	204AR-07A	Aging waste DST tank contents	Release of liquid radioactive waste and high airborne in unloading room from the Tank 241-AY-102 due to reverse pumping of Tank 241-AY-102 contents back to 204-AR	Pump in pit 02D starts and pumps back to the 204-AR building through the transfer piping and leaks	F2	S2	E06	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	COB-01	Transfer inventory	Release of radioactive and/or hazardous material from COB due to spray leak	Flange, gasket or valve, spray leak with COB lid removed	F3	S3	D12	15X
B-1-b	I-222S-1-CMP-C	222-S lab waste from Tank 219-S-102 (capacity 4000 gal)	Release (potential spray leak) of 222-S lab waste to atmosphere in diversion box or 244 S Pump Pit due to increased corrosion from failure to add sodium hydroxide	Human error - failure to add sodium hydroxide	F3	S2	E01	15X
B-1-b	I-222S-2-LEK-B	222-S lab waste from Tank 219-S-102 (capacity 4000 gal)	Release of 222-S lab waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	S2	D16	15X
B-1-b	I-222S-2-LEK-E	222-S lab waste from Tank 219-S-102 (capacity 4000 gal)	Release of 222-S lab waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from a seismic event	Seismic event	F2	S2	D18	15X
B-1-b	I-242A-1-LEK-B	Liquid waste from Tank 241-AW-102	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	S2	D16	15X
B-1-b	I-242A-1-LEK-E	Liquid waste from Tank 241-AW-102	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak	F2	S2	D18	15X
B-1-b	I-242A-2-LEK-B	Slurry from the evaporator	Release of slurry tank waste to the atmosphere due to spray leak at the diversion boxes or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	S2	D16	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-b	I-242A-2-LEK-E	Slurry from the evaporator	Release of slurry tank waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes leak	F2	S2	D18	15X
B-1-b	I-242S-2-LEK-B	Contaminated fire water from 242-S pump room	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	S2	D16	15X
B-1-b	I-242S-2-LEK-E	Contaminated fire water from 242-S pump room	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event	F2	S2	D18	15X
B-1-b	I-242S-4-LEK-E	Contaminate fire water from 242-S condenser room	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from an seismic event	Seismic event causes spray leak	F2	S2	D18	15X
B-1-b	I-BPLANT-1-CMP-B	Low level waste from B Plant Tank 24-1 (administrative volume limit 7500 gal)	Release (spray leak) of low level waste at diversion box from transfer of low pH material resulting in increased corrosion in pipe	Human error - failure to add sodium hydroxide leads to corrosion and leak in pipe	F3	S2	E01	15X
B-1-b	I-BPLANT-2-LEK-B	Low level waste from B Plant Tank 24-1 (administrative volume limit 7500 gal)	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	S2	D16	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-b	I-BPLANT-2-LEK-E	Low level waste from B Plant Tank 24-1 (administrative volume limit 7500 gal)	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	S2	D18	15X
B-1-b	I-PFP-2-LEK-B	TRU mixed waste from PFP Tank D-5	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	S2	D16	15X
B-1-b	I-PFP-2-LEK-E	TRU mixed waste from PFP Tank D-5	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak.	F2	S2	D18	15X
B-1-b	I-PFP-3-LEK-B	TRU mixed waste from PFP Tank D-5	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	S2	D16	15X
B-1-b	I-PFP-3-LEK-E	TRU mixed waste from PFP Tank D-5	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak	F2	S2	D18	15X
B-1-b	I-PUREX-1-AGT-B	TRU waste from PUREX	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error or mechanical failure - agitator fails or is not turned on	F3	S2	D05	15X
B-1-b	I-PUREX-1-CMP-B	TRU waste from PUREX	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error - failure to add sodium hydroxide to low level waste results in corrosion and causes spray leak	F3	S2	E01	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-b	I-PUREX-2-LEK-B	TRU waste from PUREX	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	S2	D16	15X
B-1-b	I-PUREX-2-LEK-E	TRU waste from PUREX	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by seismic event	Seismic event causes spray leak	F2	S2	D18	15X
B-1-b	I-PUREX-3-AGT-B	TRU waste from PUREX	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Agitator fails or is not turned on results in corrosion and causes spray leak	F3	S2	D05	15X
B-1-b	I-PUREX-3-CMP-B	TRU waste from PUREX	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error - failure to add sodium hydroxide to low level waste results in spray leak	F3	S2	E01	15X
B-1-b	I-PUREX-4-LEK-B	TRU waste from PUREX	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	S2	D16	15X
B-1-b	I-PUREX-4-LEK-E	TRU waste from PUREX	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	S2	D18	15X
B-1-b	I-TPLANT-1-CMP-B	Low level waste from T Plant Tank 15-1 (approximate capacity 14,500 gal)	Release (spray) of low level waste at diversion box from transfer of lower pH material resulting in increased corrosion in pipe	Human error - failure to add sodium hydroxide causes corrosion and associated spray leak	F3	S2	E01	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-b	I-TPLANT-2-LEK-B	Low level waste from T Plant Tank 15-1 (approximate capacity 14,500 gal)	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit	Corrosion in pipe line causes spray leak	F1	S2	D16	15X
B-1-b	I-TPLANT-2-LEK-E	Low level waste from T Plant Tank 15-1 (approximate capacity 14,500 gal)	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	S2	D18	15X
B-1-a	OGT-EXT3-01A	DST & SST tank inventory	Release of radioactive or hazardous aerosols from the primary pipe due to spray leak caused by truck crash into piping system	Human error, line struck by truck	F3	S3	E25	15X
B-1-a	OGT-FLOW1-03A	DST & SST tank inventory	Release of radioactive or hazardous aerosols from the primary pipe due to spray leak caused by misdirected flow	Spray leak caused by JR-1 (3-way valve) mispositioned to flush, two check valves fail, flush disconnect fails (check valve), reverse flow to external flush fixture and release to the environment	F1	S3	E06	15X
B-1-a	OGT-FLOW2-02	DST & SST tank inventory	Release of radioactive or hazardous aerosols from the primary pipe due spray leak caused by over-rated pump	Installation of incorrect pump and failure of inner pipe, failure of weld on flange of outer pipe, isolation valves closed on secondary pipe drains and no concrete shield in place	F2	S3	E13	15X
B-1-a	OGT-NP3-01	DST & SST tank inventory	Release of radioactive or hazardous aerosols from the primary pipe due spray leak caused by seismic event	Failure of line and concrete shielding during seismic event	F1	S3	D18	15X
B-1-a	OGT-NP3-02	DST & SST tank inventory	Release of radioactive or hazardous aerosols from the primary pipe due to leak caused by high wind	Pipe is blown off supports and no concrete shielding in place	F1	S3	D20	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	OGT-TEMP1-02	DST & SST tank inventory	Release of radioactive or hazardous vapors/aerosols from the primary pipe due to spray leak caused by high temperatures	Vehicle accident above ground starts fire, melt the EPDM hose causing a leak to secondary pipe, pumping occurring, fire fails gasket and facilitates a release to atmosphere	F1	S2	E25	15X
B-1-a	RCSTS-03-FLOW/INTEG03a	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error)	F2	S3	E06	15X
B-1-a	RCSTS-03-FLOW/INTEG03b	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure	F2	S3	D12	15X
B-1-a	RCSTS-03-FLOW/INTEG03c	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion	F2	S3	D16	15X
B-1-a	RCSTS-03-FLOW/ INTEG04a	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error)	F2	S3	E06	15X
B-1-a	RCSTS-03-FLOW/ INTEG04b	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure	F2	S3	D12	15X
B-1-a	RCSTS-03-FLOW/ INTEG04c	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion	F2	S3	D16	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-03-FLOW06	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	S3	E06	15X
B-1-a	RCSTS-03-FLOW07	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	S3	D12	15X
B-1-a	RCSTS-03-FLOW08	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	S3	E06	15X
B-1-a	RCSTS-03-INTEG03	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	S3	D12	15X
B-1-a	RCSTS-03-INTEG09	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	RCSTS-03-INTEG11	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	RCSTS-08-FLOW06	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-08-FLOW07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	15X
B-1-a	RCSTS-08-FLOW08	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	S3	D12	15X
B-1-a	RCSTS-08-FLOW09	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	S3	D06	15X
B-1-a	RCSTS-08-INTEG08	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of piping due to corrosion	F2	S3	D16	15X
B-1-a	RCSTS-08-INTEG09	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	RCSTS-08-INTEG10	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	RCSTS-08-INTEG11	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S3	B08	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-08-INTEG13	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of piping due to material defect	F2	S3	D12	15X
B-1-a	RCSTS-08-INTEG14	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	F1	S3	D26	15X
B-1-a	RCSTS-08-PRES01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	S3	D17	15X
B-1-a	RCSTS-08-PRES04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Water hammer	F3	S3	D17	15X
B-1-a	RCSTS-08-PRES05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Water hammer	F3	S3	D17	15X
B-1-a	RCSTS-08-TEMP02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	S3	D24	15X
B-1-a	RCSTS-08-TEMP03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	S3	D24	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-09-FLOW08	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	15X
B-1-a	RCSTS-09-FLOW09	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	15X
B-1-a	RCSTS-09-FLOW10	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	External leak of valve or valves to the vent station	F3	S3	D12	15X
B-1-a	RCSTS-09-INTEG11	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of piping due to corrosion	F2	S3	D16	15X
B-1-a	RCSTS-09-INTEG12	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	RCSTS-09-INTEG13	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	RCSTS-09-INTEG14	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S3	B08	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-09-INTEG15	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of piping due to material defect	F2	S3	D12	15X
B-1-a	RCSTS-09-PRES03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	S3	D17	15X
B-1-a	RCSTS-09-PRES04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Water hammer	F3	S3	D17	15X
B-1-a	RCSTS-09-PRES05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Water hammer	F3	S3	D17	15X
B-1-a	RCSTS-09-TEMP03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S3	D24	15X
B-1-a	RCSTS-09-TEMP04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S3	D24	15X
B-1-a	RCSTS-22-PRESS01*	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	S3	D12	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-22-PRESS02*	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	S3	D12	15X
B-1-a	RCSTS-24-FLOW/ INTEG07	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to corrosion	F2	S3	D16	15X
B-1-a	RCSTS-24-FLOW/ INTEG08	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to corrosion	F2	S3	D16	15X
B-1-a	RCSTS-24-FLOW/ INTEG09	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to gasket failure	F3	S3	D12	15X
B-1-a	RCSTS-24-FLOW/ INTEG10	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to gasket failure	F3	S3	D12	15X
B-1-a	RCSTS-24-FLOW/ INTEG11	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to misalignment	F3	S3	D06	15X
B-1-a	RCSTS-24-FLOW/ INTEG12	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to misalignment	F3	S3	D06	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-24-FLOW05	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	15X
B-1-a	RCSTS-24-FLOW06	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	15X
B-1-a	RCSTS-24-FLOW07	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	External leak of valve or valves to the lift station	F3	S3	D12	15X
B-1-a	RCSTS-24-FLOW08	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	External leak of valve or valves to the lift station	F3	S3	D12	15X
B-1-a	RCSTS-24-INTEG07	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	RCSTS-24-INTEG08	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	External event (airplane crash, etc)	F0	S3	D23	15X
B-1-a	W058-FLOW15	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	S3	E06	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W058-FLOW16	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	S3	D12	15X
B-1-a	W058-FLOW17a	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error) plus mitigative features failure	F2	S3	E06	15X
B-1-a	W058-FLOW17b	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure plus mitigative features failure	F2	S3	D12	15X
B-1-a	W058-FLOW17c	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion plus mitigative features failure	F2	S3	D16	15X
B-1-a	W058-FLOW18	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	S3	E06	15X
B-1-a	W058-FLOW19	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit plus mitigative features failure	F2	S3	D12	15X
B-1-a	W058-FLOW20a	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error) plus mitigative features failure	F2	S3	E06	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W058-FLOW20b	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure plus mitigative features failure	F2	S3	D12	15X
B-1-a	W058-FLOW20c	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion plus mitigative features failure	F2	S3	D16	15X
B-1-a	W058-INTEG32	Amount of supernate or slurry aerosol that could be released through a small orifice	Release of radioactive supernate or slurry aerosols to the atmosphere due to a spray leak from test risers located near SY-A and SY-B valve pits	Failure of primary piping and path for spray leak from test riser plus mitigative features failure	F2	S3	D12	15X
B-1-a	W058-INTEG34	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	S3	D23	15X
B-1-a	W058-INTEG35	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	S3	D18	15X
B-1-a	W058-INTEG36	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	S3	D23	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W058-INTEG37	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	S3	D18	15X
A-1-a	W320-ABCD-TRANS11	Tank inventory	Release of radioactive aerosols from transfer piping in Tank 241-AY-102 pit to atmosphere due to spray leak	Line break due to flammable gas ignition in pit causing cover blocks to fall onto piping resulting in spray leak	F2	S3	B08	15X
A-1-a	W320-ABCD-TRANS11*	Tank inventory	Release of radioactive aerosols from Tank 241-AY-102 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F2	S3	B08	15X
B-1-a	W320-ABCD-TRANS12	Transfer line Inventory	Release of radioactive aerosols from Tank 241-AY-102 distributor pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach in distributor pit with cover block off during slurry transfer	F2	S3	D12	15X
A-1-a	W320-B-TRANS23	Transfer line Inventory	Release of radioactive aerosols from Tank 241-AY-102 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach in pump pit with cover block off during sluicing	F2	S3	D12	15X
A-1-a	W320-B-TRANS24	Transfer line Inventory	Release of radioactive aerosols from Tank 241-C-106 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	F2	S3	D12	15X
A-1-a	W320-B-TRANS25	Transfer line Inventory	Release of radioactive aerosols from Tank 241-C-106 sluice pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	F2	S3	D12	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-B-TRANS26	Transfer line Inventory	Release of radioactive aerosols from Tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F2	S3	B08	15X
A-1-a	W320-B-TRANS27	Transfer line Inventory	Release of radioactive aerosols from Tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas fire/ deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F1	S3	B08	15X
B-1-a	W320-B-TRANS28	Tank 241-C-106 inventory	Release of radioactive aerosols from Tank 241-AY-102 distributor pit due to sray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	S2	D12	15X
B-1-a	W320-B-TRANS29	Tank 241-AY-102 inventory	Release of radioactive aerosols from Tank 241-AY-102 pump pit due to sray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	S2	D12	15X
B-1-a	W320-B-TRANS30	Tank 241-C-106 inventory	Release of radioactive aerosols from Tank 241-C-106 pump pit due to sray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	S2	D12	15X
B-1-a	W320-B-TRANS31	Tank 241-AY-102 inventory	Release of radioactive aerosols from Tank 241-C-106 sluice pit due to sray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	S2	D12	15X
A-1-a	W320-BCD-FLUSH01	Transfer line inventory	Release of radioactive aerosols from line in pit to atmosphere due to spray leak from mispositioned valve, cover plug removed	3-way valve left in flush position after flushing, cover plug is lifted out of cover block on initiation of sluicing process	F3	S3	E06	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-BCD-FLUSH02*	Transfer line inventory	Release of radioactive aerosols from flush tank of transfer truck to atmosphere due to spray leak from starting submersible pump in Tank 241-C-106 during the flush of slurry transfer line	Submersible pump in Tank 241-C-106 is started during the flush of slurry transfer line, flush tank is filled and pressurized resulting in rupture of flush tank or flush transfer line	F3	S3	E06	15X
A-1-a	W320-BCD-TRANS11	Transfer line inventory	Release of radioactive aerosols from transfer line in Tank 241-C-106 pit to atmosphere due to spray leak in transfer connection	Blank flange left off flushing connection in pit after flushing, cover plug is lifted out of cover block on initiation of sluicing	F3	S3	E06	15X
A-1-a	W320-BCD-TRANS12	Transfer line inventory	Release of radioactive aerosols from transfer line in Tank 241-AY-102 pit to atmosphere due to spray leak in transfer connection	Blank flange left off flushing connection in pit after flushing, cover plug is lifted out of cover block on initiation of sluicing	F3	S3	E06	15X
A-1-a	W320-BCD-TRANS13	Tank 241-C-106 inventory	Release of radioactive aerosols from line in pit to atmosphere due to spray leak from mispositioned valve, cover plug in place	3-way valve left in flush position after flushing, cover plug remains in place on initiation of sluicing process, high capacity drain cover left on and pit overflows	F3	S2	E06	15X
B-1-a	W320-D-PUMP01	Tank 241-AY-102 inventory	Release of radioactive aerosols from Tank 241-AY-102 transfer pit to atmosphere due to spray leak from break in jumper connectors, cover block is off	Immersible pump being positioned to high resulting in air entrainment in transfer line, booster pump torques in reaction to air in transfer line and jumper connectors break, cover block is off	F1	S3	D12	15X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-D-PUMP03	Transfer line inventory	Release of radioactive aerosols from Tank 241-C-106 transfer pit to atmosphere due to spray leak from break in jumper connectors, cover block is off	Immersible pump being positioned too high resulting in air entrainment in transfer line, booster pump torques in reaction to air in transfer line and jumper connectors break, cover block is off	F1	S3	E02	15X
B-1-a	W320-D-TRANS10	Transfer line inventory	Release of radioactive aerosols from pit to atmosphere due to spray leak from jumper	Seismic event damages jumper and breaches cover block by ground motion resulting in spray release	F2	S3	D18	15X
B-1-a	XS-01-TEMP01	Liquid radioactive waste in saltwell or PFP transfer piping to DCRT	Release of steam-aerosol from transfer piping in pump pit due to steam hammer and resulting pipe damage	Extended recirculation and consequential heating of saltwell liquid with sudden opening of valve when cover block is open	F3	S2	D06	15X
B-1-a	XS-06-FLOW03	Radioactive waste being transferred from PFP to DCRT	Release of liquid radioactive waste from transfer piping from PFP to DCRT due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	S3	D12	15X
B-1-a	XS-06-FLOW04	Radioactive waste being pumped from SST to DCRT	Release of liquid radioactive waste from transfer piping from an SST to a DCRT due to spray leak (SPUTTER) of saltwell liquor from DCRT pump pit	Pipe failure	F2	S2	D12	15X
ANALYZED ACCIDENT: Spray Leak from Underground Waste Transfer Lines								
B-1-a	EE-16	Material leaked from transfer line	Release of radioactive and hazardous material from transfer line spray leak due to excavation error	Excavation into waste transfer line during a transfer	F3	S3	D22	16

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITIONS								
B-1-a	102AW-01-TEMP	Radioactive waste being pumped to DCRT	Release of liquid radioactive waste aerosols from transfer pipe to Tank 241-AW-102 due to spray leak of liquid waste from transfer pipe leak	Piping leak due to exceeding the design temperature of the pipe by transferring high temperature waste	F1	S3	D01	16X
B-1-b	CP-RMV-03	Material leaked from transfer line	Release of radioactive or toxic material from transfer line through the push pipe during removal activities	Human error	F1	S3	D22	16X
B-1-b	I-222S-2-LEK-C	222-S lab waste from Tank 219-S-102 (capacity 4000 gal)	Release of 222-S lab waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	S2	D22	16X
B-1-b	I-242A-1-LEK-C	Liquid waste from Tank 241-AW-102	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line causes spray leak	F2	S2	D22	16X
B-1-b	I-242A-2-LEK-C	Slurry from the evaporator	Release of slurry tank waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line causes spray leak	F2	S2	D22	16X
B-1-b	I-242S-2-LEK-C	Contaminated fire water from 242-S pump room	Release of contaminated water to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	S2	D22	16X
B-1-b	I-BPLANT-2-LEK-C	Low level waste from B Plant Tank 24-1 (administrative volume limit 7500 gal)	Release of low level waste to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	S2	D22	16X
B-1-b	I-PFP-2-LEK-C	TRU mixed waste from PFP Tank D-5	Release of TRU mixed waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	S2	D22	16X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-b	I-PFP-3-LEK-C	TRU mixed waste from PFP Tank D-5	Release of TRU mixed waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	S2	D22	16X
B-1-b	I-PUREX-2-LEK-C	TRU waste from PUREX	Release of TRU waste from PUREX to the atmosphere due to spray leak at the rupture of the line from inadvertent excavation	Inadvertent excavation of line causes spray leak	F2	S2	D22	16X
B-1-b	I-PUREX-4-LEK-C	TRU waste from PUREX	Release of TRU waste from PUREX to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	S2	D22	16X
B-1-b	I-TPLANT-2-LEK-C	Low level waste from T Plant Tank 15-1 (approximate capacity 14,500 gal)	Release of low level waste to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	S2	D22	16X
C-3-b	NP-08	Inventory in transfer lines	Radioactive and hazardous material releases from transfer pipes due to seismic event (possible spray leak)	Seismic event shears pipes and encasements during transfer	F2	S3	D18	16X
B-1-a	RCSTS-10/11-INTEG03b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	16X
B-1-a	RCSTS-12/13-INTEG03b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A lift station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	16X
B-1-a	RCSTS-18/19-INTEG03b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	16X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-B-TRANS32	Transfer line Inventory	Release of radioactive aerosols from transfer line to atmosphere due to spray leak	Transfer line break due to light aircraft strike on underground transfer line berm	F0	S3	D23	16X
ANALYZED ACCIDENTS: Caustic Spray Leak								
B-1-a	107AN-02-PRES	Contents of caustic truck	Release of caustic aerosol from caustic truck transfer piping due to spray leak	Piping/hose leak initiated by various causes	F3	S2	D12	17
HAZARDOUS CONDITIONS								
B-1-a	107AN-01-LEVE01	Caustic solution	Release of caustic material from truck tank due to leak (aerosol spray)	Open valve on truck with pressurized tank transfer.	F3	S2	E06	17X
B-1-a	107AN-01-LEVE02	Caustic solution	Release of caustic material from truck tank due to leak (aerosol spray)	Truck tank leak	F2	S2	D12	17X
B-1-a	107AN-01-TEMP02	Caustic solution	Spray release of caustic material from truck tank due to high temperature	Fire in gas tank	F1	S2	D09	17X
B-1-a	107AN-02-PRES02	Caustic solution	Release of caustic material from transfer piping due to high pressure (aerosol spray)	Hose disconnect	F3	S2	D06	17X
B-1-a	RCSTS-2FS-FLOW01	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line break (upstream of flush pump) due to structural failure	F2	S2	D26	17X
B-1-a	RCSTS-2FS-FLOW02	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line break (downstream of flush pump) due to structural failure	F2	S2	D26	17X
B-1-a	RCSTS-2FS-FLOW03	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	S2	D26	17X
B-1-a	RCSTS-2FS-FLOW04	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	S2	D26	17X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-2FS-FLOW05	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure	Caustic injection pressure relief valve failure	F3	S2	D12	17X
B-1-a	RCSTS-2FS-FLOW07	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Flush line break due to structural failure	F2	S2	D26	17X
B-1-a	RCSTS-2FS-PRES01	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due line plug	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	S2	D26	17X
B-1-a	RCSTS-2FS-PRES02	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	S2	D26	17X
B-1-a	RCSTS-2FS-PRES03	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a line break	Flush line break due to structural failure	F2	S2	D26	17X
B-1-a	RCSTS-2FS-TEMP01	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	S2	D26	17X
B-1-a	RCSTS-2FS-TEMP02	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions	Freezing weather with loss of heat trace function	F2	S2	D24	17X
B-1-a	RCSTS-4FS-FLOW03	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open	Pressure relief valve fails open	F2	S2	D12	17X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	RCSTS-4FS-FLOW04	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open	Back pressure valve fails in closed position	F2	S2	D12	17X
B-1-a	RCSTS-4FS-FLOW05	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package	Line failure/leak due to structural failure	F2	S2	D19	17X
B-1-a	RCSTS-4FS-FLOW06	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak	Caustic drain valve leak	F2	S2	D12	17X
B-1-a	RCSTS-4FS-PRES/ TEMP01	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open	Pressure relief valve fails open on caustic injection system	F2	S2	D06	17X
B-1-a	RCSTS-4FS-PRES/ TEMP02	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line	Back pressure relief valve fails in closed position	F3	S2	D12	17X
B-1-a	RCSTS-5FS-FLOW01	Caustic water based solution	Release of caustic to the atmosphere from caustic line due to a line break	Line break due to structural failure	F2	S2	D19	17X
B-1-a	RCSTS-5FS-FLOW02	Caustic water based solution	Release of caustic to the atmosphere from caustic line due to a line break	Line plug due to debris buildup causing pressure buildup resulting in pipe failure	F2	S2	D19	17X
ANALYZED ACCIDENT: Tank Bump								
B-1-a	102AW-02-TEMP02	DST tank vapors/aerosols	Release of radioactive aerosols from Tank 241-AW-102 due to tank bump	High heat waste combined with loss of ventilation contributes to tank bump	F2	S2	D01	18A
HAZARDOUS CONDITIONS								
B-1-a	102AW-09-TEMP01	DST tank vapors/aerosols	Release of radioactive aerosols from Tank 241-AW-102 atmosphere due to tank bump	High heat waste plus loss of cooling and/or mixing pump (not yet installed) operation	F2	S2	D01	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	114SX-05.b.2	Radioactive aerosols contained in the tank headspace and some tank waste material (this tank has a dry crust which may be composed of easily disturbed dusty material)	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to sudden flashing of water added to tank for cooling	Flashing (adding cold liquid to hot tank contents)	F0	S2	D01	18AX
B-1-a	W030-25	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of the tank recirculation system fan resulting in tank bump	F3	S3	D07	18AX
B-1-a	W030-26	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of one of the main ventilation system exhaust fans resulting in tank bump	F3	S3	D07	18AX
B-1-a	W030-27	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of both of the main ventilation system fans resulting in tank bump	F2	S3	D07	18AX
B-1-a	W030-28	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank ventilation due to loss of AC power resulting in tank bump	F0	S3	D07	18AX
B-1-a	W030-29A	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from Tank 241-AZ-101 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AZ101-K1-3-1 or HEPA AZ101-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	S3	D07	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W030-29B	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from Tank 241-AZ-102 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AZ102-K1-3-1 or HEPA AZ102-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	S3	D07	18AX
B-1-a	W030-29C	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from Tank 241-AY-101 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AY101-K1-3-1 or HEPA AY101-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	S3	D07	18AX
B-1-a	W030-29D	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from Tank 241-AY-102 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AY102-K1-3-1 or HEPA AY102-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	S3	D07	18AX
B-1-a	W030-30	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of exhaust system HEME AZ-K1-9-1 resulting in tank bump	F3	S3	D07	18AX
B-1-a	W030-31A	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of the exhaust system HEPA/HEGA filters (AZ-K1-10-1A) resulting in tank bump	F3	S3	D07	18AX
B-1-a	W030-31B	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of the exhaust system HEPA/HEGA filters (AZ-K1-10-1B) resulting in tank bump	F3	S3	D07	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W030-32	Radioactive and toxic materials confined in head space	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse caused by tank bump	Loss of ventilation due to failure of the seal pot allowing water to back up to HEME and/or exhaust system condenser resulting in tank bump	F3	S3	D07	18AX
B-1-a	W151-38	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere due to tank bump	F3	S2	D07	18AX
B-1-a	W151-42	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere due to tank bump	F0	S2	D07	18AX
B-1-a	W151-46	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in tank	Release of radioactive/ hazardous material from tank to the atmosphere due to tank bump	F1	S2	D18	18AX
B-1-a	W320-A-TRANS01a	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to a large steam bump	Increase in waste temperature due to flowmeters fault, operator error, level indication fault, or Tank 241-C-106 T/C fault during sluice	F2	S2	D02	18AX
B-1-a	W320-A-TRANS01b	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to a large steam bump	Increase in waste temperature due to inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump	F2	S2	D02	18AX
B-1-a	W320-A-TRANS02	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Lowering of tank level with temperature out of spec due to equipment fault/failure or operator error resulting in tank bump	F3	S2	D02	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-A-TRANS03	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to steam bump	Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump resulting in high waste temperature during slurry transfer and resulting steam bump	F3	S2	E06	18AX
B-3-b	W320-ABCD-ALL04	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Water intrusion into Tank 241-C-106 causing water level to exceed maximum operating level, tank unsound above, waste leaks behind liner (via surface water flood, system water inleakage, excessive transfer, etc) resulting in steam bump	F3	S2	D12	18AX
B-3-b	W320-ABCD-ALL05	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Water intrusion into Tank 241-C-106 with water level exceeding top of liner level, leaking behind liner (via surface water flood, system water inleakage, excessive transfer, etc) and resulting steam bump	F2	S2	D12	18AX
B-1-a	W320-ABCD-TRANS01	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosols to the atmosphere due leak into tank liner gap resulting in steam bump	Inadvertent operator action directing sluicer nozzle jet at tank wall resulting in wall breach and water leaking into liner gap where steam vapor forms, steam bump breaches tank bottom	F3	S2	D06	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-ABCD-TRANS02	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Unavoidable operator action causing loss of sluicer arm control in tank resulting in jet striking tank liner with liner being breached, water leakage into liner gap and steam formation resulting in breach of tank bottom from steam bump	F2	S2	D06	18AX
A-1-a	W320-ABCD-TRANS03	Tank 241-C-106 inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Buildup of solids in openings or equipment casualty causes siphoning of waste from Tank 241-AY-102 to Tank 241-C-106 exceeding maximum operating level resulting in water leakage into liner gap, steam formation and bump breaching tank	F1	S2	D06	18AX
B-1-a	W320-ABCD-TRANS05	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer hose break resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breach of tank bottom from steam bump	F2	S2	D04	18AX
B-1-a	W320-ABCD-TRANS06	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicing arm breaks off penetrating tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F0	S2	D04	18AX
B-1-a	W320-ABCD-TRANS07	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner, water leakage under tank bottom, steam formation and bump breaching tank bottom	F2	S2	D04	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-ABCD-TRANS08	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching of tank bottom	F2	S2	D04	18AX
B-1-a	W320-ABCD-TRANS09	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High temperature sluice water from Tank 241-AY-102 causes excessive waste temperature change rate, liner breaches, water leakage under tank bottom, steam formation and bump breaching tank bottom	F1	S2	D04	18AX
B-1-a	W320-B-FLUSH02	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 through failed filters due to a large steam bump	Flush water spray condenses dome vapors causing high tank vacuum that results in a large steam bump	F0	S2	D11	18AX
C-1-a	W320-B-FLUSH03	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 through failed filters due to a large steam bump	Flush water spray through antisiphon holes causing high condensation rate in tank and high tank vacuum resulting in large steam bump	F0	S2	D11	18AX
C-1-a	W320-B-PUMP01	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due steam bump	Overheating of waste due to equipment fault/failure or operator error and subsequent steam bump	F3	S2	D14	18AX
C-1-a	W320-B-TRANS02	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Low slurry flow, piling of waste at base of distributor and resulting tank bump	F1	S2	D14	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-B-TRANS04	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 214-C-106 to atmosphere through failed filters tank bump	High slurry transfer rate and high waste temperature due to equipment fault/failure or operator error resulting in tank bump	F1	S2	D14	18AX
C-1-a	W320-B-TRANS05	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to steam bump and increased head space vapor pressure	Buildup of solids pile under distributor as a result of low slurry flow which results in steam bump and increased head space vapor pressure	F1	S2	D14	18AX
C-1-a	W320-B-TRANS09	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to steam bump and increased head space vapor pressure	Buildup of solids pile under distributor as a result of the distributor nozzle breaking off which causes steam bump	F1	S2	D04	18AX
B-1-a	W320-BCD-ALL07a	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Raw water leak causing water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching tank	F1	S2	D19	18AX
B-1-a	W320-BCD-ALL07b	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol to the atmosphere due to steam bump in liner gap	Surface water flood causing water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching tank bottom	F1	S2	D19	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-BCD-ALL08	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosols to the atmosphere due to steam bump in liner gap	Inadequate prediction of waste behavior causes excessive corrosion because of waste disturbance in tank resulting in leakage into liner gap, steam formation and bump breaching tank bottom	F2	S2	D16	18AX
B-1-a	W320-BCD-PUMP08	Tank inventory	Release of liquid waste to the annulus of Tank 241-C-106 and aerosol release to atmosphere due to penetration of tank and steam bump in liner gap	Submersible pump raised too high, winch lifting strap fails, pump falls and penetrates primary tank liner resulting in waste and steam bump	F0	S2	D26	18AX
C-1-a	W320-BCD-TRANS05	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Condensation of vapors due to failure of distributor causing vacuum in headspace and tank bump failing filters	F0	S2	D14	18AX
C-1-a	W320-BCD-TRANS06	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Breaking off of distributor head causing tank bump and failed filters	F0	S2	D14	18AX
C-1-a	W320-BCD-TRANS07	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to large steam bump	Filter breach from failure of T/C Tree, sluicing outside of temperature specs and large steam bump	F3	S2	D02	18AX
C-1-a	W320-BCD-TRANS08	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to tank bump	Undetected high waste temperature with many objects in waste resulting from high pressure sluice causing tank bump	F1	S2	D02	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-3-b	W320-BCD-TRANS09	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 exceeds maximum operating water level resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	S2	D06	18AX
B-1-a	W320-D-ALL01	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to a steam bump	Human error or activation of ALCs during high temperature conditions causing steam bump	F3	S2	E02	18AX
B-1-a	W320-D-ALL02a	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing tank bump	F1	S2	E02	18AX
B-1-a	W320-D-ALL02b	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing tank bump	F1	S2	D18	18AX
B-1-a	W320-D-ALL03a	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing bump in interconnected tank resulting in a tank bump and filter breach	F0	S2	D02	18AX
B-1-a	W320-D-ALL03b	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing bump in interconnected tank resulting in a tank bump and filter breach	F0	S2	D02	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-D-ALL04a	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing bump in interconnected tank resulting in a tank bump and filter breach	F0	S2	D07	18AX
B-1-a	W320-D-ALL04b	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing bump in interconnected tank resulting in a tank bump and filter breach	F0	S2	D18	18AX
B-1-a	W320-D-ALL05	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Long term loss of ventilation system resulting in tank bump and blowout of filters	F2	S2	D07	18AX
C-1-a	W320-D-ALL06	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to seismic event	Seismic event induces a steam bump in tank resulting in failure of filters or ducting	F1	S2	D18	18AX
C-3-b	W320-D-ALL09	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Seismic event breaches liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	S2	D18	18AX
C-1-a	W320-D-TRANS01	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Rapid waste level change, high waste temperature and resulting tank bump	F1	S2	D02	18AX
C-1-a	W320-D-TRANS08	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to large steam bump	Excessive fluffing of waste in tank resulting in large steam bump and unfiltered release	F1	S2	D02	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-D-TRANS09	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High pressure sluice induces movement of debris present in waste which impact and breach the tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	S2	D12	18AX
B-1-a	W320-D-VENT02	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to steam bump	Inadequate ventilation from W030 resulting in increased waste temperature, steam bump and filter breach	F3	S2	D07	18AX
C-1-a	W320-D-VENT03	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters in the 702A ventilation system due to tank bump	Severe ice storm causes excessive tank vacuum resulting in tank bump	F2	S2	D24	18AX
C-1-a	W320-D-VENT04	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 through failed filters due to tank bump	Cold water spray into tank (possible result of slurry distribution) tank vacuum and resulting tank bump	F0	S2	D11	18AX
C-1-a	W320-D-VENT05	Tank dome space inventory and filter burden	Release of radioactive aerosols from tank to atmosphere through failed filters in the W030 ventilation system due to tank bump	Severe ice storm causes excessive tank vacuum resulting in tank bump	F2	S2	D24	18AX
C-1-a	W320-D-VENT06	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to large steam bump	Volcanic ashfall causes excessive vacuum resulting in large steam bump and filter blowout	F0	S2	D18	18AX
C-1-a	W320-D-VENT09	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to loss of primary or annulus ventilation	Extended loss of power or severe ventilation casualty causes loss of primary or annulus ventilation which results in steam release	F1	S2	D07	18AX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-D-VENT19	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due large tank bump	Extended loss of power or severe ventilation casualty causes loss of primary or annulus ventilation for extended period of time resulting in rise in waste temperature and large tank bump	F0	S2	D07	18AX
B-1-a	W320-F-TERM05	Tank inventory	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Error in calculations cause high heat load after completion of sluicing process resulting in the need for water addition to tank with deteriorated tank liner, water leakage into liner gap, steam formation and bump breaching tank bottom	F1	S2	D12	18AX
B-1-a	XS-26-TEMP01	DST tank vapors/aerosols	Release of radioactive aerosols from Tank 241-AW-102 due to tank bump	High heat waste plus loss of cooling contributes to tank bump	F2	S2	D01	18AX
ANALYZED ACCIDENT: Unfiltered Release								
B-1-a	114SX-04.c.2.a	Radioactive aerosols contained in the tank headspace	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter seal failure	HEPA filter seal failure	F3	S2	D07	18B
HAZARDOUS CONDITIONS								
B-1-a	106C-11E	Tank atmosphere	Release of unfiltered tank atmosphere from Tank 241-C-106 due to damaged duct work	Damage to ventilation duct work upstream of filters	F3	S2	D07	18BX
B-1-a	106C-11L	Tank atmosphere, residual filter surface contamination	Release of radioactive and/or hazardous material from Tank 241-C-106, through HEPA filter path, due to human error in installation of filter	Improper installation of HEPAs	F3	S2	E07	18BX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	114SX-04.b.1.b.1b	Radioactive aerosols located in tank headspace	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to failure of exhaust ducting from seismic event (mechanical disruption)	Ducting failure from seismic activity	F1	S2	D18	18BX
B-1-a	114SX-04.c.1	Radioactive aerosols contained in tank headspace	Release or radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to mechanical failure of exhauster HEPA filter	Plenum structure failure pierces filter	F2	S2	D07	18BX
B-1-a	114SX-04.c.2.b	Radioactive aerosols contained in the tank headspace	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster defective HEPA filter	Defective HEPA filter	F3	S2	D07	18BX
B-1-a	114SX-04.c.2.d	Radioactive aerosols contained in the tank headspace	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter installation errors	Improper installation (human error)	F2	S2	E07	18BX
B-1-a	CRN-09-I	Residual materials in the ventilation duct work or ventilation filters	Release of radioactive and/or toxic materials from ventilation system due to damage caused by crane operation	Human error in positioning crane load	F3	S2	E26	18BX
B-1-a	CRN-10-I	Residual materials in the ventilation duct work or ventilation filters	Release of radioactive and/or toxic materials from ventilation system due to damage caused by crane operation	Mechanical failure in positioning crane load	F2	S2	D26	18BX
C-1-c	RCSTS-08-FILTER01*	Residual contamination in Diversion Box 6241-A	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter	Tornado or high winds across inlet	F1	S2	D20	18BX
C-1-c	RCSTS-08-FILTER02*	Residual contamination in Diversion Box 6241-A	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter	HEPA filter structural failure or seal failure	F3	S2	D12	18BX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-c	RCSTS-09-FILTER01*	Residual contamination in Vent Station 6241-V	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter	Tornado or high winds across inlet	F1	S2	D20	18BX
C-1-c	RCSTS-09-FILTER02*	Residual contamination in Vent Station 6241-V	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter	HEPA filter structural failure or seal failure	F3	S2	D12	18BX
B-1-a	W151-05	Tank headspace	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank ventilation ducting to atmosphere due to unfiltered release	F2	S2	D20	18BX
B-1-a	W151-09	Tank headspace	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank headspace to atmosphere due to unfiltered release	F1	S2	D20	18BX
C-1-a	W320-ABCD-CHILL01	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to exceedance of loop seal vacuum	Excessive cooling from process chiller causing vacuum in tank from ventilation system which results in exceedance of inlet filter loop seal vacuum and unfiltered release	F2	S1	D11	18BX
C-1-a	W320-ALL-TRANS02	Duct and filter burden	Release of radioactive aerosols from ventilation ducting due to high winds or tornado	High winds or tornado resulting in failed ventilation ducting and unfiltered release	F2	S2	D20	18BX
A-1a	W320-ALL-VENT01	Duct and filter burden	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to ammonium nitrate fire/deflagration	Buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc causing a breach in the ducting (assumes ventilation system failure)	F1	S1	B09	18BX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-B-ALL07	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Flammable gas collects in pit where it is ignited causing the displacement and fall of the cover block which strikes a riser-liner joint resulting in an unfiltered release from dome space	F3	S1	B08	18BX
C-1-a	W320-B-TRANS03	Tank dome space inventory and filter burden	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to condensation of vapor in head space	Condensation of vapor in head space of Tank 241-C-106 which resulted from the breaking off of sluicer head (sluicer failure, water hammer, thermal shock, corrosion or fatigue)	F0	S2	D07	18BX
C-1-a	W320-B-TRANS13	Tank dome space inventory	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Flammable gas collects/ignites in tank pit resulting in the cover blocks being displaced, falling into pit, striking riser-liner joint causing an unfiltered release from dome space	F2	S1	B08	18BX
C-1-a	W320-D-PURGE01	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to nitrogen line break	Nitrogen line break accompanied by loss of vacuum in system	F0	S2	D01	18BX
C-1-a	W320-D-TRANS03	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to tank dome breach from impact	During high velocity sluicing operations sluicer moves debris in waste impacting drop leg in tank which breaches dome causing unfiltered release (assumes ventilation system failure)	F2	S1	D04	18BX

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-D-TRANS04	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to increased head space pressure	High temperature in Tank 241-AY-102 causes high temperature sluice water resulting in increased head space pressure with increased errant flow (assumes ventilation system failure)	F2	S1	D02	18BX
C-1-a	W320-D-VENT07	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-105/C-106 ventilation system to atmosphere due to ventilation system leak	Ducting corrosion or seal deterioration undetermined during sluicing (assumes ventilation system failure)	F2	S1	D16	18BX
C-1-a	W320-D-VENT08	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum in tank from new ventilation system resulting in loop seal failure and unfiltered release	F3	S1	D11	18BX
C-1-a	W320-D-VENT11	Tank dome space inventory	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum from current ventilation system resulting in loop seal failure and unfiltered release	F3	S1	D11	18BX
ANALYZED ACCIDENT: Subsurface Leak Resulting in a Pool								
B-3-b	XS-07-FLOW02	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer piping out of 244 TX DCRT due to leak in primary pipe and encasement	Corrosion of inner and outer pipe	F3	S2	D16	21A
B-3-b	XS-07-FLOW06	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	Water hammer causes failure of primary pipe and encasement	F3	S2	D17	21B

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITIONS								
B-2-b	102AW-01-FLOW02	Liquid radioactive waste being transferred to DST	Release of radioactive waste to soil from transfer piping which runs to Tank 241-AW-102 due to leak from primary pipe and encasement	Excavation accident fails primary pipe and encasement	F3	S2	D22	21X
B-3-b	102AW-01-FLOW03	Liquid radioactive waste being transferred to DST	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Corrosion of inner and outer pipe cause failure of primary pipe and encasement	F3	S2	D16	21X
B-3-b	102AW-01-FLOW04	Liquid radioactive waste being transferred to DST	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	High structural loading from traffic or cranes fails primary pipe and encasement	F3	S2	D10	21X
B-3-b	102AW-01-FLOW05	Liquid radioactive waste being transferred to DST	Release of radioactive waste to soil from transfer piping to Tank 241-AW-102 due to leak from primary pipe and encasement	Seismic event fails primary pipe and encasement	F2	S2	D18	21X
B-3-b	102AW-01-FLOW06	Liquid radioactive waste being transferred to DST	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Undermining due to leak of nearby pipes cause failure of primary pipe and encasement	F3	S2	D12	21X
B-3-b	102AW-01-FLOW07	Liquid radioactive waste being transferred to DST	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Water hammer cause failure of primary pipe and encasement	F3	S2	D17	21X
C-2-b	CP-GRT-02	Liquid waste being transferred	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error AND Mechanical failure of push pipe integrity inside the transfer line	F1	S3	D22	21X
C-2-b	CP-MSP-01	Liquid waste being transferred	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations	F1	S2	D22	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	CP-SSP-01	Liquid waste being transferred	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations.	F1	S3	D22	21X
C-2-b	CP-SSP-16	Liquid waste being transferred	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error AND Mechanical failure of push pipe integrity inside the transfer line	F1	S3	D22	21X
B-2-b	CRN-03-IB	Contents of facility	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Human error results in excessive weight on top of containment	F3	S2	E10	21X
B-2-b	CRN-04-IB	Contents of facility	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Crane or rigging failures drop load resulting in large impact to top of containment	F2	S2	D10	21X
B-2-b	CRN-21-IB	Contents of facility	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility (surface pool)	Human error: improper load assembly, rigging, positioning error	F3	S2	E10	21X
B-2-b	CRN-22-IB	Contents of facility	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility (surface pool)	Mechanical failure: corrosion, faulty materials, hydraulics	F2	S2	D10	21X
C-2-b	RCSTS-04/05-INTEG01a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	S2	D06	21X
C-2-b	RCSTS-04/05-INTEG01b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-04/05-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	S2	D05	21X
C-3-b	RCSTS-04/05-INTEG03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	21X
C-2-b	RCSTS-04/05-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	S2	D12	21X
C-2-b	RCSTS-04/05-TEMP01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	S2	D24	21X
C-3-b	RCSTS-10/11-INTEG01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D19	21X
C-3-b	RCSTS-10/11-INTEG02a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	S2	D16	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-3-b	RCSTS-10/11-INTEG03a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	21X
C-3-b	RCSTS-10/11-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	S2	D23	21X
C-3-b	RCSTS-10/11-INTEG05a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to pipihg system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	21X
C-3-b	RCSTS-10/11-PRES01a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	S2	D17	21X
C-3-b	RCSTS-10/11-TEMP01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	S2	D24	21X
C-3-b	RCSTS-10/11-TEMP02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	S2	D26	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-3-b	RCSTS-12/13-INTEG01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D19	21X
C-3-b	RCSTS-12/13-INTEG02a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	S2	D16	21X
C-3-b	RCSTS-12/13-INTEG03a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	21X
C-3-b	RCSTS-12/13-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	S2	D23	21X
C-3-b	RCSTS-12/13-INTEG05a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	21X
C-3-b	RCSTS-12/13-PRES01a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	F3	S2	D26	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-3-b	RCSTS-12/13-PRES02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	S2	D17	21X
C-3-b	RCSTS-12/13-TEMP01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	S2	D24	21X
C-3-b	RCSTS-12/13-TEMP02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	S2	D26	21X
C-2-b	RCSTS-15/16-INTEG01a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	S2	D12	21X
C-2-b	RCSTS-15/16-INTEG01b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	21X
C-3-b	RCSTS-15/16-INTEG02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F2	S2	D22	21X
C-2-b	RCSTS-15/16-INTEG03a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D12	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-15/16-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	S2	D05	21X
C-2-b	RCSTS-15/16-TEMP01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	S2	D24	21X
C-3-b	RCSTS-18/19-INTEG01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D19	21X
C-3-b	RCSTS-18/19-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	S2	D16	21X
C-3-b	RCSTS-18/19-INTEG03a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	21X
C-3-b	RCSTS-18/19-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	S2	D23	21X
C-3-b	RCSTS-18/19-INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-3-b	RCSTS-18/19-PRES01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	S2	D17	21X
C-3-b	RCSTS-18/19-TEMP01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	S2	D24	21X
C-3-b	RCSTS-18/19-TEMP02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	S2	D26	21X
C-2-b	W058-INTEG01a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	S2	D12	21X
C-2-b	W058-INTEG01b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	S2	D12	21X
C-2-b	W058-INTEG03a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F2	S2	D05	21X
C-2-b	W058-INTEG07a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F3	S2	D12	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W058-INTEG09a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	S2	D24	21X
C-2-b	W058-INTEG11a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	S2	D18	21X
C-2-b	W058-INTEG13a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	S2	D06	21X
C-2-b	W058-INTEG13b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	S2	D12	21X
C-2-b	W058-INTEG14a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc) plus mitigative features failure	F2	S2	D05	21X
C-2-b	W058-INTEG18a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	S2	D12	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W058-INTEG20a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	S2	D24	21X
C-2-b	W058-INTEG22	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	S2	D18	21X
B-3-b	XS-01-PRES01	Liquid radioactive waste in saltwell or PFP transferred to DCRT	Release of liquid radioactive waste from damaged transfer piping to 244 TX DCRT due to over pressure (pool)	Use of wrong size pump and closed valve causes over pressure and subsequent pipe failure	F2	S2	E13	21X
B-3-b	XS-02-FLOW05	PFP waste being transferred to DCRT	Release of liquid radioactive waste to the soil from PFP transfer piping due to pipe break	Pipe break from various causes	F3	S2	D12	21X
B-3-b	XS-06-FLOW05	Radioactive liquid waste transferred from DCRT	Release of waste from transfer pipe out of 244 TX DCRT to the soil due to flow path to soil	Concurrent failure of transfer piping and encasement	F2	S2	D12	21X
B-2-b	XS-07-FLOW01	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer piping out of 244 TX DCRT due to leak in primary pipe and encasement	Excavation accident fails primary pipe and encasement	F3	S2	D22	21X
B-3-b	XS-07-FLOW03	Liquid radioactive waste being transferred out of DCRT	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	High structural loading from traffic or cranes cause failure of primary pipe and encasement	F3	S2	D10	21X
B-3-b	XS-07-FLOW04	Liquid radioactive waste being transferred out of DCRT	Release of radioactive waste to soil from transfer piping of 244 TX DCRT due to leak in primary pipe and encasement	Seismic event fails primary pipe and encasement	F2	S2	D18	21X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-3-b	XS-07-FLOW05	Liquid radioactive waste being transferred out of DCRT	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	Undermining due to leak of nearby pipes cause failure of primary pipe and encasement	F3	S2	D12	21X
B-3-b	XS-52-FLOW01	Liquid radioactive waste transferred to DST	Release of radioactive waste to surface from transfer piping to Tank 244-CR-003 due to leak (pool)	Failure of pipe from various causes	F2	S2	D12	21X
ANALYZED ACCIDENT: Evaporator Dump								
C-1-a	102AW-02-PRES 102AW-02-TEMP	DCRT tank vapor/aerosols	Release of radioactive aerosols from Tank 241-AW-102 due to pressurization	Evaporator dump when intrusive activity is occurring which causes pressurization	F3	S2	D01	22
HAZARDOUS CONDITIONS								
C-1-a	102AW-02-PRES08	DST tank vapor/aerosols	Release of radioactive aerosols from Tank 241-AW-102 due to positive pressure	Evaporator dump of hot liquid generates aerosols and pressurizes the tank	F3	S2	D01	22X
B-1-a	102AW-02-PRES09	DST tank atmosphere	Release of radioactive aerosols from head space of Tank 241-AW-102 due to positive pressure (lower energy than tank bump)	Loss of fan with airlift circulators running, generating aerosols and pressurizing the tank	F3	S2	D07	22X
C-1-a	102AW-09-TEMP	DST pump pit vapor/aerosols	Release of aerosols from Tank 241-AW-102 vapor space due to pressurization	Transfer of hot solution from facility, generates aerosols and pressurizes the tank	F3	S2	D01	22X
B-1-a	102S-04.a3	Gases within the tank waste	Release of radioactive aerosols trapped in gases throughout Tank 241-S-102 waste to the atmosphere due to periodic release of toxic gases (lower energy than tank bump)	Waste growth (bump) due to chemistry within the waste coupled with crust movement	F3	S2	D02	22X
C-1-a	244AR-03.a.05	Radioactive material contained in the tank	Release of radioactive aerosols from tanks headspace due to ventilation system blockage	Ventilation and risers blocked while jetting occurring	F2	S2	D07	22X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	244AR-03.a.08	Radioactive material contained in tank	Release of radioactive aerosols created by boiling waste to the cell atmosphere	Steam being supplied to tank heating/cooling coils	F3	S2	D01	22X
B-1-a	I-242A-2-FLW-A	Aerosols from receiver tank	Release of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank and possible structural damage to the tank	Human error - pump is run at maximum speed	F3	S2	E15	22X
C-1-a	I-242A-2-FLW-B	Aerosols from receiver tank	Release of aerosols to the atmosphere through 12 inch opening in inlet station due to over pressurization of the receiver tank and possible structural damage to the tank	Human error - pump is run at maximum speed	F3	S2	E15	22X
C-1-a	I-242A-2-VSC-A	Aerosols from receiver tank	Release of aerosols in receiver tank due to tank burp from over concentration, potential to generate conditions similar to Tank 241-SY-101, "Tank Burp" due to hydrogen being trapped in thick solution (lower energy than tank bump)	Human error - over concentration of slurry at evaporator	F2	S2	E03	22X
B-1-a	I-242A-3-FLW-A	Aerosols from Tank 241-AW-102	Release of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the feed tank and possible structural damage to the tank	Uncontrolled pot dump at evaporator (loss of electricity or air)	F3	S2	D01	22X
C-1-a	I-242A-3-FLW-B	Aerosols from Tank 241-AW-102	Release of aerosols to the atmosphere through 12 inch opening in inlet station due to over pressurization of the feed tank and possible structural damage to the tank	Uncontrolled pot dump at evaporator (loss of electricity or air)	F3	S2	D01	22X
C-1-a	I-242A-7-FLW-A	Aerosols from the head space of Tank 241-AW-102	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Compressor fails and 241-AW Tank Farm air supplied from 242-A	F1	S2	D05	22X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	I-242A-7-FLW-B	Aerosols from the head space of Tank 241-AW-102	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Valve inadvertently closed, 241-AW Tank Farm air supplied from 242-A	F1	S2	E05	22X
C-1-a	I-242A-7-FLW-C	Aerosols from the head space of Tank 241-AW-102	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Filter plugged, 241-AW Tank Farm air supplied from 242-A	F1	S2	D05	22X
B-1-a	ITK-05	Tank inventory	Release of radioactive and/or hazardous material from point of in-tank access (non-fire, non-explosion) due to intrusive activity	Tank burps from intrusive activity	F2	S2	E04	22X
ANALYZED ACCIDENT: Mixing of Incompatible Material - Toxic Vapor Generation								
C-1-a	XS-26-PRES XS-26-TEMP	DST vapor/aerosols	Release of toxic vapors from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible waste causes chemical reaction	F3	S2	E06	23
HAZARDOUS CONDITIONS								
C-1-a	102AW-02-LEVE01	DST tank vapor/aerosols	Release of toxic gases from Tank 241-AW-102 due to accumulations of gases	Slurry growth	F1	S2	D02	23X
C-1-a	102AW-02-PRES02	DST vapor/aerosols	Release of toxic gases from Tank 241-AW-102 due to chemical reaction in waste	Transfer of incompatible waste to Tank 241-AW-102 causes tank gas accumulation	F3	S2	E01	23X
B-1-a	ITK-05-I	Gases or aerosols generated inside MISF from gas release	Release of radioactive and/or hazardous material from point of in-facility access due to gas release from in-facility waste during intrusive activity (non-fire, non-explosion)	Gas release from in-facility waste during intrusive activity	F2	S2	E04	23X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	RCSTS-01-FLOW05	Ammonia liberated from mixing waste with a limited number of drums of relatively dilute caustic	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic	Human error	F2	S3	D01	23X
C-1-a	W151-21	Tank headspace and contaminated material in filter	Release of radioactive/hazardous material in headspace	Release of radioactive/ hazardous material from tank to atmosphere due to HEPA filter failure	F2	S2	D02	23X
C-1-a	XS-03-PRES02 XS-21-PRES (244-S-DCRT)	DCRT tank contents	Release of toxic vapors from 244 TX DCRT due to decreased ability to keep vapors in solution (fan on)	Heating of DCRT or chemical adjustment	F3	S2	D01	23X
B-1-a	XS-03-PRES05	DCRT tank vapor/aerosols	Release of toxic vapors from DCRT due to increased concentrations in DCRT atmosphere	Transfer of steam from PFP causing evolution of toxic gases due to heating tank	F2	S2	D01	23X
C-1-a	XS-03-TEMP02	DCRT vapor/aerosols	Release of toxic vapor from DCRT due to chemical reaction	Chemical reaction in DCRT toxic vapor	F2	S2	D01	23X
C-1-a	XS-13-PRES03	Catch tank vapor/aerosols	Release of toxic vapors due to chemical reaction from 241-U-301B	Draining of incompatible chemicals to catch tank	F2	S2	D01	23X
C-1-a	XS-20-FLOW04	DCRT vapor/aerosols	Release of toxic vapors from 244 TX DCRT due to chemical reaction with incompatible material in 244 S DCRT	Mixing contents of 244-TX and 244-S due to misrouting causes chemical reaction	F2	S2	E06	23X
ANALYZED ACCIDENT: Leak from Rail Car/Tank Trailer								
B-2-b	204AR-01H	20,000 gallons of liquid radioactive waste from the rail car	Release of airborne and waterborne contaminates outside building on track spur, and potential contamination in unloader room from rail car due to spilling rail car contents	Rail car rupture due to collision with other or a derailment	F2	S2	D25	25

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITIONS								
C-2-b	204AR-01I	20,000 gallons of liquid radioactive waste from the rail car	Release of airborne and waterborne contaminates outside building on track spur, and potential contamination in unloader room from rail car due to leak	Rail car leak due to tanker corrosion or other degradation	F2	S2	D12	25X
B-2-b	204AR-02A	5000 gallons of liquid radioactive waste from trailer	Release of liquid radioactive material and toxic chemicals outside and inside the 204AR building from the trailer due to collision which causes a spill	Tank trailer damage due to running into the building and causing the tank contents to spill	F2	S2	D25	25X
C-2-b	204AR-02B	5000 gallons of liquid radioactive waste from trailer	Release of radioactive material and toxic chemicals from trailer due to structural degradation of trailer	Tank trailer damaged due to corrosion or other degradation	F2	S2	D12	25X
C-2-b	204AR-09B	5000 - 20,000 of liquid radioactive waste from rail car or trailer	Release of airborne and radiation contamination in the unloader room from trailer or rail car leak due to high level in sump pit	Catastrophic leak from a large liquid source such as a trailer or rail car	F2	S2	D12	25X
C-2-b	204AR-09C	5000 of liquid radioactive waste	Release of airborne and radiation contamination in the unloader room from rail car due to gross overfilling of catch tank	Gross overfilling of catch tank either from large source such as the trailers or rail cars or continual pumping of transfer water through a leaky pipe	F2	S2	D06	25X
C-2-b	204AR-09D	5000 - 20,000 of liquid radioactive waste from rail car or trailer	Release of radioactive liquid waste in the unloader room from the rail car or trailer due to failed rail car or trailer	Failed tank car or rail car (initially full of liquid waste) overflowing the catch tank and sump pit	F2	S2	D12	25X
C-2-b	PB-J01	10,000 gallons of fuel oil	Release of toxic materials to the environment	Release of fuel oil from refueling truck to the soil surface due to truck rollover, no ignition source present	F1	S0	E25	25X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Surface Leak Resulting Pool								
C-2-b	W058-PRES01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer plus mitigative features failure	F3	S2	D17	26
HAZARDOUS CONDITIONS								
C-2-b	102AW-01-FLOW10	Liquid radioactive waste involved in transfer	Release of liquid radioactive waste from Tank 241-AW-102 due to overflow	Misrouting of waste from reverse flow caused by the combination of an incorrectly wired pump and a full transfer pipe	F2	S2	E06	26X
C-2-b	102AW-01-FLOW11	Liquid radioactive waste involved in transfer	Release of liquid radioactive waste to the ground surface from Tank 241-AW-102 due to overflow of Tank 241-AW-102 or underground structure	Misrouting to destination other than intended causes overflow	F3	S2	E06	26X
C-2-b	102AW-01-TEMP01	Liquid radioactive waste being transferred to DST	Release of liquid radioactive waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to corrosion caused by transferring high temperature waste	F2	S2	D01	26X
C-2-b	102AW-01-TEMP01A	Liquid radioactive waste being transferred to DST	Release of liquid waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to thermal stress of transferring hot solution in cold pipe	F2	S2	D01	26X
C-2-b	102AW-01-TEMP02	Liquid radioactive waste being transferred to DST	Release of liquid radioactive waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to exceeding the design temperature of the pipe by transferring high temperature waste	F2	S2	D01	26X
C-2-b	102AW-02-LEVE03	DST contents	Release of radioactive liquid from Tank 241-AW-102 due to overfilling	Failure to stop transfer causes overfilling of tank	F3	S2	E06	26X
C-2-b	102AW-02-LEVE04	DST contents	Release of radioactive liquid from Tank 241-AW-102 due to overfilling	Misrouting causes overfilling of tank	F3	S2	E06	26X

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BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	102AW-02-LEVE05	DST contents	Release of radioactive liquid from Tank 241-AW-102 to the soil column due to gross overfilling of tank (Pool)	Misrouting causes overfilling of tank	F3	S2	E06	26X
C-2-b	102AW-13-FLOW02	Liquid waste being transferred from DST	Release of radioactive liquid from transfer piping out of Tank 241-AW-102 due to backflow of radioactive material into flush pit and subsequent overflow (Pool)	Multiple valving errors and failure of backflow prevention devices dumps to pit as designed	F3	S2	E06	26X
C-2-b	102S-01.a1	Radioactive/hazardous material contained in pumpable liquids from various S Farm Tanks.	Radioactive/hazardous liquid released to soil surface from tank diversion box/access pit to the ground surface due to misrouting a transfer.	Human error (jumper/blank installation) + Mistransfer to Tank 241-S-102 (450-600 Kgal) overfills tank	F2	S2	E06	26X
C-2-b	102S-01.b2	Radioactive/hazardous material contained in pumpable liquids from Tank 241-S-102.	Radioactive liquid released to soil surface from Tank 241-S-102 pump pit due to leak in jumpers connecting tank transfer lines SL-140, SN-242 during saltwell pumping.	Jumper failure + Drain plugged	F2	S2	D12	26X
B-2-b	114SX-02.b	Radioactive material contained in pumpable liquid	Radioactive liquid released from tank pump pit to the ground surface due to inadvertent pumping activity (pool)	Human error (not normal activity)	F1	S2	E06	26X
C-2-b	204AR-09A	Up to 20,000 of liquid radioactive waste from rail car	Release of airborne and waterborne contamination from the sump pit due to ruptured piping during transfer.	Rupture of transfer piping section above the sump pit	F2	S2	D12	26X
C-1-a	244AR-02.a.07	Radioactive material contained in vessel	Release of radioactive aerosols from vessel headspace to building atmosphere with eventual release outside facility due to overfilling of sump causing tank failure	Rain or snow water intrusion	F1	S2	D01	26X
C-2-b	CCF-07	Overflow of tank contents	Release of radioactive and hazardous materials from tank due to overfill	Disabled or unavailable staff to terminate transfer	F3	S2	E06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	COB-04	Transfer inventory	Release of radioactive and/or hazardous material from COB lid due to overflow of COB during transfer (pool)	Leak into COB with floor drain plugged, leak detector failed	F3	S2	D12	26X
C-2-b	COB-08	Transfer inventory	Release of radioactive and/or hazardous material from COB due to over filling of COB (pool)	Transfer pipe or riser rupture, backfilling lower part of COB then filling COB via the floor drain	F3	S2	D12	26X
C-2-b	CRN-11-IC	Contents of facility	Release of radioactive and/or toxic materials from facility due to containment top collapse damage by boom failure (pool)	Human error: improper load assembly, rigging, crane overloaded	F3	S2	E10	26X
C-2-b	CRN-12-IC	Contents of facility	Release of radioactive and/or toxic materials from facility due to containment top collapse by boom failure (pool)	Mechanical failure: corrosion, faulty materials	F2	S2	D10	26X
C-3-b	EE-11	Contents of affected tank	Release of radioactive and hazardous materials from tank due to overfilling	Water line breaks and overfills tank	F2	S2	D12	26X
C-2-b	I-242A-6-FLW-B	Aerosols and liquid waste from Tank 241-AW-102 diluted with raw water from the evaporator	Release of diluted high level tank waste from Feed Tank 241-AW-102 caused by overfilling Tank 241-AW-102 and annulus, aggravated by an uncontrolled evaporator dump when a raw water leak occurs in evaporator condenser room	Rupture of raw water line in condenser/pump room	F3	S2	D12	26X
C-2-b	I-242S-2-FLW-A	Contaminated fire water and other liquid waste in Tank 241-SY-102	Release of tank waste diluted with contaminated fire water to the soil due to flooding the pump room from a fire main break and pumping the water to Tank 241-SY-102 which overfills the tank and floods pit through risers	Break in fire main	F1	S2	D12	26X
C-2-b	I-242S-2-FLW-E	High level waste from tank farms	Release of high level waste to the ground outside the 242-S building due to unmitigated reverse flow to the pump room from Tank 241-SY-102	Human error - incorrect valve line up	F2	S2	E06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	I-242S-4-FLW-C	High level waste from tank farms	Release of high level waste to the ground outside the 242-S building due to unmitigated reverse flow to the condenser room	Human error - incorrect valve line up	F2	S2	E06	26X
C-2-b	I-242S-4-FLW-D	Contaminated fire water and other waste in Tank 241-SY-102	Release of tank waste diluted with contaminated water to the soil due to flooding the condenser room which is pumped to Tank 241-SY-102 and overfills the tank and floods pit through risers	Break in fire main	F1	S2	D12	26X
C-2-b	I-PUREX-4-FLW-B	High level tank waste diluted with flush water	Release (ground surface) of high level tank waste diluted with flush water from the receiver tank due to overfilling from sending excess water	Block valve on flush water inadvertently left opened or leaking	F3	S2	D06	26X
C-2-b	I-UPLANT-1-LEK-B	Contaminated rain water from U Plant stack	Release of low level waste to the ground at the rupture of the line	Inadvertent excavation of line	F1	S2	D22	26X
B-2-b	OGT-EXT3-01B	DST & SST tank inventory	Release of radioactive or hazardous material from the primary pipe due to leak caused by truck crash into piping system	Human error, line struck by truck	F2	S2	E25	26X
C-2-b	OGT-FLOW1-02	DST & SST Tank inventory	Release of radioactive or hazardous material from pit overflow due to primary pipe leak caused by over-rated pump	Incorrect pump installed creates excessive flow and pressure on OGT system eroding EPDM pipe causing leak to secondary pipe with drain in pit plugged	F2	S2	E13	26X
B-2-b	OGT-FLOW1-03B	DST & SST tank inventory	Release of radioactive or hazardous material from the primary pipe due to misdirected flow of waste through flush line	JR-1 (3-way valve) mispositioned to flush, two check valves fail, flush disconnect fails (check valve), and reverse flow to water truck, drum or onto ground	F1	S2	E06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-2-b	OGT-FLOW1-04	DST & SST Tank Inventory	Release of radioactive or hazardous material from the primary pipe due to valve failure resulting in misdirected flow of waste through flush line to flush water supply truck	JR-1 leak (bleed-by), two check valves fail, and flush disconnect fails and pump started causing reverse flow to flush water truck tank	F1	S2	D06	26X
C-2-b	OGT-FLOW1-06	DST & SST tank inventory	Release of radioactive or hazardous material from the DCRT due to overflow	Exceed volume available in DCRT/insufficient volume available, condition goes unnoticed until overflow occurs	F2	S2	E06	26X
B-2-b	OGT-FLOW2-01B	DST & SST Tank Inventory	Release of radioactive or hazardous material from the primary pipe due to leak caused by incorrect pump installed	Incorrect pump installed creates excessive flow and isolation valve closed on secondary pipe, erosion of EPDM and pressurization of secondary pipe causing leaks from flanges gasket within concrete shield	F2	S2	E13	26X
B-2-b	OGT-FLOW2-03B	DST & SST tank inventory	Release of radioactive or hazardous material from the primary pipe due leak caused by incorrect pump installed	Installation of incorrect pump, failure of inner pipe and isolation valves closed on secondary pipe drains causing leak from failed welds on flange within the concrete shield	F1	S2	E13	26X
C-2-b	OGT-PRES1-01	DST & SST tank inventory	Release of radioactive or hazardous material from overflow of pit due to leak caused by high pressure	Heat up of hydro test by heat tape or high ambient temperature, high pressure results from captive fluid heat up, inner pipe damaged, leaks to secondary pipe and drains back to pits and insufficient drainage in pit	F1	S2	D05	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	OGT-REAC1-01	DST & SST tank inventory	Release of radioactive or hazardous material from overflow of pit due to primary pipe leak cause by chemical reaction	Pumping from multiple tanks to single OGT, potential for adverse chemical reactions in pipeline damaging inner pipe, leaks to secondary pipe and drains back to pits and insufficient drainage in pit	F1	S2	D01	26X
C-2-b	OGT-TEMP1-03	DST & SST tank inventory	Release of radioactive or hazardous material from overflow of pit due to leak caused by high temperature	High temperature flush water fails inner pipe causing leak to secondary pipe, drain to pit with insufficient drainage in pit	F1	S2	E01	26X
C-2-b	PB-D07.03	40,000 gallons of fuel oil	Release of toxic materials to the environment	Release of fuel oil from package boiler storage tank to the soil surface due to vehicle impact, no ignition source present	F2	S0	D25	26X
C-2-b	RCSTS-01-FLOW03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of 102-SY tank due to mistransfer	Mistransfer of material from east area via the supernate piping route	F3	S2	D06	26X
C-2-b	RCSTS-03-FLOW/ INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error)	F3	S2	E06	26X
C-2-b	RCSTS-03-FLOW/ INTEG02a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error)	F3	S2	E06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-03-FLOW/ INTEG02b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure	F2	S2	D12	26X
C-2-b	RCSTS-03-FLOW/ INTEG02c	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion	F2	S2	D12	26X
C-2-b	RCSTS-03-FLOW02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	E06	26X
C-2-b	RCSTS-03-FLOW03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit	F2	S2	D12	26X
C-2-b	RCSTS-03-FLOW04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	E06	26X
C-2-b	RCSTS-03-FLOW05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit	F2	S2	D12	26X
C-2-b	RCSTS-03-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	S2	D23	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-03-INTEG07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	S2	D23	26X
C-2-b	RCSTS-03-PRES02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer	F3	S2	D17	26X
C-2-b	RCSTS-03-PRES03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer	F3	S2	D17	26X
C-2-b	RCSTS-08-FLOW01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	26X
C-2-b	RCSTS-08-FLOW02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	26X
C-2-b	RCSTS-08-FLOW03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	S2	D12	26X
C-2-b	RCSTS-08-FLOW04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	S2	D12	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-08-FLOW05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	S2	D06	26X
C-2-b	RCSTS-08-INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Failure of piping due to corrosion	F2	S2	D16	26X
C-2-b	RCSTS-08-INTEG02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	External event (airplane crash, etc)	F0	S2	D23	26X
C-2-b	RCSTS-08-INTEG03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S2	B08	26X
C-2-b	RCSTS-08-INTEG04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Failure of piping due to material defect	F2	S2	D12	26X
C-2-b	RCSTS-08-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	F1	S2	D26	26X
C-2-b	RCSTS-08-INTEG17a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to corrosion plus mitigative features failure	F2	S2	D06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-08-INTEG17b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to unrecognized material flaw	F2	S2	D12	26X
C-2-b	RCSTS-08-INTEG18	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to external event (airplane crash, volcanism, etc)	F0	S2	D05	26X
C-2-b	RCSTS-08-PRES02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Water hammer	F3	S2	D17	26X
C-2-b	RCSTS-08-PRES03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Water hammer	F3	S2	D17	26X
C-2-b	RCSTS-08-TEMP01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	S2	D24	26X
C-2-b	RCSTS-08-TEMP04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to freezing	F1	S2	D24	26X
C-2-b	RCSTS-09-FLOW01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Flow of slurry to vent station due to incomplete closing of vent valves after venting	F3	S2	D06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-09-FLOW02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	26X
C-2-b	RCSTS-09-FLOW03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	26X
C-2-b	RCSTS-09-FLOW04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	External leak of valve or valves to the vent station	F3	S2	D12	26X
C-2-b	RCSTS-09-FLOW05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	External leak of valve or valves to the vent station	F3	S2	D12	26X
C-2-b	RCSTS-09-FLOW06	Amount of supernate involved in a transfer (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Flow of supernate to vent station due to incomplete closing of vent valves after venting	F3	S2	D06	26X
C-2-b	RCSTS-09-FLOW07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	S2	D06	26X
B-1-a	RCSTS-09-FLOW11	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	S3	D06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-09-INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Failure of piping due to corrosion	F2	S2	D16	26X
C-2-b	RCSTS-09-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Failure of piping due to corrosion	F2	S2	D16	26X
C-2-b	RCSTS-09-INTEG03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	External event (airplane crash, etc)	F0	S2	D23	26X
C-2-b	RCSTS-09-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	External event (airplane crash, etc)	F0	S2	D23	26X
C-2-b	RCSTS-09-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S2	B08	26X
C-2-b	RCSTS-09-INTEG07	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Failure of piping due to material defect	F2	S2	D12	26X
C-2-b	RCSTS-09-INTEG08	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Failure of piping due to material defect	F2	S2	D12	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-09-PRES01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Water hammer	F3	S2	D17	26X
C-2-b	RCSTS-09-PRES02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Water hammer	F3	S2	D17	26X
C-2-b	RCSTS-09-TEMP01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S2	D24	26X
C-2-b	RCSTS-09-TEMP02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S2	D24	26X
C-2-b	RCSTS-15/16-INTEG03b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	S2	D12	26X
C-3-b	RCSTS-18/19-INTEG05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to flammable gas explosion in primary piping	F2	S2	B08	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-1FS-LEVEL03	Caustic water based solution mixed with radioactive material being transferred via cross site transfer line	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	F2	S2	D06	26X
B-2-b	RCSTS-22-PRESS03*	Amount of slurry transferrable through a pipe break	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping break	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	S2	D12	26X
B-2-b	RCSTS-22-PRESS04*	Amount of supernate transferrable through a pipe break	Release of radioactive slurry to soil surface from overflow of 244-A lift station due to piping break	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	S2	D12	26X
C-2-b	RCSTS-24-FLOW/ INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to corrosion	F2	S2	D16	26X
C-2-b	RCSTS-24-FLOW /INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to corrosion	F2	S2	D16	26X
C-2-b	RCSTS-24-FLOW/ INTEG03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to gasket failure	F3	S2	D12	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-24-FLOW/ INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to gasket failure	F3	S2	D12	26X
C-2-b	RCSTS-24-FLOW/ INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to misalignment	F3	S2	D06	26X
C-2-b	RCSTS-24-FLOW/ INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to misalignment	F3	S2	D06	26X
C-2-b	RCSTS-24-FLOW01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	26X
C-2-b	RCSTS-24-FLOW02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	26X
C-2-b	RCSTS-24-FLOW03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	External leak of valve or valves to the lift station	F3	S2	D12	26X
C-2-b	RCSTS-24-FLOW04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	External leak of valve or valves to the lift station	F3	S2	D12	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	RCSTS-24-INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	External event (airplane crash, etc)	F0	S2	D23	26X
C-2-b	RCSTS-24-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	External event (airplane crash, etc)	F0	S2	D23	26X
B-1-a	RCSTS-24-INTEG06	Aerosol fraction of slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	S2	B08	26X
C-2-b	RCSTS-24-PRES01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	F3	S2	D26	26X
C-2-b	RCSTS-24-PRES02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Water hammer	F3	S2	D17	26X
C-2-b	RCSTS-24-PRES03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Water hammer	F3	S2	D17	26X
C-2-b	TFS-1	Waste from Tank 241-SY-102	Release of radioactive or hazardous waste liquid from overflow of 244 S vault to the 244 S pump pit due to syphon effect on Tank 241-SY-102 (pump does not overflow)	Human Error - failure to close isolation valve (or valve malfunction) following waste transfer which allows flow to continue (syphon) when pump is stopped	F3	S2	E06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W058-FLOW01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected plus mitigative features failure	F3	S2	E06	26X
C-2-b	W058-FLOW03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-FLOW05a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error) plus mitigative features failure	F3	S2	E06	26X
C-2-b	W058-FLOW05b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-FLOW05c	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-FLOW07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected plus mitigative features failure	F3	S2	E06	26X
C-2-b	W058-FLOW09	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit plus mitigative features failure	F2	S2	D12	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W058-FLOW11a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error) plus mitigative features failure	F3	S2	E06	26X
C-2-b	W058-FLOW11b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-FLOW11c	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-FLOW13	Portion of supernate or slurry transferred (20,000 to 1,000,000 gallons) even if the primary line failed catastrophically, it would still provide a flow path; hence, the leak via the test riser would be a side stream	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Open path for pool leak from test riser	F3	S2	E06	26X
C-2-b	W058-INTEG01c	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	S2	D12	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W058-INTEG01d	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-INTEG03b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F2	S2	D05	26X
C-2-b	W058-INTEG05a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F2	S2	D22	26X
C-2-b	W058-INTEG05b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	S2	D22	26X
C-2-b	W058-INTEG07b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-INTEG09b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	S2	D24	26X
C-2-b	W058-INTEG11b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	S2	D18	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W058-INTEG13c	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	S2	D06	26X
C-2-b	W058-INTEG13d	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	S2	D12	26X
C-2-b	W058-INTEG14b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc) plus mitigative features failure	F2	S2	D05	26X
C-2-b	W058-INTEG16a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	S2	D22	26X
C-2-b	W058-INTEG16b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	S2	D22	26X
C-2-b	W058-INTEG18b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	S2	D12	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W058-INTEG20b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	S2	D24	26X
C-2-b	W058-INTEG24	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	S2	D23	26X
C-2-b	W058-INTEG26	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	Seismic event plus mitigative features failure	F1	S2	D18	26X
C-2-b	W058-INTEG28	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	S2	D23	26X
C-2-b	W058-INTEG30	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Seismic event	F1	S2	D18	26X
C-2-b	W058-PRES03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer plus mitigative features failure	F3	S2	D17	26X
C-2-b	W151-13	Tank inventory	Leak to soil surface	Release of radioactive/ hazardous material from tank to soil surface due to tank overflow	F2	S2	D19	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W320-ABCD-ALL07	Tank 241-C-106 overflow volume	Release of radioactive liquid from Tank 241-C-106 to the soil surface due to tank overflow	Large water intrusion (raw water, surface flood, cascade) or excessive transfer causing overflow of tank	F1	S3	D06	26X
C-2-b	W320-ABCD-ALL08*	Tank 241-C-106 overflow volume	Release of radioactive liquid from Tank 241-C-106 to soil surface due to tank overflow	Siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	F1	S3	D06	26X
C-2-b	W320-B-ALL13	Tank 241-AY-102 overflow volume	Release of radioactive liquid from Tank 241-AY-102 to soil surface due to tank overflow	Large water intrusion causing overflow of tank (raw water, surface flood, or ventilation system water inleakage)	F1	S2	D06	26X
C-2-b	W320-B-FLUSH06	Flushing water in Pit AY-102	Release of radioactive liquid from overflow of pit on Tank 241-AY-102 to soil surface due to transfer line leak	Pipe break in pit with the high capacity drain cover on resulting in overflow of pit	F2	S2	D12	26X
C-2-b	W320-B-FLUSH07	Flushing water in transfer line	Release of radioactive liquid from overflow of pit to the soil surface due to pipe break during flushing	Pipe break in pit during flushing and drain plug cover on resulting in overflow of pit	F2	S2	D12	26X
C-2-b	W320-B-TRANS22a	Transfer line Inventory	Release of radioactive liquid from transfer line to the soil surface due to local flooding during transfer	Raw water leak resulting in line being uncovered and breached during transfer	F3	S2	D19	26X
C-2-b	W320-B-TRANS22b	Transfer line Inventory	Release of radioactive liquid from transfer line to the soil surface due to local flooding during transfer	Natural flow resulting in line being uncovered and breached	F3	S2	D19	26X
A-1-a	W320-BCD-ALL10	Transfer line inventory	Small release of aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration, transfer started	Plugging of transfer line occurs, flammable gas builds up and is ignited resulting in a breach of transfer line; pumping is started (collection in pit)	F1	S2	B08	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	W320-BCD-TRANS10	Tank 241-AY-102 inventory	Release of radioactive liquid from overflow of pit on Tank 241-AY-102 to the soil surface due to blank flange left off flushing connection	Blank flange left off flushing connection in pit and drain cover left on resulting in overflow of pit during sluicing	F2	S2	E06	26X
B-1-a	XS-01-FLOW05	Liquid radioactive waste being transferred to DCRT	Release of radioactive contaminated liquid from transfer piping to 244 TX DCRT via the raw water system due to reverse flow of liquid waste (pool)	Mis-valving causes mixing of waste into raw water system that causes leak in the flush pit cover block	F2	S2	E06	26X
B-2-b	XS-01-FLOW06	Saltwell liquor being transferred to DCRT	Release of liquid radioactive waste from saltwell pumping transfer piping in DCRT pump pit to surface due to overflow (pool)	Open jumper in single shell tank pump pit leads to overflowing of pump pit	F3	S2	E06	26X
C-2-b	XS-03-TEMP04 XS-21-TEMP (244-S-DCRT)	DCRT contents	Release of liquid radioactive waste from 244 TX DCRT due to overflow	Freezing temperatures causing raw water line break-leak with leakage to tank causes overflow	F3	S2	D24	26X
C-2-b	XS-11-LEVE01	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Plugged drain and misrouting causes overflow	F3	S2	E06	26X
C-2-b	XS-11-LEVE02	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Plugged drain and open jumper causes overflow	F3	S2	E06	26X
C-2-b	XS-11-LEVE03	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste from diversion box to surface due to overflow	Plugged drain and piping leak causes overflow	F3	S2	D12	26X
C-2-b	XS-12-FLOW05	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Backflow from catch tank causes overflow from diversion box	F3	S2	D06	26X
C-2-b	XS-20-FLOW08	Liquid radioactive waste in catch tank and DCRT	Release of radioactive waste from 244 TX DCRT to surface due to overflow	Transfer of excess waste to 244-TX DCRT due to improper valve lineup causes overflow	F3	S2	E06	26X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	XS-20-FLOW09	Liquid radioactive waste in catch tank and DCRT	Release of radioactive waste from 244 S DCRT to surface due to overflow	Transfer of waste from 244-TX DCRT due to improper valve lineup causes overflow	F3	S2	E06	26X
C-2-b	XS-35-FLOW02	Liquid radioactive waste from cross-site transfer	Release of radioactive waste to surface from 242-S Evaporator sump due to backflow to and overflow	Human error of leaving open flow path after emptying the sump and backflow and subsequent overflow	F3	S2	E06	26X
C-2-b	XS-37-FLOW01	Liquid waste involved in cross-site transfer	Release of radioactive liquid waste from catch tank to surface due to overfilling (pool)	Leak of transfer piping with drainage to catch tank causes overflow	F3	S2	D12	26X
C-2-b	XS-41A-FLOW01	Liquid radioactive waste from cross-site transfer	Release of radioactive waste from vent station nozzle pit to surface due to overflow	Catastrophic failure of vent piping causes overflow of nozzle pit	F3	S2	D12	26X
C-2-b	XS-41A-FLOW02	Liquid radioactive waste from cross-site transfer	Release of radioactive waste to surface from vent station nozzle pit due to overflow	Vent valve left open or leaking during transfer causes overflow	F3	S2	E06	26X
C-2-b	XS-41B-LEVE03	Liquid radioactive waste in vent station catch tank and waste being transfered	Release of radioactive waste to surface from vent station nozzle pit due to overflow	Failure to empty catch tank, causing overflow of tank and pit due to transfer failure	F3	S2	E06	26X
C-2-b	XS-52-FLOW02	Liquid radioactive waste transfer to DST	Release of radioactive waste from Tank 244-CR-003 to surface due to overflow (pool)	Mis-valving or valve failure during cross-site transfer causes overflow	F3	S2	E06	26X
ANALYZED ACCIDENT: Unplanned Excavation/Drilling in Pond/Crib/Ditch								
C-2-c	CDP-10	Portion of radioactive material present in crib, ditch or pond	Release of radioactive contamination to soil surface from excavation or drilling in cribs, ditches or ponds that disturbs radioactive material	Excavation or drilling	F3	S2	D22	28

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITIONS								
C-1-a	EE-17	Materials in inactive equipment	Radioactive and hazardous material release from inactive equipment due to excavation error	Excavation into abandoned or inactive equipment	F3	S2	D22	28X
ANALYZED ACCIDENT: Subsurface Leak Remaining Subsurface								
B-3-b	102S-01.b3	Radioactive/hazardous material contained in pumpable liquids from Tank 241-S-102.	Radioactive liquid released to the soil subsurface from leaks in transfer lines SL-140, SN-242. (Plume)	Line leak during saltwell pumping (corrosion)	F3	S2	D12	29
HAZARDOUS CONDITIONS								
C-3-b	102AW-04-STRU04	Radioactive waste transfer through DST central pump pit	Release of liquid radioactive waste from Tank 241-AW-102 central pump pit due to leak to soil	Piping leak and leak from pump pit due to equipment drop	F2	S2	D10	29X
C-3-b	102AW-04-STRU05	Radioactive waste transfer through DST central pump pit	Release of liquid radioactive waste from Tank 241-AW-102 central pump pit due to leak to soil	Piping leak and leak from pump pit due to seismic event	F1	S2	D18	29X
C-3-b	RCSTS-10/11-INTEG02b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	S2	D16	29X
C-3-b	RCSTS-10/11-INTEG05b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	29X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-3-b	RCSTS-10/11-PRES01b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	S2	D17	29X
C-3-b	RCSTS-12/13-INTEG02b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	S2	D16	29X
C-3-b	RCSTS-12/13-INTEG05b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	29X
C-3-b	RCSTS-12/13-PRES01b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	F3	S2	D26	29X
C-3-b	W320-B-ALL11	Tank inventory	Release of radioactive liquid waste from Tank 241-C-106 to soil subsurface due to large water intrusion	Large water intrusion resulting in high hydrostatic pressure and tank breach (raw water, surface flood, excessive transfer, or cascade)	F2	S2	D19	29X
B-3-b	XS-01-FLOW07	Saltwell liquor being transferred to DCRT	Release of liquid radioactive waste to the soil from transfer piping from SST to DCRT due to leakage (plume)	Pipe failure from various causes	F3	S2	D12	29X
B-3-b	XS-02-FLOW04	PFP waste being transferred to DCRT	Release of liquid radioactive waste to soil from transfer pipe (non-pool) subsurface plume	Failure to adjust waste pH prior to transfer causes leak	F2	S2	E01	29X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-3-b	XS-37-FLOW02	Liquid waste involved in cross-site transfer	Release of radioactive liquid waste to soil from transfer piping due to leak of liquid waste from concrete encasement (subsurface plume)	Leak of transfer piping with encasement leak or blocked drain to catch tank (liquid oozes out concrete encasement)	F3	S2	D12	29X
B-3-b	XS-48-FLOW	Liquid waste transferred from B-Plant to diversion box	Release of liquid waste to soil from transfer piping between B-Plant and 241-ER-152 diversion box due to leak (plume)	Piping failure from various causes	F3	S2	D12	29X
ANALYZED ACCIDENT: Sodium Fire								
A-1-a	2727W-06	Building inventory	Release of hazardous materials from 2727-W due to sodium-water reactions	High wind or tornado destroys building with rain/snow	F2	S2	D20	30
HAZARDOUS CONDITIONS								
A-1-a	2727W-02	Building inventory	Release of hazardous material from 2727-W due to sodium fire	Vehicle crashes into building and ignites sodium	F1	S2	B25	30X
A-1-a	2727W-03	Building inventory	Release of hazardous material from 2727-W due to sodium fire	Lightning	F2	S2	B21	30X
A-1-a	2727W-04	Building inventory	Release of hazardous material from 2727-W due to sodium fire	Overhead power line falls through building	F1	S2	B09	30X
A-1-a	2727W-05	Building inventory	Release of hazardous material from 2727-W due to sodium fire	Nitrogen tank overpressurizes sodium tank, ignites sodium	F3	S2	B01	30X
ANALYZED ACCIDENT: Above Ground Structure Failure								
B-1-a	ITK-FR-08	DST & SST tank liquid held in flex receiver	Release of radioactive aerosols/vapors from flex receiver due to structural failure	High winds tear flex receiver bag	F3	S2	D20	31
HAZARDOUS CONDITIONS								
B-1-a	CRN-11-IB	Contents of equipment	Release of radioactive and/or toxic materials from facility due to equipment damage by boom failure	Human error: improper load assembly, rigging, crane overloaded	F3	S2	E10	31X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	CRN-12-IB	Contents of equipment	Release of radioactive and/or toxic materials from facility due to equipment damage by boom failure	Mechanical failure: corrosion, faulty materials	F2	S2	D10	31X
B-1-a	CRN-13-IB	Contents of equipment	Release of radioactive and/or toxic materials from above ground facility due to equipment damage by boom failure	High wind or seismic event	F2	S2	D05	31X
B-1-a	CRN-18	Contaminates on above ground equipment	Release of radioactive or toxic material from above ground tank equipment due to dropping crane load	Human error: improper load assembly, rigging, crane overloaded	F3	S2	D10	31X
B-1-a	CRN-18-I	Material in aboveground facility equipment	Release of radioactive or toxic material from aboveground facility equipment due to dropping crane load	Human error: improper load assembly, rigging, crane overloaded	F3	S2	E10	31X
B-1-a	CRN-19-I	Material in aboveground facility equipment	Release of radioactive or toxic material from aboveground facility equipment due to dropping crane load	Mechanical failure: corrosion, faulty materials	F2	S2	D10	31X
B-1-a	CRN-20-I	Material in aboveground facility equipment	Release of radioactive or toxic material from aboveground facility equipment due to dropping crane load	High wind or seismic event	F2	S2	D05	31X
B-1-a	CRN-23-IB	Contents of facility	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility	High wind or seismic event	F2	S2	D05	31X
C-2-b	CRN-25-IB	Material in aboveground facility or equipment	Release of radioactive or toxic material from aboveground MISF due to swinging load into equipment caused by loss of lateral load control	Human error: improper load assembly, rigging, positioning error	F3	S2	E26	31X
C-2-b	CRN-26-IB	Material in aboveground facility or equipment	Release of radioactive or toxic material from aboveground MISF due to swinging load into equipment caused by loss of lateral load control	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil	F2	S2	D26	31X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-2-b	CRN-27-IB	Material in aboveground facility or equipment	Release of radioactive or toxic material from aboveground MISF due to swinging load into equipment caused by loss of lateral load control	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil	F2	S2	D10	31X
C-1-a	ITK-FR-03	DST & SST tank inventory	Release of radioactive aerosols from tank and/or receiver due to equipment jam in riser	Equipment becomes lodged in riser, efforts to remove pull riser out of tank causing breach of tank & receiver containment	F1	S2	E05	31X
C-1-a	ITK-FR-22	DST & SST tank liquid held in flex receiver	Release of radioactive aerosols from flex receiver due to tank gas release	Tank gas release pressurizes bag and causes bag to rupture	F1	S2	D01	31X
B-1-a	LDUA 5-40	Radioactive aerosols in single shell tank headspace	Release of contamination from TRIC and tank riser due to damage during wind storm	High winds	F3	S2	D14	31X
A-1-a	NP-05	Head space inventories, ventilation system inventories, surface contaminates, 209-E inventory, tanker spill at 204-AR	Radioactive and hazardous material release from tanks, nearby ground surfaces, and ventilation systems due to above grade disturbances	High winds	F1	S2	D20	31X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Steam Intrusion from Interfacing Systems								
B-1-a	I-242A-6-CMP-A	Aerosols and particulates entrained in steam from Tank 241-AW-102	Release (steam) of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank	Human error - steam block valve inadvertently left opened	F3	S3	E01	32
HAZARDOUS CONDITIONS								
B-1-a	I-222S-1-LVL-A	Aerosols and particulates from 244-S entrained in the steam	Release (steam) of aerosols and entrained particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to tank farm	Human error - failing to shut off steam after Tank 219-S-102 is empty	F3	S2	E01	32X
B-1-a	I-222S-2-PRS-A	Aerosols and particulates from 244-S entrained in the steam	Release (steam) of aerosols and particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to tank farm	Steam reducer valve fails open	F3	S2	D01	32X
B-1-a	I-242A-2-CMP-B	Aerosols and particulates entrained in steam from receiver tank	Release to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank	Steam block valves inadvertently opened or left open	F2	S3	E01	32X
B-1-a	I-PFP-2-TMP-B	Steam release of aerosols and entrained particulates from 244-TX	Release (steam) of aerosols and entrained particulate from 244 TX ventilation system due to saturating HEPAs with steam sending higher pressure steam to steam jet, gassing it out	Failure of steam reducer	F2	S2	D01	32X
B-1-a	I-PUREX-1-LVL-A	Aerosols from Tank 241-AW-105	Release of aerosols from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from transfer of steam	Human error - failure to shut off steam jet when U-3 is empty	F3	S2	E01	32X

Table C-2. Analyzed Accidents and the Represented Hazardous Conditions. (141 Sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	I-PUREX-2-PRS-A	Aerosols and particulates entrained in steam from receiver tank	Release (steam) of aerosols and particulates through cracks in the cover block from the receiver tank due to tank pressurization which gases out the steam jet	Steam reducer fails	F2	S2	D01	32X
B-1-a	I-PUREX-3-LVL-A	Aerosols from Tank 241-AW-105	Release of aerosols from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from transfer of steam	Human error - failure to shut off steam jet when U-3 is empty	F3	S2	E01	32X
B-1-a	I-PUREX-4-PRS-A	Aerosols and particulates entrained in steam from receiver tank	Release of aerosols and particulates through cracks in the cover block from the receiver tank due to tank pressurization which gases out the steam jet	Steam reducer fails	F2	S2	D01	32X
B-1-a	I-TPLANT-2-CMP-A	Aerosols and particulates from 244-S entrained in the steam	Release (steam) of aerosols and entrained particulates to atmosphere through ventilation due to over pressurization of 244-S DCRT caused by sending just steam to the tank farm	Human error - steam block valve inadvertently opened or failure to close valve when Tank 15-1 is low	F3	S2	E01	32X
B-1-a	XS-02-FLOW02	DCRT filter inventory	Release of aerosols and particulate from DCRT ventilation filter due to transfer of steam from PFP steam jet into DCRT headspace	Human error (failure to shut off steam jet at completion of transfer) which causes DCRT ventilation filter failure	F3	S2	E01	32X

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APPENDIX D
HAZARD EVALUATION RESULTS

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APPENDIX D
HAZARD EVALUATION RESULTS

LIST OF TABLES

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LIST OF TERMS

ALARA	As Low As Reasonably Achievable
COB	cleanout box
CPS	criticality prevention specification
DCRT	double-contained receiver tank
diff.	differential
DST	double-shell tank
dT	temperature differential
EPDM	ethylene-propylene diene monomer
FSAR	Final Safety Analysis Report
GRE	gas release event
H2	hydrogen
HEPA	high efficiency particulate air (filter)
ID	identification
LFL	Lower Flammability Limit
MISF	miscellaneous inactive storage facility
NA	not assigned
NaOH	sodium hydroxide
$NaNO_3$	sodium nitrite
NC	no controls
NPH	normal paraffinic hydrocarbon
OGT	overground transfer
PFP	Plutonium Finishing Plant
PPE	personal protective equipment
PRV	pressure relief valve
PUREX	Plutonium Uranium Extraction (Facility)
SCBA	self-contained breathing apparatus
SST	single-shell tank
TRU	transuranic
TWRS	Tank Waste Remediation System
VSU	vertical storage unit

KEY TO TABLE HEADINGS IN APPENDIX D

ID—This field contains a unique alpha/numeric identification code for each Hazardous Condition identified during the TWRS hazard evaluations activities. In general, these codes, derived from the name of the evaluation and the node numbering used in the evaluation, can be used to identify the analysis they came from.

Hazardous Condition—A description of the Hazardous Condition associated with the unique ID code. In general, Hazardous Conditions are related to uncontrolled releases of hazardous or radioactive material, however there are occurrences of Hazardous Conditions listed that are not specific to release events that can be identified by the BIN code.

Cause—A description of the factors that could cause the identified Hazardous Condition.

Initial Freq NC—Frequency/No Controls - The frequency of Hazardous Condition occurrence assuming no controls are present for a specific Hazardous Condition. (Qualitatively assessed before performance of the accident analysis).

Env Cons—Environmental Consequence - The resultant effect to the environment of a release associated with a specific Hazardous Condition assuming no controls are present. (Assessed qualitatively).

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APPENDIX D
HAZARD EVALUATION RESULTS

Appendix D organizes the results of the hazard evaluations (i.e., identified hazardous conditions) by consequence. This allows for rapid location of hazardous conditions within the same consequence category.

The tables in this appendix have been produced using a relational data base tool, which is used to manage the hazard analysis data base. The data contained in the tables appears as it is stored in the data base. No attempts have been made to reformat the information.

This appendix consists of six tables.

- Table D-1, "Hazardous Conditions With Potential Significant Offsite Consequences (S3)," lists the S3 hazardous conditions by identification number, cause, qualitative frequency with no controls, and qualitative environmental consequence.

- Table D-2, "Hazardous Conditions With Potential Significant Onsite Consequences (S2)," lists the S2 hazardous conditions by identification number, cause, qualitative frequency with no controls, and qualitative environmental consequence.

- Table D-3, "Hazardous Conditions With Potential Significant Worker Consequences (S1)," lists the S1 hazardous conditions by identification number, cause, qualitative frequency with no controls, and qualitative environmental consequence.

- Table D-4, "Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3)," lists the E2 and E3 hazardous conditions by identification number, cause, qualitative frequency with no controls, and qualitative environmental consequence.

- Table D-5, "Hazardous Conditions With Potential Radiation Exposure Consequences (RP)," lists the radiation exposure hazardous conditions by identification number and cause.

- Table D-6, "Hazardous Conditions With Potential Occupational Safety Consequences," lists the occupational safety hazardous conditions by identification number and cause.

Hazardous conditions listed in Tables D-5 and D-6 also appear in Table D-3. However, because they are either radiation protection or occupational safety issues and do not result in an uncontrolled release of material, the hazard analysis for these events was not completed for the FSAR. Therefore, a designation of "N/A" was applied when further hazard analysis information (frequency and/or environmental consequences) was not assigned (developed) for these hazardous conditions.

Appendix D contains tables of hazardous conditions grouped by assessed consequences. The purpose of this information is to provide results consistent with the hazard evaluation results reported in Chapter 3.0, Section 3.3.2 and to support the graded approach to safety analysis and risk management also discussed in Chapter 3.0.

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-01-FLOW 102AW-02-PRES	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by chemical reaction of incompatible wastes	Misrouting to destination other than intended creates chemical incompatibility	F0	E3
102AW-01-FLOW 102AW-04-PRES	Release of radioactive aerosol from transfer pipe which runs from DCRT to Tank 241-AW-102 due to spray leak into open underground structure	Piping leak due to thermal stress of transferring hot solution in cold pipe	F3	E2
102AW-01-FLOW01	Release of liquid radioactive waste aerosols from transfer pipe to Tank 241-AW-102 due to spray leak into open underground structure	Piping leak due to corrosion caused by transferring high temperature waste	F2	E2
102AW-01-TEMP	Release of liquid radioactive waste aerosols from transfer pipe to Tank 241-AW-102 due to spray leak of liquid waste from transfer pipe leak	Piping leak due to exceeding the design temperature of the pipe by transferring high temperature waste	F1	E3
102AW-02-PRES01	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in waste tank (Dome Collapse)	Flammable concentration of gases in tank vapor space with spark source	F2	E2
102AW-02-PRES03	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Blocked ventilation inlet causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES04	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Condensation of vapors causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES05	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Sub-cooling of vapor during equipment flushing causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES06	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Ventilation imbalance causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES07	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Wrong size portable ventilator chosen for support work causes excessive vacuum leading to dome collapse	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-03-LEVE03	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by floating the primary tank within the annulus	Misrouting of liquid waste to the annulus causes floating of primary tank and subsequent dome collapse	F1	E3
102AW-03-TEMP01	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by an fire/explosion in the annulus	Fire/ Explosion of flammable liquid spilled into annulus via a riser	F2	E3
102AW-04-STRU01A	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive dome loading	Equipment drop during crane work causes excessive dome loading	F3	E3
102AW-04-STRU02	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive dome loading	Violation of limits on dome loading	F3	E3
102AW-09-COMP01	Release of combustion product aerosols from Tank 241-AW-102 due to fire in separable organic layer in waste tank causing dome collapse	Organic reaching flash point or being aerosolized plus ignition source	F2	E3
102AW-09-COMP02	Release of radioactive waste aerosols from Tank 241-AW-102 due to fire in fuel spilled in waste tank causing dome collapse	Spill of fuel from external source plus fuel reaching flash point or being aerosolized plus ignition source	F2	E3
102AW-13-FLOW01	Release of radioactive waste aerosols due to spray leak of waste from flush pit	Backflow of waste to flush pit with valve or pipe leak and cover block off	F1	E3
102S-03.b4	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into waste tank causing dome collapse	Vehicle drives into open riser puncturing gas tank + Ignition + Flammable organic vapors in tank	F3	E3
102S-04.c	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to ignition of flammable gas in tank causing HEPA failure	Concentration of H2 or Ammonia (or other flammable gasses) above LFL + Ignition source	F1	E3
102S-04.d1	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to the atmosphere due to low pressure causing dome collapse	Misoperation of exhauster during saltwell pumping	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102S-04.e3	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to generation of excessive heat leading to dome collapse	Addition of incompatible waste/chemical (misroute)	F0	E3
102S-05.a1a	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Excess gravel overburden	F3	E3
102S-05.a1aa	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Large vehicle traffic over tank	F3	E3
102S-05.a2	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Seismic event (common mode failure)	F1	E3
102S-05.a3	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Past thermocycling of tank	F1	E3
102S-05.a3a	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Long term aging	F1	E3
106C-01A	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Air inlet plugged due to icing/dust	F0	E3
106C-01B	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Inlet air valve closed	F0	E3
106C-01C	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage, and dome collapse due to tank low pressure	Exhauster damper positioned incorrectly	F0	E3
106C-01D	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Wrong sized portable exhauster	F0	E3
106C-01E	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Subcooling of tank vapor space due to water addition of flushing	F2	E3
106C-01I	Release of radioactive and/or hazardous material from Tank 241-C-106 due to possible dome collapse caused by tank high pressure	Fire in waste tank	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-01J	Release of radioactive and/or hazardous material from Tank 241-C-106 due to high pressure in tank and possible dome collapse	Fire/explosion in waste tank	F2	E3
106C-01Ma	Release of radioactive and/or hazardous material from Tank 241-C-106 due to flammable gas fire/explosion in tank caused by high temperature (dome collapse)	Chemical reaction in tank	F2	E2
106C-01X	Release of radioactive and/or hazardous material from Tank 241-C-106, dome structural damage and/or personnel injury due to overload of tank dome	Overweight vehicles over top of tank	F3	E3
106C-01Y	Release of radioactive and/or hazardous material from Tank 241-C-106, dome structural damage and/or personnel injury due to overload of tank dome	Flooding over top of tank	F2	E3
106C-02A	Release of radioactive and/or hazardous material from Tank 241-C-106 due to dome collapse caused by ignition of high flammable gas content in tank	High waste temperature	F2	E3
106C-02B	Release of radioactive and/or hazardous material from Tank 241-C-106 due to ignition of high flammable gas content in tank and possible dome collapse	Ventilation system failure	F2	E3
106C-02C	Release of radioactive and/or hazardous material from Tank 241-C-106 due to dome collapse caused by ignition of high flammable gas content in tank	Tank burp, release of trapped gas	F2	E3
106C-04A	Release of radioactive and/or hazardous material from Tank 241-C-106 due to tank damage caused by flammable gas fire/explosion because of high flammable gas content in the tank (dome collapse)	High flammable gas content due to chemical reaction in sludge layer	F2	E2
106C-04B	Release of radioactive and/or hazardous material from Tank 241-C-106 due to fire/explosion caused by ignition of flammable gas released from radiolysis in tank sludge	Radiolysis in sludge layer allows release of trapped gas to vapor space	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-13A	Release of radioactive and/or hazardous material from Tank 241-C-106 due to possible dome collapse, tank damage caused by high temperature	Fire in Tank 241-C-105 propagates into Tank 241-C-106	F2	E3
114SX-04.a.2	Radioactive aerosols released from failed tank dome due to vacuum produced by valving error.	Human error: Valve out flammable watch list (Tank 241-SX-109) butterfly valve	F0	E3
114SX-04.a.3	Release of radioactive aerosols from Tank 241-SX-114 to atmosphere due to high temperatures causing dome concrete strength loss	No ventilation flow High ambient temperature conditions Resulting in tank degradation	F1	E3
114SX-04.b.1.a.2	Release of radioactive material from Tank 241-SX-114 to atmosphere due to high temperature in the dome leading to dome collapse (long term closure of butterfly valve)	Human error: Closure of Tank 241-SX-114 exhaust butterfly valve isolating tank from exhaust plenum Resulting in tank degradation	F1	E3
114SX-04.b.1.b.2a	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to heat induced tank dome collapse	Ducting failure due to bad welds	F1	E3
114SX-04.b.1.b.2b	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to heat induced tank dome collapse	Ducting failure due to seismic activity coupled with failure to respond Resulting in tank degradation	F1	E3
114SX-04.b.1.c.2	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to dome collapse	Exhauster failure Fan failure Filter rupture (low differential pressure shutdown) Resulting in tank degradation	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
114SX-04.b.1.d.2	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Filter plugging results in lack of heat removal with high temperatures degrading dome strength	F1	E3
114SX-04.b.3b	Release of radioactive aerosols from head space of Tank 241-SX-114 to atmosphere through exhaust HEPA filter due to flammable gas ignition in the headspace (dome collapse)	Flammable gas fire/explosion in Tank 241-SX-114 {Note: Tank 241-SX-114 is NOT currently identified as a Flammable Gas Watch List Tank} Requires spark to be present	F1	E2
114SX-05.b.1	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to flammable gas ignition resulting in dome collapse	Radiolysis creating bubbles of gases in waste	F2	E3
114SX-05.b.3	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse caused by sudden vacuum in tank	Quenching (adding cold liquid to hot tank contents) creating a vacuum	F0	E3
114SX-05.c.2b	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Chemical reaction caused by addition of chemical/solution. Resulting in tank degradation	F1	E3
114SX-06.a.1a	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Gravel overburden Large vehicle	F3	E3
114SX-06.a.1b	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere as a result of a dome collapse	Deflagration of H2 (Implies gas generation with spark)	F1	E3
114SX-06.a.3	Release of radioactive aerosols from Tank 241-SX-114 waste to the atmosphere due to dome collapse caused by loss of strength due to aging	Long term aging resulting in tank degradation	F1	E3
244AR-02.a.14	Release of radioactive aerosols from waste contained in tanks (4) and building due to earthquake	Seismic event collapses building and four tanks	F1	E3
CCF-17	Release of radioactive and hazardous materials from tank due to dome collapse	Corrosion of rebar in concrete SST domes	F1	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CCF-18	Release of radioactive and hazardous materials from tanks due to dome collapses	Fire in tank propagates to connecting tank and both tanks collapse during cooldown from negative tank pressure	F0	E3
CCF-19	Release of radioactive and hazardous materials from tanks due to dome collapses	Fire in tank causes pressure transient that leads to GRE in connecting tank with subsequent fire and tank collapses from negative tank pressure	F0	E3
COB-01	Release of radioactive and/or hazardous material from COB due to spray leak	Flange, gasket or valve, spray leak with COB lid removed	F3	E2
CP-GRT-02	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error AND Mechanical failure of push pipe integrity inside the transfer line	F1	E3
CP-MSP-05	Release of radioactive or toxic material to atmosphere from waste tank due to flammable gas deflagration	Human error AND Flammable gas is present in tank AND Mechanical failure of the pipe and probe (ignition source)	F1	E3
CP-MSP-06	Release of radioactive or toxic material to atmosphere due to flammable gas deflagration caused by puncture and ignition of flammable gas in transfer line which propagates to the waste tank	Human error AND Flammable gas is present in transfer pipe AND Spark from probe tip (ignition source)	F1	E3
CP-RMV-03	Release of radioactive or toxic material from transfer line through the push pipe during removal activities	Human error	F1	E3
CP-SET-04	Release of radioactive or toxic material from waste tank due to dome collapse	Excessive weight on tank dome (static load of platform)	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CP-SET-05	Release of radioactive or toxic material from waste tank due to dome collapse caused by load drop	Mechanical failure of equipment causes load drop	F2	E3
CP-SET-06	Release of radioactive or toxic material from waste tank due to dome collapse caused by load drop	Human error causes load drop	F3	E3
CP-SSP-01	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations.	F1	E3
CP-SSP-16	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error AND Mechanical failure of push pipe integrity inside the transfer line	F1	E3
CRN-03	Release of radioactive and/or toxic materials from tank due to dome collapse	Human error results in excessive weight on dome	F3	E3
CRN-04	Release of radioactive and/or toxic materials from tank due to dome collapse	Crane or rigging failures drop load resulting in large impact to dome	F3	E3
CRN-11	Radioactive or toxic material release from tank due to boom failure and tank/equipment damage and dome collapse	Human error: improper load assembly, rigging, crane overloaded	F3	E3
CRN-12	Radioactive or toxic material release from tank due to boom failure and tank/equipment damage and dome collapse	Mechanical failure: corrosion, faulty materials	F3	E3
CRN-13-a	Release of radioactive or toxic material from tank/equipment damage and dome collapse due to boom failure	High wind	F3	E3
CRN-13-b	Release of radioactive or toxic material from tank/equipment damage and dome collapse due to boom failure	Seismic event	F1	E3
EE-01	Release of radioactive and toxic materials from tanks due to external force and fire	Aircraft crash	F1	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
EE-04-a	Release of radioactive and hazardous materials from SST tank due to external fires	Vehicle accident involving propane, diesel or gasoline delivery	F2	E3
EE-04-b	Release of radioactive and hazardous materials from DST tank due to external fires	Vehicle accident involving propane, diesel or gasoline delivery	F2	E3
EE-05-a	Release of radioactive or hazardous materials from SST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	E3
EE-05-b	Release of radioactive or hazardous materials from DST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	E3
EE-16	Release of radioactive and hazardous material from transfer line spray leak due to excavation error	Excavation into waste transfer line during a transfer	F3	E2
I-222S-1-CMP-E	Release of radioactive aerosols to the atmosphere from 244 S or receiver tank due to over pressurization of tank caused by organic fire	Human error - upset of 222-S Lab operations	F3	E3
I-242A-1-FLW-A	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from dead heading	Valves fail to regulate (closed position) which fails pump and creates ignition source, sufficient hydrogen accumulation for fire/ explosion.	F2	E3
I-242A-1-FLW-B	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source	Feed pump fails and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3
I-242A-1-FLW-C	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from dead heading	Plugged line which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3
I-242A-1-FLW-D	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source	Pump plugged which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242A-1-FLW-E	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from pump cavitation	Empty feed tank which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3
I-242A-2-CMP-B	Release to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank	Steam block valves inadvertently opened or left open	F2	E3
I-242A-4-TMP-A	Release of radioactive material from Tank 241-AW-102 caused by ignition of organics in Tank C-100 which pressurizes the drain line and propagates the fire down the line to Feed Tank 241-AW-102	Faulty control of vacuum to CA-1 vessel causing pot to boil with organic layer available	F0	E3
I-242A-6-CMP-A	Release (steam) of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank	Human error - steam block valve inadvertently left opened	F3	E3
I-BPLANT-1-CMP-E	Release of tank waste due to fire in receiver tank from transferring organics from B Plant	Human error - tank containing organics in B Plant rupture and spills organics to the drains which eventually end up in Tank 24-1 and an inadvertent transfer to tank farms	F1	E3
I-PFP-1-CMP-E	Release of high level waste from receiver tank due to fire from organics transferred from PFP	Excess organic material added to waste results in fire	F2	E3
ITK-08	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Exothermic reaction of incompatible materials in tank	F3	E2
ITK-09	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Failure to bond components or incorrect bonding	F3	E2
ITK-10-a	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	F3	E2
ITK-10-b	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	F3	E2
ITK-11	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Lightning, range fire, or seismic event ignites tank vapors	F2	E2

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
ITK-FR-04	Release of radioactive aerosols from tank due to tank collapse	Equipment becomes lodged in riser, efforts to remove pull riser out of tank causing loss of structural integrity leading to tank collapse	F1	E3
ITK-FR-19	Release of radioactive aerosols from tank due to dome collapse	Hydraulic jacks on assembly stand are operated while assembly is bolted to flange tearing out riser and destroying tank integrity leading to dome collapse	F1	E3
LDUA 1-25	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Fire (electrical, lighting)	F2	E3
LDUA 1-32	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	During planned intrusive activities, sampling triggers GRE	F3	E3
LDUA 1-33	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Non-arm end effectors (OVS, OSVS) dropped down riser	F2	E3
LDUA 2-2	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of hydraulic fluid	Structural failure of hydraulic system	F2	E3
LDUA 2-20	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Combustible source of gas located near the compressor intake.	F3	E3
LDUA 2-51	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Supervisor error - arm in wrong mode, Electric remains on after air purge fault, flammable gas enters arm, spark ignites gas	F1	E3
LDUA 5-43	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Lightning strikes VPM in raised position	F2	E3
LDUA 5-45	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Helicopter/airplane crash	F1	E3
LDUA 6-24	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Wrong setting on safety interlock for electric shutdown on loss of purge air	F3	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
LDUA/EREE 1-22	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Electrical Short in LDUA Lighting short	F2	E3
LDUA/EREE 1-28	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Electrical Short in LDUA/ EREE Lighting short	F3	E3
NP-07	Radioactive and hazardous material releases from tanks and ventilation systems due to seismic event	Seismic event collapses domes	F1	E3
NP-08	Radioactive and hazardous material releases from transfer pipes due to seismic event (possible spray leak)	Seismic event shears pipes and encasements during transfer	F2	E2
NP-11	Radioactive and hazardous material releases from tank farms due to lava flow	Eruption of molten lava from fissures	F0	E3
NP-13	Radioactive and hazardous material releases from tanks due to excessive weight on dome	Accumulations of heavy snow followed by heavy rain	F2	E3
OGT-EXT3-01A	Release of radioactive or hazardous aerosols from the primary pipe due to spray leak caused by truck crash into piping system	Human error, line struck by truck	F3	E3
OGT-FLOW1-03A	Release of radioactive or hazardous aerosols from the primary pipe due to spray leak caused by misdirected flow	Spray leak caused by JR-1 (3-way valve) mispositioned to flush, two check valves fail, flush disconnect fails (check valve), reverse flow to external flush fixture and release to the environment	F1	E3
OGT-FLOW2-02	Release of radioactive or hazardous aerosols from the primary pipe due spray leak caused by over-rated pump	Installation of incorrect pump and failure of inner pipe, failure of weld on flange of outer pipe, isolation valves closed on secondary pipe drains and no concrete shield in place	F2	E2
OGT-NP3-01	Release of radioactive or hazardous aerosols from the primary pipe due spray leak caused by seismic event	Failure of line and concrete shielding during seismic event	F1	E2

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
OGT-NP3-02	Release of radioactive or hazardous aerosols from the primary pipe due to leak caused by high wind	Pipe is blown off supports and no concrete shielding in place	F1	E2
PB-D07.04	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to in-tank fuel fire	F2	E3
PB-D07.08	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to high winds	F1	E2
PB-J01a	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to in-tank fuel fire	F1	E2
PB-J01b	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tanks in 241-AW to atmosphere due to in-tank fuel fire involving multiple tanks	F0	E3
PB-J01c	Release of radioactive and/or toxic materials in double shell tank	Release of radioactive and/or toxic materials from double shell tanks in 241-AW to atmosphere due to dome collapse	FO	E2
RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible material from east area via the supernate piping route	F2	E3
RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic	Human error	F2	E3
RCSTS-03-FLOW/INTEG03 a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG03 b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-03-FLOW/INTEG03 c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW/INTEG04 a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG04 b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure	F2	E3
RCSTS-03-FLOW/INTEG04 c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	E3
RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	E3
RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3
RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-08-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-08-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	E3
RCSTS-08-FLOW09	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	E3
RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of piping due to corrosion	F2	E3
RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	F2	E3
RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of piping due to material defect	F2	E3
RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	F1	E3
RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Seismic event	F1	E3
RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Seismic event	F1	E3
RCSTS-08-PRES01	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E3
RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Water hammer	F3	E3
RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Water hammer	F3	E3
RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-09-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-09-FLOW09	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	External leak of valve or valves to the vent station	F3	E3
RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E3
RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of piping due to corrosion	F2	E3
RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3
RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of piping due to material defect	F2	E3
RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Seismic event	F1	E3
RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Seismic event	F1	E3
RCSTS-09-PRES03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Water hammer	F3	E3
RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Water hammer	F3	E3
RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3
RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3
RCSTS-24-FLOW/INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E3
RCSTS-24-FLOW/INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E3
RCSTS-24-FLOW/INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to misalignment	F3	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-24-FLOW/INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to misalignment	F3	E3
RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Seismic event	F1	E3
RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Seismic event	F1	E3
W030-25	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of the tank recirculation system fan resulting in tank bump	F3	E3
W030-26	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of one of the main ventilation system exhaust fans resulting in tank bump	F3	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-27	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of both of the main ventilation system fans resulting in tank bump	F2	E3
W030-28	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank ventilation due to loss of AC power resulting in tank bump	F0	E3
W030-29A	Release of radioactive/hazardous material from Tank 241-AZ-101 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AZ101-K1-3-1 or HEPA AZ101-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-29B	Release of radioactive/hazardous material from Tank 241-AZ-102 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AZ102-K1-3-1 or HEPA AZ102-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-29C	Release of radioactive/hazardous material from Tank 241-AY-101 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AY101-K1-3-1 or HEPA AY101-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-29D	Release of radioactive/hazardous material from Tank 241-AY-102 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AY102-K1-3-1 or HEPA AY102-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-30	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of exhaust system HEME AZ-K1-9-1 resulting in tank bump	F3	E3
W030-31A	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of the exhaust system HEPA/HEGA filters (AZ-K1-10-1A) resulting in tank bump	F3	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-31B	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of the exhaust system HEPA/HEGA filters (AZ-K1-10-1B) resulting in tank bump	F3	E3
W030-32	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse caused by tank bump	Loss of ventilation due to failure of the seal pot allowing water to back up to HEME and/or exhaust system condenser resulting in tank bump	F3	E3
W030-33	Release of radioactive/hazardous material from tank headspace to atmosphere due to dome collapse/damage caused by flammable gas deflagration	Accumulation of flammable gas from steady state generation with ignition source present resulting in fire/deflagration	F3	E3
W030-34	Release of radioactive/hazardous material from tank headspace to atmosphere due to dome collapse/damage caused by flammable gas deflagration	Accumulation of flammable gas from a gas release event (GRE) with ignition source present resulting in fire/deflagration	F3	E3
W030-35A	Release of radioactive material from Tank 241-AZ-101 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3
W030-35B	Release of radioactive material from Tank 241-AZ-102 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3
W030-35C	Release of radioactive material from Tank 241-AY-101 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3
W030-35D	Release of radioactive material from Tank 241-AY-102 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-36	Release of radioactive material from tank to atmosphere due to dome failure or collapse caused by excessive vacuum	Ventilation imbalance causes excessive vacuum resulting in dome failure/collapse	F0	E3
W030-37	Release of radioactive material from tank to atmosphere due to dome collapse caused by excessive pressure	Excessive air supply to air lift circulators causes excessive pressure in tank causing dome collapse/damage	F0	E3
W030-43	Release of radioactive material from ventilation ducting to atmosphere due to criticality	Buildup of fissile material in ventilation ducting until criticality occurs	F0	E3
W058-FLOW15	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
W058-FLOW16	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	E3
W058-FLOW17a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error) plus mitigative features failure	F2	E3
W058-FLOW17b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure plus mitigative features failure	F2	E3
W058-FLOW17c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion plus mitigative features failure	F2	E3
W058-FLOW18	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
W058-FLOW19	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit plus mitigative features failure	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-FLOW20a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error) plus mitigative features failure	F2	E3
W058-FLOW20b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure plus mitigative features failure	F2	E3
W058-FLOW20c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion plus mitigative features failure	F2	E3
W058-INTEG32	Release of radioactive supernate or slurry aerosols to the atmosphere due to a spray leak from test risers located near SY-A and SY-B valve pits	Failure of primary piping and path for spray leak from test riser plus mitigative features failure	F2	E3
W058-INTEG34	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E3
W058-INTEG35	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3
W058-INTEG36	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E3
W058-INTEG37	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3
W151-14	Leak to soil surface and release to atmosphere	Release of radioactive/hazardous material from tank to soil surface due to load drop	F1	E3
W151-19	Release to the environment	Release of radioactive/hazardous material from tank to atmosphere and leak to soil due to flammable gas deflagration	F2	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-31	Criticality	Release of radioactive/hazardous material from tank to the atmosphere due to criticality	F1	E3
W151-32	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to dome overload resulting in collapse	F2	E3
W151-48	Release of radioactive/hazardous material in tank and contaminated material plugging stack	Release of radioactive/hazardous material from tank to soil subsurface and contaminated material from stack to atmosphere due to flammable gas deflagration	F1	E3
W320-A-TRANS05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Temperature out of specification causing a steam bump when level is lowered resulting in release/ignition of a flammable gas	F0	E3
W320-A-TRANS06	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Waste temperature out of specification during start of slurry transfer in tank and subsequent ignition of organics	F0	E3
W320-ABCD-ALL01a	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL01b	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL02a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL02b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL03a	Release of radioactive aerosols from tank to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-ALL03b	Release of radioactive aerosols from tank to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 to the soil surface due to tank overflow	Large water intrusion (raw water, surface flood, cascade) or excessive transfer causing overflow of tank	F1	E3
W320-ABCD-ALL08*	Release of radioactive liquid from Tank 241-C-106 to soil surface due to tank overflow	Siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	F1	E3
W320-ABCD-CHILL03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Excessive cooling from process chiller restricts inflow, loop seal fails to operate and vacuum is formed which damages tank structure	F0	E3
W320-ABCD-TRANS11	Release of radioactive aerosols from transfer piping in Tank 241-AY-102 pit to atmosphere due to spray leak	Line break due to flammable gas ignition in pit causing cover blocks to fall onto piping resulting in spray leak	F2	E3
W320-ABCD-TRANS11*	Release of radioactive aerosols from Tank 241-AY-102 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F2	E3
W320-ABCD-TRANS12	Release of radioactive aerosols from Tank 241-AY-102 distributor pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach in distributor pit with cover block off during slurry transfer	F2	E3
W320-ABCDF-ALL01*	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration in pit	Flammable gas generation from tank waste builds up in pit drain pipe and is ignited	F1	E3
W320-B-ALL01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Volcanic event results in buildup of ashfall on top of tank; weight of ash exceeds design limit and causes dome collapse	F0	E3
W320-B-ALL02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Volcanic event results in buildup of ashfall on top of tank; weight of ash exceeds design limit and causes dome collapse	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-ALL03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Extreme snow fall results in large amounts of snow accumulating on top of tank; weight of snow on tank exceeds design limits and causes dome collapse	F0	E3
W320-B-ALL04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Extreme snow fall results in large amounts of snow accumulating on top of tank; weight of snow on tank exceeds design limits and causes dome collapse	F0	E3
W320-B-ALL05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Maintenance error or procedure violation result in overloading tank dome past design limits resulting in dome collapse	F0	E3
W320-B-ALL06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Maintenance error or procedure violation result in overloading tank dome past design limits resulting in dome collapse	F0	E3
W320-B-ALL08a	Large release of radioactive aerosols from Tank 241-AY-102 due to flammable gas fire/deflagration	Raw water leak causes a large water intrusion that induces a flammable gas release event which is ignited resulting in a dome space fire	F0	E3
W320-B-ALL08b	Large release of radioactive aerosols from Tank 241-AY-102 due to flammable gas fire/deflagration	Surface water flood causes a large water intrusion that induces a flammable gas release event which is ignited resulting in a dome space fire	F0	E3
W320-B-ALL09	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to organic waste fire	Formation of organic layer in tank during slurry distribution and subsequent ignition of organics	F1	E3
W320-B-ALL10	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Formation of organic layer in tank during sluicing and subsequent ignition of organics	F1	E3
W320-B-FLUSH04	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Flushing water spray through sluice nozzle resulting in excessive tank vacuum damaging tank	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS14	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Low slurry flow to distributor resulting in solids piling up, flammable gas generation, LFL being reached and ignition occurs resulting in a dome space fire	F0	E3
W320-B-TRANS15	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Air is injected into the waste from the startup of slurry flow from the distributor, gas is scrubbed from the waste, LFL is reached in dome space and ignition occurs resulting in dome space fire	F0	E3
W320-B-TRANS16	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Distributor nozzle breaks off causing solids to pile up generating significant amounts of flammable gas, LFL is reached and an ignition source is present resulting in a dome space fire	F0	E3
W320-B-TRANS23	Release of radioactive aerosols from Tank 241-AY-102 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach in pump pit with cover block off during sluicing	F2	E3
W320-B-TRANS24	Release of radioactive aerosols from Tank 241-C-106 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	F2	E3
W320-B-TRANS25	Release of radioactive aerosols from Tank 241-C-106 sluice pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	F2	E3
W320-B-TRANS26	Release of radioactive aerosols from Tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F2	E3
W320-B-TRANS27	Release of radioactive aerosols from Tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F1	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS32	Release of radioactive aerosols from transfer line to atmosphere due to spray leak	Transfer line break due to light aircraft strike on underground transfer line berm	F0	E3
W320-B-VENT08	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	F0	E3
W320-B-VENT09*	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	F0	E3
W320-BCD-ALL02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Closing of W030 ventilation system inlet damper, build up of excessive vacuum with PCV failure resulting in tank damage	F0	E3
W320-BCD-ALL03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Ventilation system fan overspeed with failure of tank loop seal failure results in excessive vacuum and tank damage	F0	E3
W320-BCD-FLUSH01	Release of radioactive aerosols from line in pit to atmosphere due to spray leak from mispositioned valve, cover plug removed	3-way valve left in flush position after flushing, cover plug is lifted out of cover block on initiation of sluicing process	F3	E3
W320-BCD-FLUSH02*	Release of radioactive aerosols from flush tank of transfer truck to atmosphere due to spray leak from starting submersible pump in Tank 241-C-106 during the flush of slurry transfer line	Submersible pump in Tank 241-C-106 is started during the flush of slurry transfer line, flush tank is filled and pressurized resulting in rupture of flush tank or flush transfer line	F3	E3
W320-BCD-PUMP04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Submersible pump raised too high in tank, winch lifting strap fails, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	E3
W320-BCD-TRANS11	Release of radioactive aerosols from transfer line in Tank 241-C-106 pit to atmosphere due to spray leak in transfer connection	Blank flange left off flushing connection in pit after flushing, cover plug is lifted out of cover block on initiation of sluicing	F3	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-TRANS12	Release of radioactive aerosols from transfer line in Tank 241-AY-102 pit to atmosphere due to spray leak in transfer connection	Blank flange left off flushing connection in pit after flushing, cover plug is lifted out of cover block on initiation of sluicing	F3	E3
W320-D-ALL07	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Seismic event releases flammable gas from the waste and after shocks cause mechanical sparks which ignite the flammable gas mixture	F2	E3
W320-D-ALL08	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Human error or activation of ALCs during high temperature condition causes GRE above LFL	F1	E3
W320-D-CHILL01	Release of radioactive aerosols from damaged Tank 241-C-106 to the atmosphere due to propylene glycol fire/deflagration	Piping or tubing leak of propylene glycol from pit chiller into tank with ignition source	F0	E3
W320-D-CHILL02	Release of radioactive aerosols from damaged Tank 241-C-106 to the atmosphere due to propylene glycol fire/deflagration	Piping or tubing leak of propylene glycol from pit chiller into tank with ignition source	F0	E3
W320-D-PUMP01	Release of radioactive aerosols from Tank 241-AY-102 transfer pit to atmosphere due to spray leak from break in jumper connectors, cover block is off	Immersible pump being positioned to high resulting in air entrainment in transfer line, booster pump torques in reaction to air in transfer line and jumper connectors break, cover block is off	F1	E3
W320-D-PUMP03	Release of radioactive aerosols from Tank 241-C-106 transfer pit to atmosphere due to spray leak from break in jumper connectors, cover block is off	Immersible pump being positioned too high resulting in air entrainment in transfer line, booster pump torques in reaction to air in transfer line and jumper connectors break, cover block is off	F1	E3
W320-D-PUMP04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Pumping of more solids than anticipated, annulus cooling mod not completed, waste is overheated causing a tank bump that results in large flammable gas release/ignition	F0	E3
W320-D-TRANS05	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	GRE causes head space gas concentration above LFL in tank and start of pumping ignites	F1	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-TRANS07	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Sluice water transfer rate is excessive causing the level of waste to be lowered quickly with the waste temperature too high resulting in a large steam bump and flammable gas release/ignition	F1	E3
W320-D-TRANS10	Release of radioactive aerosols from pit to atmosphere due to spray leak from jumper	Seismic event damages jumper and breaches cover block by ground motion resulting in spray release	F2	E3
W320-D-TRANS11	Release of radioactive aerosols from transfer line to the atmosphere due spray leak	Seismic event damages transfer line by ground motion resulting in spray release	F1	E3
W320-D-VENT12	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure and tank collapse	F0	E3
W320-D-VENT13	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable fire/deflagration	Influx of cold water spray into tank causing excessive vacuum with a large flammable gas release as a result of slurry distribution; gas is ignited causing dome fire	F0	E3
W320-D-VENT16	Large release of aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration in the dome space	Loss of primary or annulus ventilation for an extended period resulting in a gradual rise in waste temperature, buildup of flammable gas to the LFL and ignition resulting in a dome space fire	F0	E3
W320-D-VENT17	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Ice storm prevents air inflow into tank causing excessive tank vacuum, flammable gas release with ignition source resulting in fire/deflagration	F1	E3
W320-D-VENT18	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration in the tank dome space	Volcanic event causes buildup up of ash on top of tank preventing air inflow, excessive vacuum develops and flammable gas is released to the dome space which is ignited resulting in dome space fire	F0	E3

Table D-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (31 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT20	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure	F0	E3
W320-E-TERM03	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Lack of controls on operation of tank after it has been turned into a FG group 1 tank, ignition occurs from lightning strike or other event resulting in a dome space fire	F0	E3
XS-01-FLOW02	Release of liquids, solids and/or vapors from single shell tank due to dome collapse caused by flammable gas burn	Loss of pump prime results in overheated pump that ignites flammable gas	F2	E3
XS-01-FLOW03	Release of liquids, solids and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	E3
XS-06-FLOW02	Release of liquid radioactive waste from DCRT transfer piping to Tank 241-SY-102 due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	E3
XS-06-FLOW03	Release of liquid radioactive waste from transfer piping from PFP to DCRT due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	E3
XS-13-PRES02	Release of radioactive aerosols from 241-U-301B catch tank due to fire/explosion of flammable gas	Buildup of flammable gas in catch tank and spark source	F2	E2
XS-26-PRES02	Release of radioactive aerosols from Tank 241-SY-102 due to flammable gas fire/explosion (dome collapse)	Accumulation of flammable gases in vapor space and spark source	F2	E2

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Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-01-FLOW02	Release of radioactive waste to soil from transfer piping which runs to Tank 241-AW-102 due to leak from primary pipe and encasement	Excavation accident fails primary pipe and encasement	F3	E2
102AW-01-FLOW03	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Corrosion of inner and outer pipe cause failure of primary pipe and encasement	F3	E2
102AW-01-FLOW04	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	High structural loading from traffic or cranes fails primary pipe and encasement	F3	E2
102AW-01-FLOW05	Release of radioactive waste to soil from transfer piping to Tank 241-AW-102 due to leak from primary pipe and encasement	Seismic event fails primary pipe and encasement	F2	E2
102AW-01-FLOW06	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Undermining due to leak of nearby pipes cause failure of primary pipe and encasement	F3	E2
102AW-01-FLOW07	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Water hammer cause failure of primary pipe and encasement	F3	E2
102AW-01-FLOW10	Release of liquid radioactive waste from Tank 241-AW-102 due to overflow	Misrouting of waste from reverse flow caused by the combination of an incorrectly wired pump and a full transfer pipe	F2	E2
102AW-01-FLOW11	Release of liquid radioactive waste to the ground surface from Tank 241-AW-102 due to overflow of Tank 241-AW-102 or underground structure	Misrouting to destination other than intended causes overflow	F3	E2
102AW-01-TEMP01	Release of liquid radioactive waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to corrosion caused by transferring high temperature waste	F2	E2
102AW-01-TEMP01A	Release of liquid waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to thermal stress of transferring hot solution in cold pipe	F2	E2
102AW-01-TEMP02	Release of liquid radioactive waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to exceeding the design temperature of the pipe by transferring high temperature waste	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-02-LEVE01	Release of toxic gases from Tank 241-AW-102 due to accumulations of gases	Slurry growth	F1	E1
102AW-02-LEVE03	Release of radioactive liquid from Tank 241-AW-102 due to overfilling	Failure to stop transfer causes overfilling of tank	F3	E2
102AW-02-LEVE04	Release of radioactive liquid from Tank 241-AW-102 due to overfilling	Misrouting causes overfilling of tank	F3	E2
102AW-02-LEVE05	Release of radioactive liquid from Tank 241-AW-102 to the soil column due to gross overfilling of tank (Pool)	Misrouting causes overfilling of tank	F3	E2
102AW-02-PRES 102AW-02-TEMP	Release of radioactive aerosols from Tank 241-AW-102 due to pressurization	Evaporator dump when intrusive activity is occurring which causes pressurization	F3	E2
102AW-02-PRES02	Release of toxic gases from Tank 241-AW-102 due to chemical reaction in waste	Transfer of incompatible waste to Tank 241-AW-102 causes tank gas accumulation	F3	E2
102AW-02-PRES08	Release of radioactive aerosols from Tank 241-AW-102 due to positive pressure	Evaporator dump of hot liquid generates aerosols and pressurizes the tank	F3	E1
102AW-02-PRES09	Release of radioactive aerosols from head space of Tank 241-AW-102 due to positive pressure (lower energy than tank bump)	Loss of fan with airlift circulators running, generating aerosols and pressurizing the tank	F3	E1
102AW-02-TEMP 102AW-08-TEMP	Release of radioactive aerosols from Tank 241-AW-102 due to positive pressure	Chemical reaction heating up and/or agitating tank causes positive pressure in tank	F2	E1
102AW-02-TEMP01	Release of radioactive aerosols from Tank 241-AW-102 due to boiling waste	High heat waste causing boiling	F2	E2
102AW-02-TEMP02	Release of radioactive aerosols from Tank 241-AW-102 due to tank bump	High heat waste combined with loss of ventilation contributes to tank bump	F2	E2
102AW-03-LEVE01	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus	Flammable concentration of gases in annulus vapor space due to waste leak into annulus and spark source	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-03-LEVE02	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus	Flammable concentration of gases in annulus vapor space due to waste mis-transfer into annulus and spark source	F2	E2
102AW-03-TEMP02	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus damaging primary tank	Flammable concentration of gases in annulus vapor space due to spill of fuel into annulus and spark source	F2	E2
102AW-04-STRU03	Release of radioactive particulate from Tank 241-AW-102 central pump pit due to re-suspension	Equipment drop during crane work	F2	E1
102AW-04-STRU04	Release of liquid radioactive waste from Tank 241-AW-102 central pump pit due to leak to soil	Piping leak and leak from pump pit due to equipment drop	F2	E2
102AW-04-STRU05	Release of liquid radioactive waste from Tank 241-AW-102 central pump pit due to leak to soil	Piping leak and leak from pump pit due to seismic event	F1	E2
102AW-04-TEMP	Release of radioactive particulate from Tank 241-AW-102 central pump pit due to fire	Pump motor electrical fire	F1	E1
102AW-08-COMP02	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Misrouting of waste creates critical mass	F1	E2
102AW-08-COMP02A	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Human error - addition of excess fissile material to Tank 241-AW-102 creates critical mass	F1	E2
102AW-08-COMP03	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Non-uniform distribution of fissile material (horizontally) creates critical mass	F1	E2
102AW-08-COMP04	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Non-uniform distribution of fissile material (vertically) due to addition of "rich" layer	F1	E2
102AW-08-COMP05	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Over concentration of waste creates critical mass	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-09-TEMP	Release of aerosols from Tank 241-AW-102 vapor space due to pressurization	Transfer of hot solution from facility, generates aerosols and pressurizes the tank	F3	E1
102AW-09-TEMP01	Release of radioactive aerosols from Tank 241-AW-102 atmosphere due to tank bump	High heat waste plus loss of cooling and/or mixing pump (not yet installed) operation	F2	E2
102AW-13-FLOW02	Release of radioactive liquid from transfer piping out of Tank 241-AW-102 due to backflow of radioactive material into flush pit and subsequent overflow (Pool)	Multiple valving errors and failure of backflow prevention devices dumps to pit as designed	F3	E1
102S-01.a1	Radioactive/hazardous liquid released to soil surface from tank diversion box/access pit to the ground surface due to misrouting a transfer.	Human error (jumper/blank installation) + Mistransfer to Tank 241-S-102 (450-600 Kgal) overfills tank	F2	E2
102S-01.b2	Radioactive liquid released to soil surface from Tank 241-S-102 pump pit due to leak in jumpers connecting tank transfer lines SL-140, SN-242 during saltwell pumping.	Jumper failure + Drain plugged	F2	E2
102S-01.b3	Radioactive liquid released to the soil subsurface from leaks in transfer lines SL-140, SN-242. (Plume)	Line leak during saltwell pumping (corrosion)	F3	E2
102S-02.b1	Release of radioactive aerosols to atmosphere from Tank 241-S-102 pump pit due to flammable gas generated in pump pit igniting and burning paint off pump pit walls	Jumper leak + H2 evolution (or ammonia) + Spark	F2	E1
102S-02.b2	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to flammable gas from tank igniting in pump pit and burning paint off pump pit	H2 /Ammonia production migrates into pump pit + Spark (pumps not operating)	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102S-02.d2	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into pit ignited from ruptured gas tank.	Vehicle drives into pit cover puncturing gas tank + Ignition	F3	E0
102S-03.b3	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into waste tank due to ignition of fuel from ruptured gas tank.	Vehicle drives into open riser puncturing gas tank + Ignition	F2	E2
102S-04.a3	Release of radioactive aerosols trapped in gases throughout Tank 241-S-102 waste to the atmosphere due to periodic release of toxic gases (lower energy than tank bump)	Waste growth (bump) due to chemistry within the waste coupled with crust movement	F3	E1
102S-04.e1b	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to due to ignition of flammable gas in tank causing HEPA failure	Concentration of H2 or Ammonia (or other flammable gasses) above LFL + Ignition source	F2	E2
102S-04.e4	Release of radioactive gases and aerosols from Tank 241-S-102 vapor space to atmosphere due to criticality	Criticality (misrouting)	F1	E1
106C-01F	Release of radioactive and/or hazardous material from Tank 241-C-106, blown out HEPA filters and/or discharge out cover blocks due to high tank pressure	Blockage of inlet, outlet and cascade lines	F2	E2
106C-01G	Release of radioactive and/or hazardous material from Tank 241-C-106 tank, due to waste reaction causing local discharge of contamination through blown HEPAs or out cover blocks	Addition of acid to tank	F2	E1
106C-01H	Release of radioactive and/or hazardous material from Tank 241-C-106, through blown HEPAs or out cover blocks due to tank boiling with vent path blocked or failed	Tank boiling with lack of vent path	F2	E1
106C-01M	Release of radioactive and/or hazardous material from Tank 241-C-106, due to high temperature in the waste tank	Exothermic, chemical reaction in tank due to inadvertent addition to tank	F2	E1

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-01N	Release of radioactive and/or hazardous material from Tank 241-C-106 to atmosphere due to criticality	Criticality in waste tank from high temperature	F1	E2
106C-04Aa	Release of radioactive and/or hazardous material from Tank 241-C-106 due to flammable gas content of the waste causing an exothermic reaction in waste tank	High flammable gas content in tank sludge layer due to chemical reaction	F2	E1
106C-06D	Release of contamination from Tank 241-C-106 pump pit and potential worker injury due to fire	Fire in or near pump pit due to vehicle fuel spill and burn	F2	E1
106C-06L	Release of contamination from Tank 241-C-106 pump pit due to fire/explosion affecting the structural integrity	Fire/explosion in pump pit	F2	E1
106C-10J	Release of radioactive and/or hazardous material from Tank 241-C-106 due to tank structural damage, HEPA damage caused by high temperature	Fire in or around ventilation system	F2	E3
106C-11E	Release of unfiltered tank atmosphere from Tank 241-C-106 due to damaged ductwork	Damage to ventilation ductwork upstream of filters	F3	E2
106C-11J	Release of radioactive and/or hazardous material from Tank 241-C-106 due to HEPA damage, beyond 200 F design	Exhauster heater overheat	F3	E1
106C-11K	Release of radioactive and/or hazardous material from Tank 241-C-106 due to HEPA filter damage, spread of contamination caused by high temperature in ventilation system	Fire in exhauster ductwork	F2	E1
106C-11L	Release of radioactive and/or hazardous material from Tank 241-C-106, through HEPA filter path, due to human error in installation of filter	Improper installation of HEPAs	F3	E1
106C-11M	Release of radioactive and/or hazardous material from Tank 241-C-106 due to damaged HEPA filters	Event that damages HEPAs	F3	E1
106C-11O	Release of radioactive and/or hazardous material from Tank 241-C-106 due to loss of filtration	HEPA filter blowout	F2	E1

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-12F	Release of radioactive and/or hazardous material from Tank 241-C-106 tank due to waste reaction in tank	Added chemicals to tank instead of normal water addition	F2	E2
107AN-01-LEVE01	Release of caustic material from truck tank due to leak (aerosol spray)	Open valve on truck with pressurized tank transfer.	F3	E2
107AN-01-LEVE02	Release of caustic material from truck tank due to leak (aerosol spray)	Truck tank leak	F2	E2
107AN-01-TEMP02	Spray release of caustic material from truck tank due to high temperature	Fire in gas tank	F1	E2
107AN-02-FLOW01	Release of radioactive aerosols from Tank 241-AN-107 due to surface chemical reaction	Transfer of incompatible chemical to tank via chemical addition system due to vendor or paperwork error	F3	E2
107AN-02-FLOW02	Release of toxic vapors from Tank 241-AN-107 due to surface chemical reaction	Transfer of incompatible chemical to tank via chemical addition system due to vendor or paperwork error	F3	E2
107AN-02-PRES	Release of caustic aerosol from caustic truck transfer piping due to spray leak	Piping/hose leak initiated by various causes	F3	E2
107AN-02-PRES02	Release of caustic material from transfer piping due to high pressure (aerosol spray)	Hose disconnect	F3	E1
114SX-02.b	Radioactive liquid released from tank pump pit to the ground surface due to inadvertent pumping activity (pool)	Human error (not normal activity)	F1	E2
114SX-04.b.1.b.1b	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to failure of exhaust ducting from seismic event (mechanical disruption)	Ducting failure from seismic activity	F1	E1
114SX-04.c.1	Release or radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to mechanical failure of exhauster HEPA filter	Plenum structure failure pierces filter	F2	E2
114SX-04.c.2.a	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter seal failure	HEPA filter seal failure	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
114SX-04.c.2.b	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster defective HEPA filter	Defective HEPA filter	F3	E2
114SX-04.c.2.c	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter deterioration	Deteriorated HEPA filter	F3	E2
114SX-04.c.2.d	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter installation errors	Improper installation (human error)	F2	E2
114SX-05.b.2	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to sudden flashing of water added to tank for cooling	Flashing (adding cold liquid to hot tank contents)	F0	E2
114SX-05.c.2c	Release pf radioactive gases and aerosols as well as direct radiation from Tank 241-SX-114 due to criticality	Criticality (difficult to achieve concentration needed and difficult to obtain configuration required)	F1	E1
114SX-05.d	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to localized fire/explosion of flammable gas	Core Sampling through a pocket of gas large enough to exceed local LFL with ignition source (spark) creates local fire/explosion	F3	E1
204AR-01H	Release of airborne and waterborne contaminates outside building on track spur, and potential contamination in unloader room from rail car due to spilling rail car contents	Rail car rupture due to collision with other or a derailment	F2	E2
204AR-01I	Release of airborne and waterborne contaminates outside building on track spur, and potential contamination in unloader room from rail car due to leak	Rail car leak due to tanker corrosion or other degradation	F2	E2
204AR-02A	Release of liquid radioactive material and toxic chemicals outside and inside the 204AR building from the trailer due to collision which causes a spill	Tank trailer damage due to running into the building and causing the tank contents to spill	F2	E1
204AR-02B	Release of radioactive material and toxic chemicals from trailer due to structural degradation of trailer	Tank trailer damaged due to corrosion or other degradation	F2	E1

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
204AR-07A	Release of liquid radioactive waste and high airborne in unloading room from the Tank 241-AY-102 due to reverse pumping of Tank 241-AY-102 contents back to 204-AR	Pump in pit 02D starts and pumps back to the 204-AR building through the transfer piping and leaks	F2	E2
204AR-09A	Release of airborne and waterborne contamination from the sump pit due to ruptured piping during transfer.	Rupture of transfer piping section above the sump pit	F2	E2
204AR-09B	Release of airborne and radiation contamination in the unloader room from trailer or rail car leak due to high level in sump pit	Catastrophic leak from a large liquid source such as a trailer or rail car	F2	E2
204AR-09C	Release of airborne and radiation contamination in the unloader room from rail car due to gross overfilling of catch tank	Gross overfilling of catch tank either from large source such as the trailers or rail cars or continual pumping of transfer water through a leaky pipe	F2	E2
204AR-09D	Release of radioactive liquid waste in the unloader room from the rail car or trailer due to failed rail car or trailer	Failed tank car or rail car (initially full of liquid waste) overflowing the catch tank and sump pit	F2	E1
204AR-11F	Release of airborne radiological contamination through the ventilation stack from the unloader room atmosphere due to fire in ventilation ducting	Fire in ventilation ducting resulting in damage to the HEPA filters and release to the atmosphere	F2	E1
244AR-01.b.04	Release of radioactive aerosols from the facility exhaust stack due to filter failure	HEPA filter fails	F3	E1
244AR-01.c.09	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to flammable gas ignition	Ignition of flammable gas that has collected in piping and tank dome	F2	E2
244AR-02.a.03	Release of radioactive liquid in the form of aerosols contained in a cell to the exterior of the 244-AR facility due to ignition of flammable gas	Fire/explosion from hydrogen buildup	F1	E2
244AR-02.a.07	Release of radioactive aerosols from vessel headspace to building atmosphere with eventual release outside facility due to overfilling of sump causing tank failure	Rain or snow water intrusion	F1	E2
244AR-03.a.04	Release of radioactive aerosols into cell due to ignition of flammable gas in 244-AR Vault tank headspace	Fire/explosion due to ignition of accumulated flammable gas	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
244AR-03.a.05	Release of radioactive aerosols from tanks headspace due to ventilation system blockage	Ventilation and risers blocked while jetting occurring	F2	E2
244AR-03.a.08	Release of radioactive aerosols created by boiling waste to the cell atmosphere	Steam being supplied to tank heating/cooling coils	F3	E2
244AR-03.a.09	Release of radioactive aerosols created by criticality to the cell atmosphere	Criticality in waste	F1	E2
244AR-05.a.02	Release of radioactive material from facility due to seismic event which causes building collapse without cell collapse	Seismic event damages facility structure	F2	E2
2727W-02	Release of hazardous material from 2727-W due to sodium fire	Vehicle crashes into building and ignites sodium	F1	E1
2727W-03	Release of hazardous material from 2727-W due to sodium fire	Lightning	F2	E1
2727W-04	Release of hazardous material from 2727-W due to sodium fire	Overhead power line falls through building	F1	E1
2727W-05	Release of hazardous material from 2727-W due to sodium fire	Nitrogen tank overpressurizes sodium tank, ignites sodium	F3	E1
2727W-06	Release of hazardous materials from 2727-W due to sodium-water reactions	High wind or tornado destroys building with rain/snow	F2	E1
BND-02	Release of radioactive aerosols from tank due to ignition of combustibles during preparation for bonding	Drilling holes for bonding attachments causes sparks when flammable gases or materials are present	F2	E1
CCF-01	Radioactive and hazardous release from tanks due to extended loss of ventilation (over 6 months)	Sustained loss of offsite power	F1	E2
CCF-07	Release of radioactive and hazardous materials from tank due to overfill	Disabled or unavailable staff to terminate transfer	F3	E2
CCF-20	Release of radioactive and hazardous aerosols/vapors from tanks due to chemical reactions between waste and added materials	Reactive chemical additions to two tanks	F2	E1

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CDP-10	Release of radioactive contamination to soil surface from excavation or drilling in cribs, ditches or ponds that disturbs radioactive material	Excavation or drilling	F3	E2
COB-04	Release of radioactive and/or hazardous material from COB lid due to overflow of COB during transfer (pool)	Leak into COB with floor drain plugged, leak detector failed	F3	E2
COB-08	Release of radioactive and/or hazardous material from COB due to over filling of COB (pool)	Transfer pipe or riser rupture, backfilling lower part of COB then filling COB via the floor drain	F3	E2
CP-MSP-01	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations	F1	E2
CP-MSP-08	Release of radioactive or toxic material to atmosphere from MISF Miscellaneous Inactive Storage Facilities due to flammable gas deflagration	Human error AND Mechanical failure of probe	F2	E2
CRN-03-IA	Release of radioactive and/or toxic materials from facility due to containment top collapse	Human error results in excessive weight on top of containment	F3	E1
CRN-03-IB	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Human error results in excessive weight on top of containment	F3	E2
CRN-04-IA	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Crane or rigging failures drop load resulting in large impact to top of containment	F2	E1
CRN-04-IB	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Crane or rigging failures drop load resulting in large impact to top of containment	F2	E2
CRN-05	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Human error in positioning crane load	F3	E2
CRN-06	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Mechanical failure in positioning crane load	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CRN-07	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Crane hits electrical lines/supplies	F3	E2
CRN-08	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Lightning	F3	E2
CRN-09	Release of radioactive and/or toxic materials from ventilation system due to crane damage	Human error in positioning crane load	F3	E2
CRN-09-I	Release of radioactive and/or toxic materials from ventilation system due to damage caused by crane operation	Human error in positioning crane load	F3	E1
CRN-10	Release of radioactive and/or toxic materials from ventilation system due to crane damage	Mechanical failure in positioning crane load	F3	E2
CRN-10-I	Release of radioactive and/or toxic materials from ventilation system due to damage caused by crane operation	Mechanical failure in positioning crane load	F2	E1
CRN-11-IA	Release of radioactive and/or toxic materials from facility due to containment top collapse or equipment damage by boom failure	Human error: improper load assembly, rigging, crane overloaded	F3	E1
CRN-11-IB	Release of radioactive and/or toxic materials from facility due to equipment damage by boom failure	Human error: improper load assembly, rigging, crane overloaded	F3	E1
CRN-11-IC	Release of radioactive and/or toxic materials from facility due to containment top collapse damage by boom failure (pool)	Human error: improper load assembly, rigging, crane overloaded	F3	E2
CRN-12-IA	Release of radioactive and/or toxic materials from facility due to containment top collapse or equipment damage by boom failure	Mechanical failure: corrosion, faulty materials	F2	E1
CRN-12-IB	Release of radioactive and/or toxic materials from facility due to equipment damage by boom failure	Mechanical failure: corrosion, faulty materials	F2	E1
CRN-12-IC	Release of radioactive and/or toxic materials from facility due to containment top collapse by boom failure (pool)	Mechanical failure: corrosion, faulty materials	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CRN-13-IA	Release of radioactive and/or toxic materials from below ground facility due to containment top collapse or equipment damage by boom failure	High wind or seismic event	F2	E1
CRN-13-IB	Release of radioactive and/or toxic materials from above ground facility due to equipment damage by boom failure	High wind or seismic event	F2	E1
CRN-13-IC	Release of radioactive and/or toxic materials from facility due to containment top collapse damage by boom failure	High wind or seismic event	F2	E2
CRN-18	Release of radioactive or toxic material from above ground tank equipment due to dropping crane load	Human error: improper load assembly, rigging, crane overloaded	F3	E1
CRN-18-I	Release of radioactive or toxic material from aboveground facility equipment due to dropping crane load	Human error: improper load assembly, rigging, crane overloaded	F3	E1
CRN-19	Release of radioactive or toxic material from above ground tank equipment due to dropping crane load	Mechanical failure: corrosion, faulty materials (filter crush)	F3	E1
CRN-19-I	Release of radioactive or toxic material from aboveground facility equipment due to dropping crane load	Mechanical failure: corrosion, faulty materials	F2	E1
CRN-20	Radioactive or toxic material release from pit or riser due to dropping crane load onto above ground tank equipment	High wind or seismic event (filter crush)	F3	E1
CRN-20-I	Release of radioactive or toxic material from aboveground facility equipment due to dropping crane load	High wind or seismic event	F2	E1
CRN-21-IB	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility (surface pool)	Human error: improper load assembly, rigging, positioning error	F3	E2
CRN-22-IB	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility (surface pool)	Mechanical failure: corrosion, faulty materials, hydraulics	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CRN-23	Release of radioactive or toxic materials from tank due to loss of vertical load control, dropping crane load into tank, onto tank bottom (subsurface leak)	High wind or seismic event	F3	E3
CRN-23-IA	Release of radioactive or toxic materials from underground facility bottom due to loss of vertical load control, dropping crane load into facility (subsurface leak)	High wind or seismic event	F2	E1
CRN-23-IB	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility	High wind or seismic event	F2	E2
CRN-25-IB	Release of radioactive or toxic material from aboveground MISF due to swinging load into equipment caused by loss of lateral load control	Human error: improper load assembly, rigging, positioning error	F3	E1
CRN-26-IB	Release of radioactive or toxic material from aboveground MISF due to swinging load into equipment caused by loss of lateral load control	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil	F2	E1
CRN-27-IB	Release of radioactive or toxic material from aboveground MISF due to swinging load into equipment caused by loss of lateral load control	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil	F2	E1
CVR-05	Release of radioactive or hazardous material through combustion or fire/explosion of materials in pit due to human error	Failure to sniff or improper sniffing	F3	E1
CVR-15-I	Release of radioactive or hazardous material from pit upon dropping or falling coverblocks or pieces of coverblocks	Coverblock hooks fail or pieces of degraded coverblock fall into pit	F3	E1
EE-11	Release of radioactive and hazardous materials from tank due to overfilling	Water line breaks and overfills tank	F2	E2
EE-17	Radioactive and hazardous material release from inactive equipment due to excavation error	Excavation into abandoned or inactive equipment	F3	E1
I-222S-1-CMP-C	Release (potential spray leak) of 222-S lab waste to atmosphere in diversion box or 244 S Pump Pit due to increased corrosion from failure to add sodium hydroxide	Human error - failure to add sodium hydroxide	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-222S-1-LVL-A	Release (steam) of aerosols and entrained particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to tank farm	Human error - failing to shut off steam after Tank 219-S-102 is empty	F3	E2
I-222S-1-RXN-A	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste	Transfer of incompatible waste	F3	E2
I-222S-2-FLW-C	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste	Human error - incorrect valve line up	F2	E2
I-222S-2-LEK-B	Release of 222-S lab waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	E2
I-222S-2-LEK-C	Release of 222-S lab waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	E2
I-222S-2-LEK-E	Release of 222-S lab waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from a seismic event	Seismic event	F2	E2
I-222S-2-PRS-A	Release (steam) of aerosols and particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to tank farm	Steam reducer valve fails open	F3	E2
I-242A-1-LEK-B	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	E2
I-242A-1-LEK-C	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line causes spray leak	F2	E2
I-242A-1-LEK-E	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242A-2-FLW-A	Release of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank and possible structural damage to the tank	Human error - pump is run at maximum speed	F3	E2
I-242A-2-FLW-B	Release of aerosols to the atmosphere through 12 inch opening in inlet station due to over pressurization of the receiver tank and possible structural damage to the tank	Human error - pump is run at maximum speed	F3	E2
I-242A-2-LEK-B	Release of slurry tank waste to the atmosphere due to spray leak at the diversion boxes or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	E2
I-242A-2-LEK-C	Release of slurry tank waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line causes spray leak	F2	E2
I-242A-2-LEK-E	Release of slurry tank waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes leak	F2	E2
I-242A-2-VSC-A	Release of aerosols in receiver tank due to tank burp from over concentration, potential to generate conditions similar to Tank 241-SY-101, "Tank Burp" due to hydrogen being trapped in thick solution (lower energy than tank bump)	Human error - over concentration of slurry at evaporator	F2	E2
I-242A-3-FLW-A	Release of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the feed tank and possible structural damage to the tank	Uncontrolled pot dump at evaporator (loss of electricity or air)	F3	E2
I-242A-3-FLW-B	Release of aerosols to the atmosphere through 12 inch opening in inlet station due to over pressurization of the feed tank and possible structural damage to the tank	Uncontrolled pot dump at evaporator (loss of electricity or air)	F3	E2
I-242A-6-FLW-B	Release of diluted high level tank waste from Feed Tank 241-AW-102 caused by overfilling Tank 241-AW-102 and annulus, aggravated by an uncontrolled evaporator dump when a raw water leak occurs in evaporator condenser room	Rupture of raw water line in condenser/pump room	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242A-7-FLW-A	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Compressor fails and 241-AW Tank Farm air supplied from 242-A	F1	E2
I-242A-7-FLW-B	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Valve inadvertently closed, 241-AW Tank Farm air supplied from 242-A	F1	E2
I-242A-7-FLW-C	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Filter plugged, 241-AW Tank Farm air supplied from 242-A	F1	E2
I-242S-2-FLW-A	Release of tank waste diluted with contaminated fire water to the soil due to flooding the pump room from a fire main break and pumping the water to Tank 241-SY-102 which overfills the tank and floods pit through risers	Break in fire main	F1	E2
I-242S-2-FLW-E	Release of high level waste to the ground outside the 242-S building due to unmitigated reverse flow to the pump room from Tank 241-SY-102	Human error - incorrect valve line up	F2	E2
I-242S-2-LEK-B	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-242S-2-LEK-C	Release of contaminated water to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-242S-2-LEK-E	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event	F2	E2
I-242S-4-FLW-C	Release of high level waste to the ground outside the 242-S building due to unmitigated reverse flow to the condenser room	Human error - incorrect valve line up	F2	E2
I-242S-4-FLW-D	Release of tank waste diluted with contaminated water to the soil due to flooding the condenser room which is pumped to Tank 241-SY-102 and overfills the tank and floods pit through risers	Break in fire main	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242S-4-LEK-E	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from an seismic event	Seismic event causes spray leak	F2	E2
I-BPLANT-1-CMP-B	Release (spray leak) of low level waste at diversion box from transfer of low pH material resulting in increased corrosion in pipe	Human error - failure to add sodium hydroxide leads to corrosion and leak in pipe	F3	E2
I-BPLANT-2-FLW-D	Release of aerosols and/or toxic vapors from receiver tank due to transfer of incompatible waste from B Plant	Human error - communication error between B Plant and TWRS causes transfer of incompatible waste	F3	E2
I-BPLANT-2-LEK-B	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-BPLANT-2-LEK-C	Release of low level waste to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-BPLANT-2-LEK-E	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	E2
I-PFP-1-AGT-A	Release of fission product gases and aerosols from receiver tank due to potential for solids to collect in D-5, If mixed later, potential for composition of next batch to exceed Criticality Prevention Specifications (CPS); potential "Criticality Issue"	Human error or agitator fails results in criticality	F3	E2
I-PFP-1-CMP-B	Release of fission product gases and aerosols from receiver tank due to, potential for localized concentration of fissile materials in receiver tank from failure to add ferric nitrates; potential "Criticality Issue"	Failure to add ferric nitrates, results in criticality	F3	E2
I-PFP-1-CMP-D	Release of fission product gases and aerosols from receiver tank due to excess fissile material in waste, potential to exceed criticality prevention specification requirements for shipment; potential "Criticality Issue"	Excess fissile content added to waste results in criticality	F3	E2
I-PFP-2-LEK-B	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-PFP-2-LEK-C	Release of TRU mixed waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	E2
I-PFP-2-LEK-E	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak.	F2	E2
I-PFP-2-TMP-B	Release (steam) of aerosols and entrained particulate from 244 TX ventilation system due to saturating HEPAs with steam sending higher pressure steam to steam jet, gassing it out	Failure of steam reducer	F2	E2
I-PFP-3-LEK-B	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-PFP-3-LEK-C	Release of TRU mixed waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	E2
I-PFP-3-LEK-E	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak	F2	E2
I-PUREX-1-AGT-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error or mechanical failure - agitator fails or is not turned on	F3	E2
I-PUREX-1-CMP-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error - failure to add sodium hydroxide to low level waste results in corrosion and causes spray leak	F3	E2
I-PUREX-1-LVL-A	Release of aerosols from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from transfer of steam	Human error - failure to shut off steam jet when U-3 is empty	F3	E2
I-PUREX-2-LEK-B	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-PUREX-2-LEK-C	Release of TRU waste from PUREX to the atmosphere due to spray leak at the rupture of the line from inadvertent excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-PUREX-2-LEK-E	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by seismic event	Seismic event causes spray leak	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-PUREX-2-PRS-A	Release (steam) of aerosols and particulates through cracks in the cover block from the receiver tank due to tank pressurization which gases out the steam jet	Steam reducer fails	F2	E2
I-PUREX-3-AGT-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Agitator fails or is not turned on results in corrosion and causes spray leak	F3	E2
I-PUREX-3-CMP-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error - failure to add sodium hydroxide to low level waste results in spray leak	F3	E2
I-PUREX-3-CMP-E	Release of fission product gases and aerosols from receiver tank due to criticality caused by exceeding Criticality Prevention Specifications for shipment from PUREX	Transfer of L Cell sump water to Tank F-18 and eventually to the Tank Farms	F3	E2
I-PUREX-3-LVL-A	Release of aerosols from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from transfer of steam	Human error - failure to shut off steam jet when U-3 is empty	F3	E2
I-PUREX-4-FLW-B	Release (ground surface) of high level tank waste diluted with flush water from the receiver tank due to overfilling from sending excess water	Block valve on flush water inadvertently left opened or leaking	F3	E2
I-PUREX-4-LEK-B	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-PUREX-4-LEK-C	Release of TRU waste from PUREX to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-PUREX-4-LEK-E	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	E2
I-PUREX-4-PRS-A	Release of aerosols and particulates through cracks in the cover block from the receiver tank due to tank pressurization which gases out the steam jet	Steam reducer fails	F2	E2
I-TPLANT-1-CMP-B	Release (spray) of low level waste at diversion box from transfer of lower pH material resulting in increased corrosion in pipe	Human error - failure to add sodium hydroxide causes corrosion and associated spray leak	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-TPLANT-2-CMP-A	Release (steam) of aerosols and entrained particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to the tank farm	Human error - steam block valve inadvertently opened or failure to close valve when Tank 15-1 is low	F3	E2
I-TPLANT-2-LEK-B	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit	Corrosion in pipe line causes spray leak	F1	E2
I-TPLANT-2-LEK-C	Release of low level waste to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-TPLANT-2-LEK-E	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	E2
I-UPLANT-1-LEK-B	Release of low level waste to the ground at the rupture of the line	Inadvertent excavation of line	F1	E2
ITK-05	Release of radioactive and/or hazardous material from point of in-tank access (non-fire, non-explosion) due to intrusive activity	Tank burps from intrusive activity	F2	E1
ITK-05-I	Release of radioactive and/or hazardous material from point of in-facility access due to gas release from in-facility waste during intrusive activity (non-fire, non-explosion)	Gas release from in-facility waste during intrusive activity	F2	E1
ITK-06	Release of radioactive and/or hazardous material from point of in-tank access (non-fire, non-explosion) due to criticality	Intrusive activity causes critical mass	F1	E2
ITK-06-I	Release of radioactive and/or hazardous material from point of in-facility access due to criticality within the in-facility waste during intrusive activity (non-fire, non-explosion)	Criticality from intrusive activity	F1	E2
ITK-08-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Exothermic reaction of incompatible materials in facility	F2	E2
ITK-09-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Failure to bond components or incorrect bonding	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
ITK-10-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Spark from equipment or tools provide an ignition source	F3	E2
ITK-11-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Lightning, range fire, or seismic event ignites facility vapors	F1	E2
ITK-FR-03	Release of radioactive aerosols from tank and/or receiver due to equipment jam in riser	Equipment becomes lodged in riser, efforts to remove pull riser out of tank causing breach of tank & receiver containment	F1	E2
ITK-FR-08	Release of radioactive aerosols/vapors from flex receiver due to structural failure	High winds tear flex receiver bag	F3	E2
ITK-FR-13	Release of radioactive aerosols/vapors from flex receiver due to buildup and ignition of flammable gas in receiver	Hydrogen gas buildup in tank/riser that travels into receiver with ignition source (spark from herculite or equipment)	F1	E2
ITK-FR-22	Release of radioactive aerosols from flex receiver due to tank gas release	Tank gas release pressurizes bag and causes bag to rupture	F1	E2
LDUA 5-40	Release of contamination from TRIC and tank riser due to damage during wind storm	High winds	F3	E1
NP-02	Radioactive and hazardous material releases from tanks and ventilation systems due to fire	Lightning strikes ventilation system	F2	E1
NP-03	Radioactive and hazardous material releases from tanks due to fire in tanks	Lightning strikes riser in tank farm	F2	E2
NP-05	Radioactive and hazardous material release from tanks, nearby ground surfaces, and ventilation systems due to above grade disturbances	High winds	F1	E2
NP-15	Radioactive and hazardous material release from isolated or abandoned equipment due to fire	Hydrogen producing chemical reactions in isolated or abandoned equipment	F3	E1
OGT-EXT3-01B	Release of radioactive or hazardous material from the primary pipe due to leak caused by truck crash into piping system	Human error, line struck by truck	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
OGT-FLOW1-02	Release of radioactive or hazardous material from pit overflow due to primary pipe leak caused by over-rated pump	Incorrect pump installed creates excessive flow and pressure on OGT system eroding EPDM pipe causing leak to secondary pipe with drain in pit plugged	F2	E2
OGT-FLOW1-03B	Release of radioactive or hazardous material from the primary pipe due to misdirected flow of waste through flush line	JR-1 (3-way valve) mispositioned to flush, two check valves fail, flush disconnect fails (check valve), and reverse flow to water truck, drum or onto ground	F1	E2
OGT-FLOW1-04	Release of radioactive or hazardous material from the primary pipe due to valve failure resulting in misdirected flow of waste through flush line to flush water supply truck	JR-1 leak (bleed-by), two check valves fail, and flush disconnect fails and pump started causing reverse flow to flush water truck tank	F1	E2
OGT-FLOW1-06	Release of radioactive or hazardous material from the DCRT due to overflow	Exceed volume available in DCRT/insufficient volume available, condition goes unnoticed until overflow occurs	F2	E2
OGT-FLOW2-01B	Release of radioactive or hazardous material from the primary pipe due to leak caused by incorrect pump installed	Incorrect pump installed creates excessive flow and isolation valve closed on secondary pipe, erosion of EPDM and pressurization of secondary pipe causing leaks from flanges gasket within concrete shield	F2	E2
OGT-FLOW2-03B	Release of radioactive or hazardous material from the primary pipe due leak caused by incorrect pump installed	Installation of incorrect pump, failure of inner pipe and isolation valves closed on secondary pipe drains causing leak from failed welds on flange within the concrete shield	F1	E2
OGT-PRES1-01	Release of radioactive or hazardous material from overflow of pit due to leak caused by high pressure	Heat up of hydro test by heat tape or high ambient temperature, high pressure results from captive fluid heat up, inner pipe damaged, leaks to secondary pipe and drains back to pits and insufficient drainage in pit	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
OGT-REAC1-01	Release of radioactive or hazardous material from overflow of pit due to primary pipe leak cause by chemical reaction	Pumping from multiple tanks to single OGT, potential for adverse chemical reactions in pipeline damaging inner pipe, leaks to secondary pipe and drains back to pits and insufficient drainage in pit	F1	E2
OGT-TEMP1-02	Release of radioactive or hazardous vapors/aerosols from the primary pipe due to spray leak caused by high temperatures	Vehicle accident above ground starts fire, melt the EPDM hose causing a leak to secondary pipe, pumping occurring, fire fails gasket and facilitates a release to atmosphere	F1	E2
OGT-TEMP1-03	Release of radioactive or hazardous material from overflow of pit due to leak caused by high temperature	High temperature flush water fails inner pipe causing leak to secondary pipe, drain to pit with insufficient drainage in pit	F1	E2
RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality	Mistransfer of material containing organic extractant from east area via the supernate piping route	F1	E3
RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of 102-SY tank due to mistransfer	Mistransfer of material from east area via the supernate piping route	F3	E2
RCSTS-03-FLOW/INTEG01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error)	F3	E2
RCSTS-03-FLOW/INTEG02a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error)	F3	E2
RCSTS-03-FLOW/INTEG02b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure	F2	E2
RCSTS-03-FLOW/INTEG02c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion	F2	E2
RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-03-INTEG02	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2
RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E2
RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Seismic event	F1	E2
RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer	F3	E2
RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-03-TEMP01*	Release of radioactive material to the atmosphere from the SY valve pit due to fire in pit	Fire in the pit caused by maintenance or electrical problem	F2	E1
RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2
RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-08-FILTER01*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter	Tornado or high winds across inlet	F1	E1
RCSTS-08-FILTER02*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter	HEPA filter structural failure or seal failure	F3	E1

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-08-FLOW01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-08-FLOW02	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	E2
RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	E2
RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	E2
RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Failure of piping due to corrosion	F2	E2
RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-08-INTEG03	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2
RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Failure of piping due to material defect	F2	E2
RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	F1	E2
RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Seismic event	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Seismic event	F1	E2
RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to corrosion plus mitigative features failure	F2	E2
RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to unrecognized material flaw	F2	E2
RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Water hammer	F3	E2
RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Water hammer	F3	E2
RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to freezing	F1	E2
RCSTS-09-FILTER01*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter	Tornado or high winds across inlet	F1	E1
RCSTS-09-FILTER02*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter	HEPA filter structural failure or seal failure	F3	E1
RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Flow of slurry to vent station due to incomplete closing of vent valves after venting	F3	E2
RCSTS-09-FLOW02	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-09-FLOW03	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	External leak of valve or valves to the vent station	F3	E2
RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	External leak of valve or valves to the vent station	F3	E2
RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Flow of supernate to vent station due to incomplete closing of vent valves after venting	F3	E2
RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E2
RCSTS-09-INTEG01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG03	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2
RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Seismic event	F1	E2
RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Seismic event	F1	E2
RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Water hammer	F3	E2
RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Water hammer	F3	E2
RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A lift station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F2	E2
RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to flammable gas explosion in primary piping	F2	E2
RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTSFS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	F2	E2
RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping break	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3
RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A lift station due to piping break	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3
RCSTS-24-FLOW/INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG04	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to misalignment	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-24-FLOW/INTEG06	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to misalignment	F3	E2
RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Seismic event	F1	E2
RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Seismic event	F1	E2
RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Water hammer	F3	E2
RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Water hammer	F3	E2
RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line break (upstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line break (downstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2
RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure	Caustic injection pressure relief valve failure	F3	E2
RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Flush line break due to structural failure	F2	E2
RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break	Flush line break due to structural failure	F2	E2
RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions	Freezing weather with loss of heat trace function	F2	E2
RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open	Pressure relief valve fails open	F2	E2
RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open	Back pressure valve fails in closed position	F2	E2
RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package	Line failure/leak due to structural failure	F2	E2
RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak	Caustic drain valve leak	F2	E2
RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open	Pressure relief valve fails open on caustic injection system	F2	E2
RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line	Back pressure relief valve fails in closed position	F3	E2
RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break	Line break due to structural failure	F2	E2
RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break	Line plug due to debris buildup causing pressure buildup resulting in pipe failure	F2	E2
RSR-06-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during riser removal activity	Failure to bond components or incorrect bonding allows electrostatic spark	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RSR-07-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during riser removal activity (chosen to represent all organic nitrate tanks)	Spark from failure to use non-sparking tools or sparks from welding, cutting, grinding, etc.	F3	E2
TFS-1	Release of radioactive or hazardous waste liquid from overflow of 244 S vault to the 244 S pump pit due to syphon effect on Tank 241-SY-102 (pump does not overflow)	Human Error - failure to close isolation valve (or valve malfunction) following waste transfer which allows flow to continue (syphon) when pump is stopped	F3	E2
VEH-01	Release of radioactive or toxic materials from cask due to fire caused by vehicle operation	Vehicle catches on fire	F3	E2
VEH-01-I	Release of radioactive or toxic materials from vehicle carrying MISF samples or contaminated equipment due to vehicle fire	Vehicle catches on fire	F2	E2
VEH-02	Release of radioactive or toxic material from cask due to damage to transport casks during seismic event	Seismic event	F1	E1
VEH-02-I	Release of radioactive or toxic material from MISF samples in transport casks due to seismic damage	Seismic event	F1	E1
VEH-03	Release of radioactive or toxic material from cask due to damage to transport casks during a high wind/tornado	High wind/tornado	F2	E2
VEH-03-I	Release of radioactive or toxic material from MISF samples in transport casks due to high wind/tornado damage	High wind/tornado	F2	E2
VEH-07-I	Release of radioactive or toxic material from MISF due to riser being sheared off and possibly vehicle gas tank ruptured and fire	Vehicle moving near facility risers	F3	E1
W058-FLOW01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected plus mitigative features failure	F3	E2
W058-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit plus mitigative features failure	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-FLOW05a	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error) plus mitigative features failure	F3	E2
W058-FLOW05b	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure plus mitigative features failure	F2	E2
W058-FLOW05c	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion plus mitigative features failure	F2	E2
W058-FLOW07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected plus mitigative features failure	F3	E2
W058-FLOW09	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit plus mitigative features failure	F2	E2
W058-FLOW11a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error) plus mitigative features failure	F3	E2
W058-FLOW11b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure plus mitigative features failure	F2	E2
W058-FLOW11c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion plus mitigative features failure	F2	E2
W058-FLOW13	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Open path for pool leak from test riser	F3	E2
W058-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-INTEG01c	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG01d	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2
W058-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F2	E2
W058-INTEG03b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F2	E2
W058-INTEG05a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F2	E2
W058-INTEG05b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	E2
W058-INTEG07a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F3	E2
W058-INTEG07b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	E2
W058-INTEG09a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-INTEG09b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
W058-INTEG11a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	E2
W058-INTEG11b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	E2
W058-INTEG13a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG13b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2
W058-INTEG13c	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG13d	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2
W058-INTEG14a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc) plus mitigative features failure	F2	E2
W058-INTEG14b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc) plus mitigative features failure	F2	E2
W058-INTEG16a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-INTEG16b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	E2
W058-INTEG18a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	E2
W058-INTEG18b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	E2
W058-INTEG20a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
W058-INTEG20b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
W058-INTEG22	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	E2
W058-INTEG24	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E2
W058-INTEG26	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	Seismic event plus mitigative features failure	F1	E2
W058-INTEG28	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E2
W058-INTEG30	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Seismic event	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-PRES01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer plus mitigative features failure	F3	E2
W058-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer plus mitigative features failure	F3	E2
W151-01	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to filter failure	F3	E2
W151-03	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to unfiltered release through failed filter	F0	E2
W151-05	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank ventilation ducting to atmosphere due to unfiltered release	F2	E2
W151-07	Release of radioactive material to the atmosphere	Release of radioactive/hazardous material from failed HEPA filter to the atmosphere due to flammable gas deflagration	F1	E2
W151-08	Release of radioactive material to the atmosphere	Release of radioactive/hazardous material from failed HEPA filter to the atmosphere due to flammable gas deflagration	F1	E2
W151-09	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release	F1	E2
W151-10	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F3	E2
W151-12	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to flammable gas ignition	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-13	Leak to soil surface	Release of radioactive/hazardous material from tank to soil surface due to tank overflow	F2	E2
W151-17	Unfiltered release from pit	Release of radioactive/hazardous material from tank inlet station or pit to the atmosphere due to flammable gas release with ignition	F1	E2
W151-21	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to HEPA filter failure	F2	E2
W151-22	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F2	E2
W151-24	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F3	E2
W151-25	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to the atmosphere through failed HEPA filter due to material rollover	F0	E2
W151-26	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to the atmosphere through failed HEPA filter due to flammable gas deflagration	F2	E2
W151-27	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to the atmosphere through failed HEPA filter due to high temperatures	F3	E2
W151-28	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to flammable gas deflagration	F1	E2
W151-30	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to waste redistribution	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-36	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F2	E2
W151-37	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to high pressure	F3	E2
W151-38	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	F3	E2
W151-40	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F0	E2
W151-41	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to high pressure	F0	E2
W151-42	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	F0	E2
W151-44	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F1	E2
W151-45	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to high pressure	F1	E2
W151-46	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	F1	E2
W151-49	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to atmosphere through failed filters due to flammable gas deflagration	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-50	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to atmosphere through failed filters due to fan overspeed	F3	E2
W151-52	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to atmosphere through failed filters due to excessive moisture buildup	F3	E2
W320-A-TRANS01a	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to a large steam bump	Increase in waste temperature due to flowmeters fault, operator error, level indication fault, or Tank 241-C-106 T/C fault during sluice	F2	E2
W320-A-TRANS01b	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to a large steam bump	Increase in waste temperature due to inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump	F2	E2
W320-A-TRANS02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Lowering of tank level with temperature out of spec due to equipment fault/failure or operator error resulting in tank bump	F3	E2
W320-A-TRANS03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to steam bump	Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump resulting in high waste temperature during slurry transfer and resulting steam bump	F3	E2
W320-A-TRANS04	Large release of radioactive aerosols from Tank 241-C-106 due to flammable gas fire/deflagration in dome space	High waste temperature during slurry transfer causing a steam bump which induces a flammable gas release/ignition resulting in dome fire	F0	E2
W320-ABCD-ALL04	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Water intrusion into Tank 241-C-106 causing water level to exceed maximum operating level, tank unsound above, waste leaks behind liner (via surface water flood, system water inleakage, excessive transfer, etc) resulting in steam bump	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-ALL05	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Water intrusion into Tank 241-C-106 with water level exceeding top of liner level, leaking behind liner (via surface water flood, system water inleakage, excessive transfer, etc) and resulting steam bump	F2	E2
W320-ABCD-CHILL02	Release of radioactive aerosols from covered pit or deadened pipe to atmosphere due to propylene glycol fire	Piping or tubing leak causes propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome	F1	E2
W320-ABCD-TRANS01	Release of liquid waste from Tank 241-C-106 to the soil and aerosols to the atmosphere due leak into tank liner gap resulting in steam bump	Inadvertent operator action directing sluicer nozzle jet at tank wall resulting in wall breach and water leaking into liner gap where steam vapor forms, steam bump breaches tank bottom	F3	E2
W320-ABCD-TRANS02	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Unavoidable operator action causing loss of sluicer arm control in tank resulting in jet striking tank liner with liner being breached, water leakage into liner gap and steam formation resulting in breach of tank bottom from steam bump	F2	E2
W320-ABCD-TRANS03	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Buildup of solids in openings or equipment casualty causes siphoning of waste from Tank 241-AY-102 to Tank 241-C-106 exceeding maximum operating level resulting in water leakage into liner gap, steam formation and bump breaching tank	F1	E2
W320-ABCD-TRANS05	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer hose break resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breach of tank bottom from steam bump	F2	E2
W320-ABCD-TRANS06	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicing arm breaks off penetrating tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-TRANS07	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner, water leakage under tank bottom, steam formation and bump breaching tank bottom	F2	E2
W320-ABCD-TRANS08	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching of tank bottom	F2	E2
W320-ABCD-TRANS09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High temperature sluice water from Tank 241-AY-102 causes excessive waste temperature change rate, liner breaches, water leakage under tank bottom, steam formation and bump breaching tank bottom	F1	E2
W320-ALL-TRANS01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to moisture buildup	Moisture buildup on filters from natural causes	F2	E2
W320-ALL-TRANS02	Release of radioactive aerosols from ventilation ducting due to high winds or tornado	High winds or tornado resulting in failed ventilation ducting and unfiltered release	F2	E2
W320-B-ALL11	Release of radioactive liquid waste from Tank 241-C-106 to soil subsurface due to large water intrusion	Large water intrusion resulting in high hydrostatic pressure and tank breach (raw water, surface flood, excessive transfer, or cascade)	F2	E2
W320-B-ALL13	Release of radioactive liquid from Tank 241-AY-102 to soil surface due to tank overflow	Large water intrusion causing overflow of tank (raw water, surface flood, or ventilation system water inleakage)	F1	E2
W320-B-FLUSH01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through breached filters due to ignition of flammable gas plume	Ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank	F0	E2
W320-B-FLUSH02	Release of radioactive aerosols from Tank 241-C-106 through failed filters due to a large steam bump	Flush water spray condenses dome vapors causing high tank vacuum that results in a large steam bump	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-FLUSH03	Release of radioactive aerosols from Tank 241-AY-102 through failed filters due to a large steam bump	Flush water spray through antisiphon holes causing high condensation rate in tank and high tank vacuum resulting in large steam bump	F0	E2
W320-B-FLUSH05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Flushing water spray thru antisiphon holes resulting in excessive tank vacuum and tank breach	F0	E2
W320-B-FLUSH06	Release of radioactive liquid from overflow of pit on Tank 241-AY-102 to soil surface due to transfer line leak	Pipe break in pit with the high capacity drain cover on resulting in overflow of pit	F2	E2
W320-B-FLUSH07	Release of radioactive liquid from overflow of pit to the soil surface due to pipe break during flushing	Pipe break in pit during flushing and drain plug cover on resulting in overflow of pit	F2	E2
W320-B-PUMP01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due steam bump	Overheating of waste due to equipment fault/failure or operator error and subsequent steam bump	F3	E2
W320-B-TRANS01	Release of radioactive aerosols from the annulus of Tank 241-AY-102 through failed filters due to steam pulses from boiling waste	Corrosion of primary tank due to new waste composition causes leak into annulus, steam pulses from boiling waste in annulus region resulting in failure of annulus filters	F0	E2
W320-B-TRANS02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Low slurry flow, piling of waste at base of distributor and resulting tank bump	F1	E2
W320-B-TRANS03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to condensation of vapor in head space	Condensation of vapor in head space of Tank 241-C-106 which resulted from the breaking off of sluicer head (sluicer failure, water hammer, thermal shock, corrosion or fatigue)	F0	E2
W320-B-TRANS04	Release of radioactive aerosols from Tank 214-C-106 to atmosphere through failed filters tank bump	High slurry transfer rate and high waste temperature due to equipment fault/failure or operator error resulting in tank bump	F1	E2
W320-B-TRANS05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to steam bump and increased head space vapor pressure	Buildup of solids pile under distributor as a result of low slurry flow which results in steam bump and increased head space vapor pressure	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive slurry flow	Excessive slurry flow resulting in increased aerosol generation and errant flow release (assumes filter failure)	F2	E2
W320-B-TRANS07	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to release of vapor from waste	Startup of slurry flow to distributor resulting in air being bubbled through waste and release of vapor (assumes filter failure)	F2	E2
W320-B-TRANS08	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to equipment failure	Distributor breaks off resulting in excessive aerosol generation in head space and release through HEPAs	F1	E2
W320-B-TRANS09	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to steam bump and increased head space vapor pressure	Buildup of solids pile under distributor as a result of the distributor nozzle breaking off which causes steam bump	F1	E2
W320-B-TRANS10	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to equipment failure	Distributor breaks off resulting in excessive aerosol generation in head space and release through HEPAs	F1	E2
W320-B-TRANS11	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive heat loading	Excessive corrosion and heat loading from new waste cause aerosol release (assumes HEPA plugging)	F2	E2
W320-B-TRANS12	Release of radioactive aerosols from interconnected tanks to atmosphere due to increased heat loading of Tank 241-AY-102	Increased heat loading of Tank 241-AY-102 and loss of vacuum due to inadequate ventilation or waste behavior prediction (assumes HEPA plugging)	F2	E2
W320-B-TRANS17	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due flammable gas fire/deflagration	The sluicer hose breaks impinging into the solids releasing a region of retained flammable gas which is then ignited	F0	E2
W320-B-TRANS18	Large release of radioactive aerosols from Tank 241-C-106 to the atmosphere due flammable gas fire/deflagration	Sluice water transfer rate being excessive causing waste level to be lowered quickly with waste temperature too high resulting in a large steam bump, flammable gas release and plume burn	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS22a	Release of radioactive liquid from transfer line to the soil surface due to local flooding during transfer	Raw water leak resulting in line being uncovered and breached during transfer	F3	E2
W320-B-TRANS22b	Release of radioactive liquid from transfer line to the soil surface due to local flooding during transfer	Natural flow resulting in line being uncovered and breached	F3	E2
W320-B-TRANS28	Release of radioactive aerosols from Tank 241-AY-102 distributor pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-TRANS29	Release of radioactive aerosols from Tank 241-AY-102 pump pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-TRANS30	Release of radioactive aerosols from Tank 241-C-106 pump pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-TRANS31	Release of radioactive aerosols from Tank 241-C-106 sluice pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-VENT01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Volcanic ashfall prevents air intake through existing ventilation and W030 ventilation upgrade system resulting in excessive vacuum and tank breach	F0	E2
W320-B-VENT02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Volcanic ashfall which prevents air intake through W030 ventilation upgrade system resulting in excessive vacuum and tank breach	F0	E2
W320-B-VENT03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through W030 ventilation upgrade and results in excessive vacuum causing tank damage	F0	E2
W320-B-VENT04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through existing exhaust system with W030 intake and results in excessive vacuum	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-VENT05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Cold water spray into tank which results in excessive vacuum and tank breach, possible result of slurry distribution	F0	E2
W320-B-VENT06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through existing ventilation system and results in excessive vacuum	F0	E2
W320-B-VENT07	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Volcanic ashfall prevents air inflow into tank through existing ventilation system resulting in excessive vacuum and tank breach	F0	E2
W320-BCD-ALL01	Release of radioactive aerosols from covered pit on Tank 241-C-106 to atmosphere due to propylene glycol fire	Piping or tubing leak	F1	E2
W320-BCD-ALL04	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Fan controller failure resulting in excessive vacuum in tank, loop seal actuation and tank damage	F0	E2
W320-BCD-ALL05	Small release of radioactive aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	F0	E2
W320-BCD-ALL06	Small release of radioactive aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	F0	E2
W320-BCD-ALL07a	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Raw water leak causing water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching tank	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-ALL07b	Release of liquid waste from Tank 241-C-106 to the soil and aerosol to the atmosphere due to steam bump in liner gap	Surface water flood causing water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching tank bottom	F1	E2
W320-BCD-ALL08	Release of liquid waste from Tank 241-C-106 to the soil and aerosols to the atmosphere due to steam bump in liner gap	Inadequate prediction of waste behavior causes excessive corrosion because of waste disturbance in tank resulting in leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2
W320-BCD-ALL10	Small release of aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration, transfer started	Plugging of transfer line occurs, flammable gas builds up and is ignited resulting in a breach of transfer line; pumping is started (collection in pit)	F1	E2
W320-BCD-PUMP03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Submersible pump raised to high in tank, winch lifting strap fails, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	E2
W320-BCD-PUMP05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Immersible pump raised too high in tank, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables	F1	E2
W320-BCD-PUMP08	Release of liquid waste to the annulus of Tank 241-C-106 and aerosol release to atmosphere due to penetration of tank and steam bump in liner gap	Submersible pump raised too high, winch lifting strap fails, pump falls and penetrates primary tank liner resulting in waste and steam bump	F0	E2
W320-BCD-PUMP09	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Immersible pump raised too high in tank, winch lifting strap breaks, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-TRANS01	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank pump vortices	Accumulation of material in the pump vortices until critical mass condition are met	F1	E2
W320-BCD-TRANS02a	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Flushing valve misposition	F0	E2
W320-BCD-TRANS02b	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Excessive solids in slurry flow	F0	E2
W320-BCD-TRANS03	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Primary failure of distributor	F0	E2
W320-BCD-TRANS04	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation during sluicing activities	F1	E2
W320-BCD-TRANS05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Condensation of vapors due to failure of distributor causing vacuum in headspace and tank bump failing filters	F0	E2
W320-BCD-TRANS06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Breaking off of distributor head causing tank bump and failed filters	F0	E2
W320-BCD-TRANS07	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to large steam bump	Filter breach from failure of T/C Tree, sluicing outside of temperature specs and large steam bump	F3	E2
W320-BCD-TRANS08	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to tank bump	Undetected high waste temperature with many objects in waste resulting from high pressure sluice causing tank bump	F1	E2
W320-BCD-TRANS09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 exceeds maximum operating water level resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-TRANS10	Release of radioactive liquid from overflow of pit on Tank 241-AY-102 to the soil surface due to blank flange left off flushing connection	Blank flange left off flushing connection in pit and drain cover left on resulting in overflow of pit during sluicing	F2	E2
W320-BCD-TRANS13	Release of radioactive aerosols from line in pit to atmosphere due to spray leak from mispositioned valve, cover plug in place	3-way valve left in flush position after flushing, cover plug remains in place on initiation of sluicing process, high capacity drain cover left on and pit overflows	F3	E2
W320-D-ALL01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to a steam bump	Human error or activation of ALCs during high temperature conditions causing steam bump	F3	E2
W320-D-ALL02a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing tank bump	F1	E2
W320-D-ALL02b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing tank bump	F1	E2
W320-D-ALL03a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2
W320-D-ALL03b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2
W320-D-ALL04a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-ALL04b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2
W320-D-ALL05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Long term loss of ventilation system resulting in tank bump and blowout of filters	F2	E2
W320-D-ALL06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to seismic event	Seismic event induces a steam bump in tank resulting in failure of filters or ducting	F1	E2
W320-D-ALL09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Seismic event breaches liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2
W320-D-PURGE01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to nitrogen line break	Nitrogen line break accompanied by loss of vacuum in system	F0	E2
W320-D-TERM01	Release of ionizing radiation and radioactive gas from Tank 241-AY-102 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation in tank due to natural conditions	F1	E2
W320-D-TRANS01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Rapid waste level change, high waste temperature and resulting tank bump	F1	E2
W320-D-TRANS02	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive sluicer flow	Excessive sluicer flow resulting in radioactive aerosols release through HEPAs	F2	E2
W320-D-TRANS06	Large release of radioactive aerosols from Tank 241-C-106 to the atmosphere due to flammable gas fire/deflagration	Slurry transfer rate being excessive causing a rapid reduction in the hydrostatic pressure in tank resulting in flammable gas release	F0	E2
W320-D-TRANS08	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to large steam bump	Excessive fluffing of waste in tank resulting in large steam bump and unfiltered release	F1	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-TRANS09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High pressure sluice induces movement of debris present in waste which impact and breach the tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2
W320-D-VENT01	Release of radioactive aerosols from Tank 241-AY-102 ventilation system to atmosphere due to filter breach from in tank fire/deflagration	Filter breach due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc	F1	E2
W320-D-VENT02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to steam bump	Inadequate ventilation from W030 resulting in increased waste temperature, steam bump and filter breach	F3	E2
W320-D-VENT03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters in the 702A ventilation system due to tank bump	Severe ice storm causes excessive tank vacuum resulting in tank bump	F2	E2
W320-D-VENT04	Release of radioactive aerosols from Tank 241-AY-102 through failed filters due to tank bump	Cold water spray into tank (possible result of slurry distribution) tank vacuum and resulting tank bump	F0	E2
W320-D-VENT05	Release of radioactive aerosols from tank to atmosphere through failed filters in the W030 ventilation system due to tank bump	Severe ice storm causes excessive tank vacuum resulting in tank bump	F2	E2
W320-D-VENT06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to large steam bump	Volcanic ashfall causes excessive vacuum resulting in large steam bump and filter blowout	F0	E2
W320-D-VENT09	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to loss of primary or annulus ventilation	Extended loss of power or severe ventilation casualty causes loss of primary or annulus ventilation which results in steam release	F1	E2
W320-D-VENT14	Small release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due flammable gas fire/deflagration in the annulus	Loss of primary or annulus ventilation for an extended period resulting in a gradual rise in waste temperature, leak of flammable gas into annulus and ignition resulting in the annulus being breached	F0	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT15	Small release of radioactive aerosols from standpipes in Tank 241-AY-102 due to flammable gas fire/deflagration in pipe	Natural occurrence of flammable gas generation and collection under proper conditions with ignition source present	F2	E2
W320-D-VENT19	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due large tank bump	Extended loss of power or severe ventilation casualty causes loss of primary or annulus ventilation for extended period of time resulting in rise in waste temperature and large tank bump	F0	E2
W320-E-TERM01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to tank structural damage	Excessive fluffing of waste resulting in tank structural damage	F0	E2
W320-F-TERM05	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Error in calculations cause high heat load after completion of sluicing process resulting in the need for water addition to tank with deteriorated tank liner, water leakage into liner gap, steam formation and bump breaching tank bottom	F1	E2
XS-01-FLOW01	Release of radioactive aerosols from 244 TX DCRT due to ignition of flammable gas atmosphere	Pressure drop in transfer line releases flammable gas into DCRT atmosphere and ignition source causes deflagration	F2	E2
XS-01-FLOW05	Release of radioactive contaminated liquid from transfer piping to 244 TX DCRT via the raw water system due to reverse flow of liquid waste (pool)	Mis-valving causes mixing of waste into raw water system that causes leak in the flush pit cover block	F2	E2
XS-01-FLOW06	Release of liquid radioactive waste from saltwell pumping transfer piping in DCRT pump pit to surface due to overflow (pool)	Open jumper in single shell tank pump pit leads to overflowing of pump pit	F3	E2
XS-01-FLOW07	Release of liquid radioactive waste to the soil from transfer piping from SST to DCRT due to leakage (plume)	Pipe failure from various causes	F3	E2
XS-01-PRES01	Release of liquid radioactive waste from damaged transfer piping to 244 TX DCRT due to over pressure (pool)	Use of wrong size pump and closed valve causes over pressure and subsequent pipe failure	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-01-TEMP01	Release of steam-aerosol from transfer piping in pump pit due to steam hammer and resulting pipe damage	Extended recirculation and consequential heating of saltwell liquid with sudden opening of valve when cover block is open	F3	E2
XS-02-FLOW02	Release of aerosols and particulate from DCRT ventilation filter due to transfer of steam from PFP steam jet into DCRT headspace	Human error (failure to shut off steam jet at completion of transfer) which causes DCRT ventilation filter failure	F3	E1
XS-02-FLOW03	Release of toxic gases (oxides of nitrogen) from DCRT due to chemical reaction	Chemical reaction between sodium nitrite (DCRT) and nitric acid (PFP transfer) due to failure to adjust waste pH prior to transfer	F2	E1
XS-02-FLOW04	Release of liquid radioactive waste to soil from transfer pipe (non-pool) subsurface plume	Failure to adjust waste pH prior to transfer causes leak	F2	E2
XS-02-FLOW05	Release of liquid radioactive waste to the soil from PFP transfer piping due to pipe break	Pipe break from various causes	F3	E2
XS-03-LEVE01 XS-21-LEVE (244-S DCRT)	Release of combustion products from 244 TX DCRT due to flammable gas burn in tank atmosphere	Evaporation of DCRT contents causing decreased ability of waste to retain flammable gases and spark source	F2	E2
XS-03-LEVE02 XS-21-LEVE (244-S DCRT)	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Evaporation of DCRT contents with increased solids settling on DCRT bottom creates critical mass	F3	E2
XS-03-PRES01 XS-21-PRES (244-S DCRT)	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn in tank atmosphere	Loss of ventilation flow with accumulation of flammable gas and spark source	F2	E2
XS-03-PRES02 XS-21-PRES (244-S-DCRT)	Release of toxic vapors from 244 TX DCRT due to decreased ability to keep vapors in solution (fan on)	Heating of DCRT or chemical adjustment	F3	E1
XS-03-PRES05	Release of toxic vapors from DCRT due to increased concentrations in DCRT atmosphere	Transfer of steam from PFP causing evolution of toxic gases due to heating tank	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-03-TEMP01	Release of radioactive aerosols from 244 TX DCRT headspace due to positive pressure	Chemical reaction in DCRT causes positive pressure	F2	E1
XS-03-TEMP02	Release of toxic vapor from DCRT due to chemical reaction	Chemical reaction in DCRT toxic vapor	F2	E1
XS-03-TEMP02 XS-21-TEMP (244-S-DCRT)	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Transfer of material into tank that violates criticality specification	F3	E2
XS-03-TEMP03 XS-21-TEMP (244-S-DCRT)	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn-fire/explosion in tank atmosphere	Buildup of gases, loss of ventilation, and spark source	F2	E2
XS-03-TEMP04 XS-21-TEMP (244-S-DCRT)	Release of liquid radioactive waste from 244 TX DCRT due to overflow	Freezing temperatures causing raw water line break-leak with leakage to tank causes overflow	F3	E2
XS-05-FLOW01	Release of aerosols and filter media from DCRT ventilation system due to HEPA filter damage	Replacement of exhaust fan with larger capacity fan causes HEPA filter damage	F2	E1
XS-05-TEMP01	Release to atmosphere of materials from DCRT ventilation filters and tank due to fire	Fire in ventilation system due to failure of ventilation heater controls	F3	E2
XS-05-TEMP02	Release to atmosphere of materials from DCRT ventilation filters and tank due to filter degradation	Fire in ventilation system due to flammable gas buildup and ignition	F3	E2
XS-06-FLOW01	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Transfer of inadequately recirculated waste from tank due to failure to appropriately balance flow between recirculation and transfer line causing buildup of solids creating critical mass	F3	E2
XS-06-FLOW04	Release of liquid radioactive waste from transfer piping from an SST to a DCRT due to spray leak (SPUTTER) of saltwell liquor from DCRT pump pit	Pipe failure	F2	E3
XS-06-FLOW05	Release of waste from transfer pipe out of 244 TX DCRT to the soil due to flow path to soil	Concurrent failure of transfer piping and encasement	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-07-FLOW01	Release of radioactive waste to soil from transfer piping out of 244 TX DCRT due to leak in primary pipe and encasement	Excavation accident fails primary pipe and encasement	F3	E2
XS-07-FLOW02	Release of radioactive waste to soil from transfer piping out of 244 TX DCRT due to leak in primary pipe and encasement	Corrosion of inner and outer pipe	F3	E2
XS-07-FLOW03	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	High structural loading from traffic or cranes cause failure of primary pipe and encasement	F3	E2
XS-07-FLOW04	Release of radioactive waste to soil from transfer piping of 244 TX DCRT due to leak in primary pipe and encasement	Seismic event fails primary pipe and encasement	F2	E2
XS-07-FLOW05	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	Undermining due to leak of nearby pipes cause failure of primary pipe and encasement	F3	E2
XS-07-FLOW06	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	Water hammer causes failure of primary pipe and encasement	F3	E2
XS-11-LEVE01	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Plugged drain and misrouting causes overflow	F3	E2
XS-11-LEVE02	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Plugged drain and open jumper causes overflow	F3	E2
XS-11-LEVE03	Release of radioactive waste from diversion box to surface due to overflow	Plugged drain and piping leak causes overflow	F3	E2
XS-12-FLOW02	Release of aerosols from Diversion Box 241-U-152 due to flammable gas deflagration	Chemical reaction of catch tank material with backflow of vapors via diversion box drain line	F1	E1
XS-12-FLOW03	Release of aerosols from Diversion Box 241-U-152 due to hydrogen deflagration	Radiolysis of catch tank material with backflow of vapors via diversion box drain line and ignition source	F1	E1
XS-12-FLOW05	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Backflow from catch tank causes overflow from diversion box	F3	E2
XS-13-PRES01	Release of radioactive aerosols from 241-U-301B catch tank due to chemical reaction	Draining of incompatible chemicals to catch tank	F3	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-13-PRES03	Release of toxic vapors due to chemical reaction from 241-U-301B	Draining of incompatible chemicals to catch tank	F2	E1
XS-13-PRES04	Release of fission product gases and aerosols from catch tank 241-U-301B due to criticality	Transfer of excess fissile material to catch tank creates critical mass	F1	E2
XS-20-FLOW01	Release of radioactive aerosols from 244 TX DCRT due to chemical reaction	Transfer of incompatible waste to 244-TX DCRT due to improper valve lineup	F3	E2
XS-20-FLOW03	Release of radioactive aerosols from 244 TX DCRT due to positive pressure caused by chemical reaction	Chemical reaction of 244-S material with contents of 244-TX caused by misrouting	F2	E2
XS-20-FLOW04	Release of toxic vapors from 244 TX DCRT due to chemical reaction with incompatible material in 244 S DCRT	Mixing contents of 244-TX and 244-S due to misrouting causes chemical reaction	F2	E2
XS-20-FLOW05	Release of fission product gases and aerosols from 244 S DCRT (not designated solids receiver) due to criticality	Transfer of waste from 244-TX DCRT due to improper valve lineup creates critical mass	F1	E2
XS-20-FLOW08	Release of radioactive waste from 244 TX DCRT to surface due to overflow	Transfer of excess waste to 244-TX DCRT due to improper valve lineup causes overflow	F3	E2
XS-20-FLOW09	Release of radioactive waste from 244 S DCRT to surface due to overflow	Transfer of waste from 244-TX DCRT due to improper valve lineup causes overflow	F3	E2
XS-26-PRES XS-26-TEMP	Release of toxic vapors from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible waste causes chemical reaction	F3	E2
XS-26-PRES XS-26-TEMP 102-AW-TEMP (FOR TK-102-AW)	Release of fission product gases and aerosols from Tank 241-SY-102 due to criticality	Transfer of critical mass of fissile material and achievement of critical geometry	F1	E2
XS-26-PRES01	Release of radioactive aerosols from Tank 241-SY-102 due to chemical reaction	Mis-transfer of incompatible waste causes chemical reaction	F3	E2
XS-26-TEMP01	Release of radioactive aerosols from Tank 241-AW-102 due to tank bump	High heat waste plus loss of cooling contributes to tank bump	F2	E2

Table D-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (64 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-35-FLOW02	Release of radioactive waste to surface from 242-S Evaporator sump due to backflow to and overflow	Human error of leaving open flow path after emptying the sump and backflow and subsequent overflow	F3	E2
XS-37-FLOW01	Release of radioactive liquid waste from catch tank to surface due to overfilling (pool)	Leak of transfer piping with drainage to catch tank causes overflow	F3	E2
XS-37-FLOW02	Release of radioactive liquid waste to soil from transfer piping due to leak of liquid waste from concrete encasement (subsurface plume)	Leak of transfer piping with encasement leak or blocked drain to catch tank (liquid oozes out concrete encasement)	F3	E2
XS-41A-FLOW01	Release of radioactive waste from vent station nozzle pit to surface due to overflow	Catastrophic failure of vent piping causes overflow of nozzle pit	F3	E2
XS-41A-FLOW02	Release of radioactive waste to surface from vent station nozzle pit due to overflow	Vent valve left open or leaking during transfer causes overflow	F3	E2
XS-41B-LEVE01	Release of radioactive aerosols from vent station catch tank due to flammable gas fire/explosion in nozzle pit	Failure to empty catch tank with buildup of flammable gas in nozzle pit plus ignition source	F2	E2
XS-41B-LEVE03	Release of radioactive waste to surface from vent station nozzle pit due to overflow	Failure to empty catch tank, causing overflow of tank and pit due to transfer failure	F3	E2
XS-41C-LEVE01	Release of radioactive aerosols from vent station catch tank due to flammable gas fire/explosion in catch tank pit	Leak of catch tank with buildup of flammable gas in catch tank pit plus ignition source	F2	E2
XS-48-FLOW	Release of liquid waste to soil from transfer piping between B-Plant and 241-ER-152 diversion box due to leak (plume)	Piping failure from various causes	F3	E2
XS-52-FLOW01	Release of radioactive waste to surface from transfer piping to Tank 244-CR-003 due to leak (pool)	Failure of pipe from various causes	F2	E2
XS-52-FLOW02	Release of radioactive waste from Tank 244-CR-003 to surface due to overflow (pool)	Mis-valving or valve failure during cross-site transfer causes overflow	F3	E2

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-02-LEVE	Release of radioactive aerosols from Tank 241-AW-102 annulus due to the presence of radioactive liquid waste in Tank 241-AW-102 annulus	Primary tank leakage from various causes	F3	E1
102AW-02-LEVE02	Release of liquid radioactive waste from Tank 241-AW-102 due to leak of primary and secondary tank	Structural failure of primary tank when annulus leaks	F1	E3
102AW-02-LEVE02A	Release of radioactive aerosols from Tank 241-AW-102 annulus ventilation system due to the presence of radioactive liquid waste in the annulus	Mis-routing of transfer to annulus instead of primary tank	F3	E1
102AW-02-LEVE06	Release of radioactive liquid to soil column from Tank 241-AW-102 annulus due to leakage	Primary tank leakage from various causes combined with annulus leakage	F1	E3
102AW-02-PRES.01 XS-26-PRES.01	Personnel injured by projectile debris from catastrophic fan failure	Loss of fan due to high pressure causing fan to walk into another object and become airborne		
102AW-03-PRES01 102AW-03-LEVE	Release of radioactive aerosols from Tank 241-AW-102 annulus due to the presence of radioactive liquid waste in Tank 241-AW-102 annulus	Leak of primary tank to annulus combined with annulus ventilation fan failure	F2	E1
102AW-03-PRES02 102AW-03-LEVE	Release of radioactive aerosols from Tank 241-AW-102 annulus due to the presence of radioactive liquid waste in Tank 241-AW-102 annulus	Leak of primary tank to annulus combined with loss of power to annulus ventilation	F2	E1
102AW-04-LEVE01	Release of radioactive aerosols from Tank 241-AW-102 central pump pit due to accumulation of radioactive liquids in the central pump pit	Leak of primary piping	F3	E1
102AW-04-LEVE02	Release of radioactive aerosols from Tank 241-AW-102 central pump pit due to accumulation of radioactive liquids in the central pump pit	Misrouting through an open jumper plus clogged drain	F3	E1
102AW-04-LEVE03	Release of radioactive aerosols from Tank 241-AW-102 central pump pit due to accumulation of radioactive liquids in the central pump pit	Dissolution of residual contamination in central pump pit caused by erroneous use of raw water	F3	E1
102AW-04-LEVE04	Release of radioactive aerosols from Tank 241-AW-102 central pump pit due to accumulation of radioactive liquids in the central pump pit	Dissolution of residual contamination in central pump pit caused by pit cleaning plus clogged drain	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-04-PRES.01	Personnel exposure higher than expected	Removal of cover block and pressure release due to loss of fan.		
102AW-04-PRES01	Release of radioactive particulate from Tank 241-AW-102 central pump pit due to pressurization	Loss of primary tank ventilation causes pressurization of pump pit.	F3	E1
102AW-04-PRES02	Release of radioactive particulate from Tank 241-AW-102 central pump pit due to its being open to atmosphere	Removal of cover block	F3	E1
102AW-04-STRU.01	Personnel injured by falling equipment	Equipment drop during crane work		
102AW-04-STRU.02	Release of radioactive particulate from Tank 241-AW-102 central pump pit due to confinement inadequacies	Structural degradation with time	F2	E1
102AW-04-STRU01B	Release of radioactive particulate from Tank 241-AW-102 central pump pit due pump pit structural failure	Seismic-induced failure of central pump pit	F1	E1
102AW-08-COMP01	Release of radioactive aerosols from tank vapor space due to production of aerosols from sludge and migration	Chemical reactions causing agitation	F2	E1
102AW-08-COMP06	Release of toxic gases from Tank 241-AW-102 tank vapor space due to production and migration of toxic gases from sludge	Chemical reactions in waste causes production of toxic gases	F3	E1
102AW-09-COMP03	Release of toxic vapors from a separable organic layer in Tank 241-AW-102 due to fuel spill into tank	External event (fuel spill)	F3	E1
102AW-09-COMP04	Release of toxic vapors from a separable organic layer in Tank 241-AW-102	Core sampling (NPH) releases trapped vapors	F3	E1
102AW-09-COMP05	Release of toxic vapors from a separable organic layer in Tank 241-AW-102 due to error in transfer	Generator erroneous transfer of insoluble organic material	F3	E1
102AW-09-TEMP02	Release of aerosols from annulus due to leak of liquid waste into the annulus	Tank leak due to thermal stress caused by transfer of hot solution to an almost empty tank	F1	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-13-FLOW.01	Personnel exposure due to radiation doses from contaminated pipes	Multiple valving errors and failure of backflow prevention causing reverse flow from valve pit to flush pit		
102S-02.d3	Release of radioactive aerosols to atmosphere from Tank 241-S-102 pit due to burning fuel on top of pit caused by ignition of gas from ruptured gas tank.	Vehicle drives into pit cover puncturing gas tank + Ignition	F3	E1
102S-04.e2	Release of radioactive aerosols contained in tank vapor space to atmosphere due to generation of excessive heat	Chemical reaction in waste Addition of incompatible waste/chemical (misroute)	F2	E1
102S-06.a	Release of radioactive aerosols from Tank 241-S-102 vapor space to atmosphere due to ventilation system failure	Filter plugged	F3	E1
106C-01K	Release of radioactive and/or hazardous material from Tank 241-C-106 tank due to high temperature	Water evaporation	F3	E1
106C-01S	Release of radioactive and/or hazardous material from Tank 241-C-106 caused by low level in waste tank due to high temperature	Water evaporation	F3	E1
106C-01Sa	Release of radioactive and/or hazardous material from Tank 241-C-106, due to low tank level because of tank leak	Waste tank leak	F3	E3
106C-01T	Release of radioactive and/or hazardous material from Tank 241-C-106 due to low level in waste tank	Failure to add water to tank	F3	E1
106C-01W	Release of radioactive and/or hazardous material from Tank 241-C-106, due to high level in waste tank	Level change due to barometric changes	F1	E1
106C-06A	Release of radioactive and/or hazardous material from Tank 241-C-106 pump pit, due to pump pit being opened to atmosphere	Cover blocks removed	F3	E1
106C-06F	Release (minor) of radioactive and/or hazardous material from Tank 241-C-106 pump pit, due to pump pit high level	Plugged pit drain while adding water	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-06G	Release (minor) of radioactive and/or hazardous material from Tank 241-C-106 pump pit due to pump pit high level	Plugged pit drain with rain or snow melt intrusion	F3	E1
106C-06H	Release (minor) of radioactive and/or hazardous material from Tank 241-C-106 pump pit due to pump pit high level	Plugged pit drain during pit cleaning, cover blocks are off	F3	E1
106C-06K	Release of radioactive and/or hazardous material from Tank 241-C-106 pump pit due to decreased pump pit structural integrity caused by drop	Equipment drop during crane work	F3	E1
106C-10F	Release of radioactive and/or hazardous material from Tank 241-C-106, potential spread of contamination due to reverse air flow if intake HEPAs damaged	Loss of tank active ventilation	F3	E1
106C-10H	Release of radioactive and/or hazardous material from Tank 241-C-106 due to HEPA filter damage	Low ambient air temperature results in ice on filter and filter damage	F1	E1
106C-10K	Release of radioactive and/or hazardous material from Tank 241-C-106, spread of contamination, due to ventilation air intake open to atmosphere	HEPA filter breach	F3	E1
106C-10L	Release of radioactive and/or hazardous material from Tank 241-C-106, spread of contamination, due to ventilation air intake open to atmosphere	Air intake ductwork damaged	F3	E1
106C-11A	Release of radioactive and/or hazardous material from Tank 241-C-106, due to HEPA filter damage	HEPA filters plugged	F3	E1
106C-11G	Release of tank atmosphere through exhauster drain from Tank 241-C-106 due to leak or failure to add water routinely	Loss of exhauster seal pot water due to leak or failure to add water routinely	F3	E1
106C-11H	Release of radioactive and/or hazardous material from Tank 241-C-106 due to condensate backing up into filters, de-entrainer or heater	Exhauster seal pot water freezing due to loss of heat trace	F3	E1
106C-11I	Release of radioactive and/or hazardous material from Tank 241-C-106 due to moisture carryover into HEPAs causing loss of efficiency	Exhauster heater failure	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-11N	Release of radioactive and/or hazardous material from Tank 241-C-106, through HEPA filter path, due to filter degradation over time	HEPA filter degradation	F3	E1
106C-12A	Release of radioactive and/or hazardous material from Tank 241-C-106 due to tank falling below level limit, caused by excessive tank evaporation from high temperature	Pit drain plug, water addition fails	F3	E1
106C-12B	Release of radioactive and/or hazardous material from Tank 241-C-106 due to low tank level	Water addition tank truck breakdown	F3	E1
106C-12C	Release of radioactive and/or hazardous material from Tank 241-C-106 due to low tank level because of increased evaporation	Water addition tank truck leak	F3	E1
106C-12D	Release of radioactive and/or hazardous material from Tank 241-C-106 due to excessive tank evaporation from high temperature which causes tank to fall below level limit	Tank level instrumentation fails, does not prompt water addition	F3	E1
107AN-01-LEVE03	Release of caustic material from truck tank due to leak	Failure to secure truck	F3	E2
107AN-01-TEMP.01	Thermal hazard to personnel	Caustic in tank heated too hot at source		
107AN-02-FLOW03	Release of concentrated caustic solution to surface from transfer piping due to leak	Caustic solution transfer line leak	F2	E2
107AN-02-TEMP01	Release of caustic material from transfer piping due to low temperature during transfer	Low temperature from truck	F2	E1
107AN-03-FLOW	Release of concentrated caustic solution to surface from transfer piping due to backflow of caustic	Low temperature causes backflow	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
114SX-04.a.1a	Radioactive aerosols released from Tank 241-SX-114 head space, via tank ventilation (requires failure of outlet filter), to the atmosphere due to exhauster failure	Exhauster failure Mechanical Low temperature (thermocouple in exhaust duct not insulated picks up radiated temperature from ductwork.)	F3	E0
114SX-04.a.1b	Radioactive aerosols released from Tank 241-SX-114 head space, via tank ventilation (requires failure of outlet filter), to the atmosphere due to exhauster failure	Filter plugged	F3	E0
114SX-04.a.4	Release of radioactive aerosols from Tank 241-SX-114 headspace to atmosphere due to inlet HEPA filter failure coupled with exhauster failure	Filter failure	F3	E1
114SX-04.b.1.a.1	Release of radioactive aerosols from Tank 241-SX-114 headspace to atmosphere due to inlet HEPA filter failure coupled with exhaust butterfly valve closure	Human error: Closure of Tank 241-SX-114 exhaust butterfly valve isolating tank from exhaust plenum	F3	E1
114SX-04.b.1.b.1a	Release radioactive aerosols released from Tank 241-SX-114 head space to the atmosphere due to ventilation system ducting failure (with failed inlet filter)	Ducting failure from bad welds	F3	E1
114SX-04.b.1.c.1	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster failure and multiple filter failure	Exhauster failure Fan failure Filter rupture (low differential pressure shutdown) Resulting in tank degradation	F3	E1
114SX-04.b.1.d.1	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster filter plugging (requires failure of inlet filter)	Exhaust filter plugging plus inlet filter failure	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
114SX-04.b.5	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to failure of exhauster HEPA filters	No ventilation flow High ambient temperature conditions Leading to filter failure	F3	E1
114SX-06.b	Personnel exposed to ionizing radiation due to lack of shielding	Inadvertent removal of tank overburden (gravel)		
204AR-01A	Release and spread of airborne radiological contamination from the rail car due to over pressurization	Over pressure in the rail car due to chemical reaction, rupture disk fails	F3	E1
204AR-01B	Release of airborne contamination and toxic chemical exposure to worker from the rail car due to high ambient temperature	Over pressure in the rail car due to high ambient temperature, rupture disk fails	F3	E1
204AR-01C	Release of airborne contamination and toxic chemical exposure to worker from the rail car due to chemical reaction causing over pressurization	High temperature in the rail car due to chemical reaction of the rail car contents, rupture disk fails	F3	E1
204AR-01D	Release and spread of airborne contamination and toxic chemical exposure to worker from the rail car due to leaking rail car caused by high ambient temperature and over pressurization of car tank	High ambient temperature causing pressurization of rail car and possible leakage, failed rupture disk	F3	E1
204AR-01E	Release of airborne contamination and toxic chemical exposure to worker from the rail car due to damaged rupture disk	Chemical reaction or internal fire resulting in an over pressure condition on rail car	F2	E1
204AR-01F	Release of airborne contamination and toxic chemical exposure to worker from the rail car due to an over pressurization which results from a diesel fuel fire under the car	Fire from diesel fuel of the locomotive that results in an over pressure condition on the rail car, rupture disk fails	F1	E1
204AR-01G	Release of airborne and liquid contamination from overflowing catch tank due to siphoning of rail car contents	Vacuum condition on rail car results in siphoning of rail car contents to the catch tank	F2	E1
204AR-01J	Release of airborne contamination from overflowing catch tank due to overfilling through priming line	Priming line inadvertently fills up rail car and overflows rail car through its vent line to the catch tank	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
204AR-01K	Release of airborne contamination from unloader room due to overflowing catch tank	During sluicing operations, fill up rail car and overflow through its vent line to the catch tank	F3	E1
204AR-02C	Release of airborne and toxic chemical exposure to worker from the rail car due to over pressurization on trailer	Chemical reaction in trailer resulting in an over pressure condition, rupture disk fails	F2	E1
204AR-02D	Release of airborne and toxic chemical exposure to worker from the rail car due to diesel fuel fire causing over pressurization on the trailer	Diesel fuel fire from the truck causing an over pressure condition in the tank trailer, rupture disk fails	F2	E1
204AR-02E	Release of radioactive material and toxic chemicals from trailer due to damage caused by trailer jack failure	Leak from tank trailer due to trailer jack failure	F3	E1
204AR-02F	Release of airborne contamination from unloader room due to overflowing catch tank	Priming line inadvertently fills up trailer and overflows trailer through vent line to the catch tank	F3	E1
204AR-03A	Release of contamination and airborne release around the catch tank area and chemical exposure in mechanical equipment room from catch tank or Sodium Nitrate Tank due to failed tank	Sodium Nitrite Tank #2 either fails or has a drain valve open and empties its contents to the floor drains in the mechanical equipment room	F3	E1
204AR-03B	Release of airborne contamination around the catch tank area and chemical exposure in mechanical equipment room from the Sodium Nitrite Tank #2 due to overfilling and spilling to catch tank.	Sodium Nitrite Tank #2 overfilled and contents spilled into floor drains	F3	E1
204AR-03C	Release of airborne contamination in unloader room and chemical exposure to worker from overfilled catch tank due to tank failure.	Sodium Nitrite Tank #2 tank failure (leak at bottom) filling the catch tank with potential for airborne	F2	E1
204AR-04A	Release of airborne and waterborne contamination from high level in the catch tank due to Sodium Hydroxide Tank #3 failure	Sodium Hydroxide Tank #3 failure or drain valve open which empties contents into the floor drains	F3	E1
204AR-04B	Release of airborne contamination around the catch tank area and chemical exposure in mechanical equipment room from the Sodium Hydroxide Tank #3 and catch tanks due to overfilling of the Sodium Hydroxide Tank	Sodium Hydroxide Tank #3 overfilled and contents spilled into the floor drains	F3	E1
204AR-04C	Release of chemicals to the mechanical equipment room environment from the Sodium Nitrite Tank due to adding chemicals too quickly	Adding caustic chemicals too quickly to the tank - human error	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
204AR-04D	Release of sodium hydroxide particulates from the Sodium Hydroxide Tank due to thermal stress to piping and eventual valve leakage of Sodium Hydroxide Tank piping	Adding too much sodium hydroxide resulting in high temperatures	F3	E1
204AR-04E	Release of sodium hydroxide particulates from the Sodium Hydroxide Tank due to damage to the chemical addition pump diaphragm	Adding steam heat to the coils resulting in high temperatures	F3	E1
204AR-04F	Release of airborne and waterborne contamination from high level in the catch tank due to Sodium Hydroxide Tank failure	Sodium Hydroxide Tank #3 failure (leak at bottom) filling the catch tank with potential for airborne	F2	E1
204AR-05A	Release of toxic chemicals to mechanical equipment room from chemical addition piping due to large leak in chemical addition piping	Large leak in the chemical addition piping during the transfer process	F2	E1
204AR-05B	Release of toxic chemicals and worker exposure from chemical addition piping due to over pressure of piping and subsequent damage	Over pressure while running chemical addition pump due to dead heading the pump	F3	E1
204AR-05C	Release of Tank 241-AY-102 liquid radioactive waste to the mechanical equipment room from Tank 241-AY-102 due to pumping and reversing flow from Tank 241-AY-102 to the 204-AR facility	Reverse flow of transfer piping fluid through the chemical addition piping in the mechanical equipment room	F2	E1
204AR-06A	Release of liquid radioactive waste to the unloader room or caustic chemicals to the mechanical equipment room from the priming water piping or transfer piping due to over pressurization of piping	Raw water supply pressure higher than normal	F3	E1
204AR-06B	Release of liquid radioactive waste to the unloader room or caustic chemicals to the mechanical equipment room from the priming water piping or transfer piping due to over pressurization of piping	Water hammer in priming piping from raw water supply	F3	E1
204AR-06C	Release of airborne contamination from unloader room due to overflowing catch tank	High flow through the priming line and transfer piping due to misalignment which fills up the rail car or trailer and overflows it to the catch tank	F3	E1
204AR-07B	Release of contaminated water to encasement outside of 204-AR building and floor drains inside building from the transfer piping due to over pressure and leakage from raw water flush	Over pressure of raw water through transfer piping during post transfer flush	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
204AR-07C	Release of airborne and spread of contamination from the transfer piping due to leak from improper valve lineup	Leaking transfer piping due to transfer pump being dead headed (e.g., a valve in the transfer line is closed)	F2	E1
204AR-09E	Release of airborne contamination and increased radiation levels from catch tank due to blocked catch tank ventilation and over pressure of catch tank	A heat source is in the catch tank and the overflow and vent of the catch tank are blocked off or obstructed, resulting in a catch tank over pressure	F2	E1
204AR-09F	Release of airborne contamination and increased radiation levels from catch tank due to blocked catch tank ventilation and over pressure of catch tank	Ventilation to the catch tank is blocked off with heaters on, resulting in a catch tank high pressure	F3	E1
204AR-09H	Release of airborne and waterborne contamination in the unloader room from transfer piping and sump pit due to floating the catch tank and damaging piping	Rupture of raw water line piping above sump pit, causing sump pit to fill before catch tank	F2	E1
204AR-11A	Release of airborne radioactivity from unloader room due to loss of confinement caused by power failure	Loss of confinement due to power failure and total loss of ventilation fan	F3	E1
204AR-11B	Release of airborne radioactivity from unloader room due to loss of confinement caused by low ventilation flow	Loss of confinement due to low ventilation flow	F3	E1
204AR-11C	Release of airborne contamination from the unloader room due to failure of ventilation fan	Failure of EF-1 fan resulting in loss of confinement	F3	E1
204AR-11D	Release of airborne contamination from the unloader room due to blocked ventilation flow	No ventilation flow because of damper closed	F3	E1
204AR-11E	Release of airborne contamination from the unloader room due to plugged ventilation flow	No ventilation flow because of plugged HEPA filter	F3	E1
213 W-01	Release of radioactive and/or hazardous materials in 213-W work room due to error in repackaging or instrument repair	Handling error (forklift, spills, etc)	F3	E1
213 W-02	Release of radioactive and/or hazardous materials in 213-W work room due to error in repackaging or instrument repair	Failure of tools	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
213 W-03	Release of radioactive and/or toxic materials from 213-W due to fire in ventilation system	Electrical fault in ventilation or monitoring system	F2	E1
213 W-04	Release of radioactive and/or hazardous materials in 213-W work room due to fire	Human error (handling, smoking, hot tools)	F2	E1
213 W-05	Release of radioactive and/or hazardous materials in 213-W work room due to fire	Electrical or mechanical fault in tools, heating system, or hydraulics	F2	E1
213 W-06	Release of radioactive and/or toxic materials from 213-W due to fire in ventilation system	Lightning	F2	E1
213 W-07	Release of radioactive and/or toxic materials from 213-W due to structural failure of building	Seismic event	F1	E1
213 W-08	Release of radioactive and/or toxic materials from 213-W due to structural failure of building	High winds or tornado	F2	E1
213 W-09	Release of radioactive and/or toxic materials from 213-W due to structural failure of building	Loss of control of vehicle in vicinity of building	F3	E1
244AR-01.a.03	Radioactive aerosols released from tank headspace exit building through the inlet side of the canyon ventilation system due to mechanical failure	Failure of vessel venting with open vents to cell atmosphere and jetting operations occurring plus failure of exhaust fans	F3	E1
244AR-01.b.01	Radioactive aerosols released from tank headspace and exit building through the inlet side of the canyon ventilation system due to mechanical failure	Fan Failure with jetting occurring	F3	E1
244AR-01.b.02	Radioactive aerosols released from tank headspace and exit building through the inlet side of the canyon ventilation system due to mechanical failure	HEPA filter plugged with jetting occurring	F3	E1
244AR-01.b.03	Radioactive aerosols released from tank headspace and exit building through the inlet side of the canyon ventilation system due to human error	Damper closed with jetting occurring	F3	E1

Table D-3 Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
244AR-01.c.01	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to vessel ventilation failure	Plugged vessel ventilation system filters	F3	E0
244AR-01.c.02	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to ventilation system failure	Vessel ventilation system fan shutdown or failure	F3	E0
244AR-01.c.03	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to human error	Valve closed in exhaust flow path	F3	E0
244AR-01.c.07	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to human error	All inlets to tank sealed with pumping of tank occurring	F2	E0
244AR-01.c.08	Release of radioactive aerosols from vessel headspace into canyon atmosphere due tank rupture	Plugged tank vents with gas evolution in tank contents	F3	E0
244AR-01.c.10	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to plugged ventilation system	Air purge operating with ventilation system plugged	F3	E0
244AR-01.c.11	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to ventilation system filter plugging	Air heaters off (steam supplied)	F3	E0
244AR-01.c.13	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to ventilation system filter plugging	Air heater off with significant heat generating waste in tanks	F2	E0
244AR-02.a.08	Release of radioactive liquid into cells due to jumper leak causing release of aerosols through cracks	Jumper leak (general)	F3	E0
244AR-02.a.09	Release of radioactive liquid to soil from leaking sump filled by leaking jumper	Jumper leak (general)	F3	E2
244AR-02.a.10	Release of radioactive liquid into cells due to jumper leak	Jumper (B Plant to AY Tank Farm through cell) leak	F3	E0
244AR-02.a.11	Release of radioactive liquid to soil from leaking sump filled by leaking jumper	Jumper (B Plant to AY Tank Farm through cell) leak	F3	E2
244AR-02.a.12	Release of radioactive liquid into cells due to tank leak	Tank leak	F3	E0

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
244AR-03.a.03	Release of radioactive aerosols into cell due to collapse of tank	Complete sealing of all risers with vessel ventilation system piping blocked and pumping of tank occurring	F1	E1
244AR-03.a.06	Release of radioactive aerosols from tanks headspace due to steam pressure control failure for jetting system	Jetting operation with failure of jetting steam pressure regulation	F3	E1
244AR-03.a.07	Release of radioactive aerosols from tanks headspace due to air purge pressure control failure	Air purge with blocked ventilation and risers and failure of air pressure control	F2	E1
244AR-03.a.13	Release of radioactive aerosol being jetted from tank or sump due to overflow into sump	Jetting activities moving material from sump or another tank	F3	E0
244AR-03.a.14	Release of radioactive liquid being jetted from tank or sump due to overflow of tank	Inter-facility tank transfers	F3	E0
244AR-03.a.18	Release of radioactive aerosols from tank due to seismic event	Seismic event	F2	E0
244AR-04.a.01	Release of radioactive aerosols in sump due to disturbance of radioactive material by falling crane	Seismic event	F2	E0
244AR-05.a.01	Weak roof structure permits person to fall through roof	Aging (roof)		
244AR-06.a.02	High activity radioactive material exposes person to ionizing radiation	Tank ventilation heater coil failure		
244AR-07.a.01	Radioactive contamination contained in cells moved out of cell area into canyon area due to steam pressure control failure	Failure of PRV during jetting activities coupled with failure of ventilation systems	F2	E1
244AR-07.a.02	Radioactive contamination back flow into steam system due to steam supply failure	Steam supply failure	F3	E1
244AR-07.a.03	Radioactive contamination back flow into steam system due to compressed air failure	Steam supply failure and air blow failure	F3	E1
244AR-07.a.04	Exposure to low concentrations of radioactive material	Excess water used in steam jet flush	F3	
244AR-PH01	Water hammer during setup for jetting	Condensate in the lines coming into contact with steam		

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
244AR-PH02	Asphyxiation due to entry into confined space	Lack of oxygen due to corrosion, decomposition or fire/explosion		
244AR-PH03	Contamination of personnel with radioactive material	Radioactive contamination in canyon or sample gallery being disturbed by personnel entry		
244AR-PH04	Person falls from elevated surface	Roof weakness (more than 2 stories high)		
244AR-PH05	Person falls from elevated surface	Crane maintenance activities		
244AR-PH06	Person falls from elevated surface	Walking over weak filter vault roof		
244AR-PH07	Person falls from elevated surface	Ladder climbing		
244AR-PH08	Person comes in contact with rotating equipment	Maintenance work on rotating equipment		
244AR-PH09	Person comes in contact with rotating equipment	Process operations activities		
244AR-PH10	Person injured by failure of equipment during over speed event	Equipment malfunction		
244AR-PH11	Personnel injury from contact with energized circuits or faulted equipment	Insulation failure		
244AR-PH12	Personnel injury from contact with energized circuits or faulted equipment	Maintenance activities		
244AR-PH13	Personnel injury from contact with energized circuits or faulted equipment	Mechanical damage to insulation		
244AR-PH14	Personnel injury due to electrical fire	Insulation failure		
244AR-PH15	Personnel injury due to electrical fire	Overload conditions, breaker failure, sparking in flammable atmosphere		
244AR-PH16	Personnel exposure to insulation or construction materials containing asbestos	Disturbance from: fire, maintenance, wind, aging, water intrusion		

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
244AR-PH17	Personnel exposed to toxic or corrosive materials	Maintenance and operations activities combined with leakage such as pipe failure, pump failure or valve packing leaks		
244AR-PH18	Personnel injured by high pressure gas bottles becoming projectiles	Malfunction of bottle regulator		
244AR-PH19	Personnel injured by high pressure gas bottles becoming projectiles	Improper storage and transport		
2727W-01	Release of hazardous materials from 2727-W due to sodium reactions with limited water	Water enters through roof vents when tanks not sealed	F2	E1
90D-01	Release of radioactive and toxic aerosols/vapors from 90 Day Storage Pad due to container breach	Container breach from internal chemical, thermal or radiolysis reactions; corrosion, freeze-thaw cycles	F3	E1
90D-02	Release of radioactive and toxic aerosols/vapors from 90 Day Storage Pad due to container breach	Container breach from external impact from handling error, forklift, handling equipment airborne missile from wind, seismic	F3	E1
90D-03	Release of radioactive and toxic aerosols/vapors from 90 Day Storage Pad due to container breach	Container breach from airborne missile from wind, or from a seismic event	F3	E1
90D-04	Release of radioactive and toxic aerosols/vapors from 90 Day Storage Pad due to fire or explosion	Waste ignition from spontaneous combustion, incompatible wastes, heat from sun, waste handling or other human activities	F3	E1
90D-05	Release of radioactive and toxic aerosols/vapors from 90 Day Storage Pad due to fire or explosion	External events cause waste ignition (range fires, lightning, seismic event, airplane crash)	F1	E1
90D-06	Release of radioactive and toxic aerosols/vapors from Intermediate Holding Area due to container breach	Container breach from internal chemical, thermal or radiolysis reactions; corrosion, freeze-thaw cycles	F3	E1
90D-07	Release of radioactive and toxic aerosols/vapors from Intermediate Holding Area due to container breach	Container breach from external impact from handling error, forklift, handling equipment airborne missile from wind, seismic	F3	E1
90D-08	Release of radioactive and toxic aerosols/vapors from Intermediate Holding Area due to container breach	Container breach from airborne missile from wind, or from a seismic event	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
90D-09	Release of radioactive and toxic aerosols/vapors from Intermediate Holding area due to fire/explosion	Waste ignition from spontaneous combustion, incompatible wastes, heat from sun, waste handling or other human activities	F2	E1
90D-10	Release of radioactive and toxic aerosols/vapors from Intermediate Holding Area due to fire/explosion	Natural Phenomena cause waste ignition (range fires, lightning, seismic event)	F1	E1
90D-11	Release of radioactive and toxic aerosols/vapors from waste transport vehicle due to loss of waste confinement	Failure to secure waste, vehicle accident, improper packaging, waste reactions	F3	E1
BND-01	Industrial hazards (lifting, bending, tool accidents; creates tripping hazard)	Failure to follow safe work practices, equipment failures		
BND-01-I	Injury of worker from (lifting, bending, tool accidents; creates tripping hazard) due to bonding activities	Failure to follow safe work practices, equipment failures	NA	E1
BND-02-I	Injury of worker from ignition of combustibles due to preparation for bonding	Drilling holes for bonding attachments causes sparks which is a hazard	F2	E1
CCF-02	Radioactive and hazardous release from tanks due to short term loss of ventilation	Loss of offsite power	F3	E1
CCF-03	Degraded ventilation performance at 702-A due to condensed water vapors on HEPAs	Sustained loss of water supply (month)	F3	E0
CCF-04	Degraded ventilation performance at 702-A due to condensed water vapors on HEPAs	Sustained loss of steam supply	F3	E0
CCF-14	Personnel illness or asphyxiation due to air supply faults	SCBA air supply of poor quality		
CCF-15	Degraded operations, increased down time, possible personnel injury due to supply of inferior parts	Faulty parts or equipment supplied (e.g. o-rings, seals, electronics, HEPAs, pressure regulators, etc)		
CCF-16	Subsurface releases of radioactive or hazardous material due to leaks in multiple tanks	Tanks, tank penetrations and tank components deteriorate due to corrosion	F3	E3
CDP-01	Release of radioactive contamination to soil surface from crib or ditch due to animal intrusion	Animal intrusion into crib or ditch	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CDP-03	Release of radioactive contamination to soil surface from inactive pond due flooding in crib or ditch	Flooding	F3	E1
CDP-05	Release of radioactive contamination to atmosphere from inactive pond due to high wind/tornado disturbing radioactive contamination in crib or ditch	High winds/tornados	F2	E1
CDP-06	Release of radioactive contamination to atmosphere from inactive pond due to high wind/tornado disturbing inactive pond	High winds/tornadoes	F3	E0
CDP-08	Release of airborne radioactive contamination from contaminated vegetation due to fire in weed growth on top of cribs or ditches	Range fire	F3	E1
CDP-09	Driver error during drive-by causes injury to personnel	Driver error		
COB-02	Release of radioactive and/or hazardous material from COB due to spray leak	Flange, gasket or valve, spray leak with COB lid in place	F3	E2
COB-03	Release of radioactive and/or hazardous material from COB due to spray leak	Piping leak into COB due to chemical reaction degrading pipe, lid in place	F3	E2
COB-05a	Release of radioactive and/or hazardous material from COB due to existing contamination inside COB and lid removed	Inspection of COB	F3	E1
COB-05b	Release of radioactive and/or hazardous material from COB due to existing contamination inside COB and lid off during high wind	High wind with COB cover off	F3	E1
COB-05c	Release of radioactive and/or hazardous material from COB due to flooding	Flooding of COB due to rain/snow melt	F3	E1
COB-05d	Release of radioactive and/or hazardous material release from COB due to vehicle accident	Vehicle accident involving COB	F3	E1
COB-05e	Release of radioactive and/or hazardous material from COB due to seismic event	Seismic event	F3	E1
COB-05f	Release of radioactive and/or hazardous material from COB due to existing contamination inside COB and COB lid off	Human error leaving COB lid off	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
COB-06a	Release of radioactive and/or hazardous material from COB due to COB caisson pressurized	Weather heatup with HEPA filter plugged	F3	E1
COB-06b	Release of radioactive and/or hazardous material from COB due to COB caisson pressurized	Leak into COB with HEPA filter plugged	F3	E1
COB-07	Release of radioactive and/or hazardous material from COB due to reverse flow through COB from adjacent transfer line	COB setup is such that a transfer through the adjacent transfer line backflows through the COB drain line into the primary transfer line that the COB is attached to	F2	E1
CP-GRT-01	Personnel exposure to contaminated pipe string due to removal of pipe during grouting	Contaminated soil in pipe	F3	E0
CP-MSP-02	Release of radioactive or toxic material to soil (plume) remaining subsurface from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations	F3	E3
CP-MSP-04	Release of radioactive or toxic material to soil (plume) remaining subsurface from waste tank due to puncture of tank	Human error - Undetected deflection of drill string pipe causes breach of tank	F1	E3
CP-MSP-09	Release of isotope source to the soil surface due to load drop	Human Error caused load drop	F3	E0
CP-MSP-10	Release of isotope source to the soil surface due to load drop	Mechanical failure caused load drop	F2	E0
CP-MSP-11	Release of radioactive material to the soil surface due to crushed sensor package	Human Error: Heavy load inadvertently set on top of sensor package	F3	E1
CP-RMV-01	Release of radioactive or toxic material to soil (plume) remaining subsurface from inactive transfer line damaged during push operations	Human error caused puncture to inactive transfer line during push operations	F3	E2
CP-RMV-02	Personnel exposure to high level waste contamination on surface of pipe string due contact with leaking waste	Human error caused puncture to inactive transfer line during push operations	F3	E0
CP-RMV-04	Personnel exposure to radiation through push pipe due to puncture of tank dome	Human error results in removal of sample canister containment	F3	E1
CP-SET-01	Release of radioactive or toxic material from above ground structure due to load movement	Mechanical failure of equipment causes load to swing into above ground structure	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CP-SET-02	Release of radioactive or toxic material from above ground structure due to load movement	Human error causes load to swing into above ground structure	F3	E1
CP-SET-03	Release of radioactive or toxic material from above ground structure due to load movement	High wind causes load to swing into above ground structure	F1	E1
CP-SET-09	Release of isotope source from the MSP to the soil surface due to load drop	Human error causes load drop	F3	E1
CP-SET-10	Release of isotope source from the MSP to the soil surface due to load drop	Mechanical failure causes load drop	F2	E1
CP-SET-11	Release of radioactive material from the MSP to the soil surface due to crushing of the sensor package	Human error: Heavy load is inadvertently set on top of the sensor package	F3	E1
CP-SSP-02	Release of radioactive or toxic material to soil (plume) remaining subsurface from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations	F3	E3
CP-SSP-04	Release of radioactive or toxic material to soil (plume) remaining subsurface from waste tank due to puncture of tank	Human error - Undetected deflection of drill string pipe causes breach of tank	F1	E3
CP-SSP-06	Personnel exposure to contaminated soil sample while removing sampling canister from pipe sleeve	Human error	F3	E0
CP-SSP-07	Personnel exposure to contaminated soil sample while removing sampling canister from pipe sleeve	Mechanical failure	F2	E0
CP-SSP-08	Personnel exposure to contaminated soil sample while removing sampling canister from pipe sleeve	High wind	F2	E0
CP-SSP-09	Personnel exposure to contaminated pipe string caused by failure of sampling canister soil catcher to close properly	Mechanical failure	F3	E0
CP-SSP-10	Personnel exposure to puff release of contaminated dust (particulates) caused by air movement as the sample canister is withdrawn from pipe sleeve	Contaminated inner tube	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CP-SSP-11	Release of contamination to environment due to dropping of the sample canister during transfer of sample from pipe to the shipping cask	Human error - workers drop sample canister or fail to handle properly	F3	E1
CP-SSP-12	Release of contamination to environment due to dropping of the sample canister during transfer of sample from pipe to the shipping cask	Mechanical failure of the sample canister	F3	E1
CP-SSP-13	Release of contamination to environment due to dropping of the sample canister during transfer of sample from outer push pipe to the shipping cask	High wind	F3	E1
CP-SSP-14	Release of contamination to environment due to dropping of the repackaged soil sample container	Human error - workers drop sample canister or fail to handle properly	F3	E1
CP-SSP-15	Release of contamination to environment due to dropping of the repackaged soil sample container	High wind	F2	E1
CP-SSP-19	Release of radioactive material to the soil surface due to rupture of the probe capsule	Human error: Results in package being ruptured when vehicle runs over the probe	F2	E1
CRN-01	Release of radioactive and/or toxic materials from riser due to breach by crane movement	Human errors or failure to follow safe work practices	F3	E1
CRN-01-I	Release of radioactive and/or toxic materials from riser breach due to crane movement	Human errors or failure to follow safe work practices	F3	E1
CRN-02	Release of radioactive and/or toxic materials from riser due to breach by crane movement	Mechanical failures of crane (brakes, throttle)	F3	E1
CRN-02-I	Release of radioactive and/or toxic materials from riser breach due to crane movement	Mechanical failures of crane (brakes, throttle)	F2	E1
CRN-05-I	Release of radioactive and/or toxic materials from surface contamination and fuel tank on crane or support vehicle due to fuel tank fire (see In-Facility Equipment Installation for facility fires)	Human error in positioning crane load	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CRN-06-I	Release of radioactive and/or toxic materials from surface contamination and fuel tank on crane or support vehicle due to fuel tank fire (see In-Facility Equipment Installation for facility fires)	Mechanical failure in positioning crane load causes crane fuel tank rupture and fire	F3	E1
CRN-07-I	Release of radioactive and/or toxic materials from surface contamination and fuel tank on crane or support vehicle due to fuel tank fire (see In-Facility Equipment Installation for facility fires)	Crane hits electrical lines/supplies	F2	E1
CRN-08-I	Release of radioactive and/or toxic materials from surface contamination and fuel tank on crane or support vehicle due to fuel tank fire (see In-Facility Equipment Installation for facility fires)	Lightning	F1	E1
CRN-14	Boom failure leads to worker injury or exposure	Human error: improper load assembly, rigging, crane overloaded		
CRN-14-I	Injury of worker from boom failure due to human error	Human error: improper load assembly, rigging, crane overloaded	NA	E1
CRN-15	Boom failure leads to worker injury or exposure	Mechanical failure: corrosion, faulty materials		
CRN-15-I	Injury of worker from boom failure due to mechanical failure	Mechanical failure: corrosion, faulty materials	NA	E1
CRN-16	Boom failure leads to worker injury or exposure	High wind or seismic event		
CRN-16-I	Injury of worker from boom failure due to high wind or seismic	High wind or seismic event	NA	E1
CRN-17	Release of radioactive or toxic material from tanks due to power failure from crane hitting power lines/supplies	Human error: improper load assembly, rigging, crane positioning	F3	E1
CRN-17-I	Injury of worker from electricity due to crane hitting powerlines/supplies	Human error: improper load assembly, rigging, crane positioning	NA	E1
CRN-24	Carbon monoxide from crane accumulates in pits or temporary confinement (greenhouse, etc)	Oxygen deficient atmosphere and failure to provide adequate ventilation, Failure to sniff or improper sniffing		
CRN-24-I	Injury of worker from carbon monoxide accumulation in pits or temporary confinement (greenhouse, etc) due to crane motor exhaust	Failure to provide adequate ventilation,!Failure to sniff or improper sniffing	NA	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CRN-25	Loss of lateral load control, swinging load into personnel or equipment	Human error: improper load assembly, rigging, positioning error		
CRN-25-IA	Injury of worker from swinging load into personnel due to loss of lateral load control	Human error: improper load assembly, rigging, positioning error	NA	E1
CRN-26	Loss of lateral load control, swinging load into personnel or equipment	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil		
CRN-26-IA	Injury of worker from swinging load into personnel due to loss of lateral load control	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil	NA	E1
CRN-27	Loss of lateral load control, swinging load into personnel or equipment	High wind or seismic event		
CRN-27-IA	Injury of worker from swinging load into personnel due to loss of lateral load control	High wind or seismic event	NA	E1
CVR-01	Release (greater than expected) of radioactive or hazardous material from pit due to lifting cover blocks	Failure to monitor or improper monitoring	F3	E1
CVR-01-I	Release of greater than expected amount of radioactive or hazardous material from pit upon lifting coverblocks due to monitoring failure	Failure to monitor or improper monitoring	F3	E1
CVR-02	Release (greater than expected) of radioactive or hazardous material from pit due to lifting cover blocks	Mechanical failure of equipment in pit (corrosion, leaks, etc)	F3	E1
CVR-02-I	Release of greater than expected amount of radioactive or hazardous material from pit upon lifting coverblocks due to mechanical failures	Mechanical failure of equipment in pit (corrosion, leaks, etc)	F3	E1
CVR-03	Release (greater than expected) of radioactive or hazardous material from pit due to lifting cover blocks	Wind or dust devil	F3	E1
CVR-03-I	Release of greater than expected amount of radioactive or hazardous material from pit upon lifting coverblocks due to windy conditions	Wind or dust devil	F3	E1
CVR-04	Release (greater than expected) of radioactive or hazardous material from pit due to earthquake lifting cover blocks	Seismic event	F1	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CVR-04-I	Release of greater than expected amount of radioactive or hazardous material from pit upon lifting coverblocks due to seismic event	Seismic event	F2	E1
CVR-05-I	Release of radioactive or hazardous material from pit due to combustion or explosion of materials in pit	Failure to sniff or improper sniffing	F1	E1
CVR-06	Person falls in pit sustaining injury or exposed to surface radiation in pit	Failure to erect fence or failure to erect securely		
CVR-06-I	Injury of worker from falling into pit due to missing or improperly installed fence possibly resulting in personnel exposure	Failure to erect fence or failure to erect securely	NA	E1
CVR-07	Person falls in pit sustaining injury or exposed to surface radiation in pit	Person leans over fence too far		
CVR-07-I	Injury of worker from falling into pit due to human error possibly resulting in personnel exposure	Person leans over fence too far	NA	E1
CVR-08	Person falls in pit sustaining injury or exposed to surface radiation in pit	Fence failure		
CVR-08-I	Injury of worker from falling into pit due to fence failure possibly resulting in personnel exposure	Fence failure	NA	E1
CVR-09	Person falls in pit sustaining injury or exposed to radiation	Seismic event or high wind/tornado		
CVR-09-I	Injury of worker from falling into pit due to seismic event or high winds possibly resulting in personnel exposure	Seismic event or high wind/tornado	NA	E1
CVR-10	Person(s) asphyxiated	Oxygen deficient atmosphere and failure to sniff or improper sniffing		
CVR-10-I	Injury of worker from asphyxiation due to pit atmosphere	Failure to sniff or improper sniffing	NA	E1
CVR-11	Person(s) asphyxiated	Oxygen deficient atmosphere and fresh air supply faults		
CVR-11-I	Injury of worker from asphyxiation due to fresh air supply faults	Fresh air supply faults	NA	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CVR-12-I	Release of radioactive or hazardous material from pit upon lifting coverblocks due to incorrect spraying of fixative	Spraying of fixative (soil cement) causes spray of material out of pit	F3	E1
CVR-13-I	Release of radioactive or hazardous material from pit upon lifting coverblocks due to open nozzles or risers in pit	Open nozzles or risers in pit with radioactive or hazardous material inside	F3	E1
CVR-14-I	Injury of worker from biological hazards (spiders, snakes, etc.) due to open nozzles or risers in pit	Open nozzles or risers in pit with biological hazards (spiders, snakes, etc.) inside	F3	E1
DCN-01	Decontamination personnel are contaminated or exposed	Failure of PPE		
DCN-01-I	Injury of worker from contamination or exposure of decontamination personnel due to failed PPE	Failure of PPE	NA	E1
DCN-02	Release of radioactive or toxic material outside immediate area from equipment removed from tank due to decontamination of equipment	Miss direction of cleaning spray (human error)	F3	E1
DCN-02-IA	Release of radioactive or toxic material outside immediate area from equipment being decontaminated due to spray misdirection	Misdirection of cleaning spray (mechanical failure of spray ring)	F2	E1
DCN-02-IB	Release of radioactive or toxic material outside immediate area from equipment being decontaminated due to spray misdirection	Misdirection of cleaning spray (mechanical failure of spray ring)	F2	E1
DCN-03	Decon personnel are contaminated, aerosol release outside immediate area	Seismic event	F1	E1
DCN-03-I	Decontamination personnel are contaminated, release of aerosol outside immediate area from equipment being decontaminated due to seismic event	Seismic event	F2	E1
DCN-04	Decon personnel are contaminated, aerosol release outside immediate area	Wind/tornado	F2	E1
DCN-04-I	Decontamination personnel are contaminated, release of aerosol outside immediate area from equipment being decontaminated due to wind	Wind/tornado	F2	E2

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
DCN-05-I	Injury of worker from contact with tools due to human error during decontamination activities	Human error	NA	E1
DCN-06	Personnel exposure higher than expected	More contamination than expected		
DCN-06-I	Injury of worker from higher than expected exposure due to unknown contamination	More contamination than expected	NA	E1
DCN-07-I	Injury of worker from exposure to asphyxiant due to PPE failure	PPE failure or absence in confined space	NA	E1
EE-02	Release of radioactive contaminants from Tank Farms due to external fires	Range fire	F3	E1
EE-03	Release of radioactive and hazardous materials from tanks due to loss of active ventilation	Dam collapse	F2	E1
EE-06	Release of radioactive and hazardous materials from tank farm due to external fires	On-site rail accident involving flammable materials	F2	E1
EE-09	Surface flooding at tank farm	Water line breaks and causes flooding at tank farm	F3	E0
EE-10	Release of radioactive and hazardous materials from tanks due to loss of tank integrity	Water line breaks, saturates subsurface, and hydrostatic head causes tank to float	F0	E3
EE-12	Washout of soils surrounding a transfer pipe	Water main to evaporator or steam plant breaks		E0
EE-14	Worker injury due to electrocution	Excavation into power source		
EE-15	Washout of soils resulting in sink hole due to excavation error	Excavation into water line		
GRN-01	Industrial hazards (lifting, bending, trips and falls, tool operations)	Human errors		
GRN-01-I	Injury of worker from (lifting, bending, tool accidents; creates tripping hazard) due to temporary confinement activities	Human errors	NA	E1
GRN-02	Industrial hazards (lifting, bending, trips and falls, tool operations)	Mechanical failure of equipment, tools		

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
GRN-02-I	Injury of worker from (lifting, bending, trips and falls, tool operations) due to mechanical failures	Mechanical failure of equipment, tools	NA	E1
GRN-03-I	Injury of worker from asphyxiants in greenhouse due to collection of asphyxiants before removal	Human error	NA	E1
I-222S-1-CMP-A	Release of 222-S lab waste from transfer line due to leak from rapid corrosion caused by transfer of pH 1 solution	Human error - failure to add sodium hydroxide	F3	E1
I-222S-2-FLW-A	Release (steam) of aerosols and particulates to the atmosphere due to reverse flowing steam into Tank 219-S-102 which saturates the HEPAs	Block valve inadvertently closed at tank farms and transfer via this line	F3	E1
I-242A-2-CMP-A	Release (potential for leak) to tank annulus (secondary confinement) caused by damage to feed tank due to overfilling of tank	Valve failure or inadvertently opened valve	F3	E1
I-242A-4-FLW-A	Release of diluted high level waste to the ground through risers after unmitigated over filling of Tank 241-AW-102 and annulus with condensate	Tube rupture of raw water in condenser	F3	E1
I-242A-6-FLW-A	Release of diluted high level waste to the ground through risers after unmitigated over filling of Tank 241-AW-102 and annulus with raw water	Rupture of raw water line in condenser/pump room	F3	E1
I-242A-6-FLW-C	Release of contaminated aerosols to the 242-A Evaporator building through the drain lines, potential worker hazard	Higher vacuum at evaporator than at tank farms	F3	E0
I-242A-7-CMP-A	Release of aerosols through the risers due to potential to get glycol into instrument air and pressure monitoring system, potential for pressure gages to fail and inability for operators to detect tank pressurization	Compressor head leaks 241-AW Tank Farm air supplied from 242-A, a tank pressurization event for a release	F1	E1
I-242A-7-PRS-A	Personnel hazard from ruptured compressed air line	Failure of compressor unloading switch due mechanical failure or incorrect setting during maintenance	F2	E0
I-242S-1-PRS-A	Release of airborne contaminates through cracks due to over pressurization of 242-S building and contamination of control room where tank farm controls are located	Exhaust fan failure	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242S-1-TMP-A	Release of contaminated water to the ground outside of the 242-S Evaporator due to unmitigated leak in the pump room from the fire protection system's frozen and ruptured line	Low ambient temperature freezes and breaks pipe	F3	E1
I-242S-2-FLW-B	Release of contaminated water to condenser room increasing contamination in the condenser room due to overfilling Tank 241-C-100	Human error - incorrect valve line up	F2	E0
I-242S-4-FLW-B	Release of high level waste to the 242-S condenser room due to reverse flow from Tank 241-SY-102 caused by improper valve line up	Human error - incorrect valve line up	F2	E0
I-242S-4-LEK-B	Release of contaminated water to the atmosphere due to spray leak at the condenser room, caused by corrosion in the pipe	Corrosion in pipe line	F3	E0
I-242S-4-LEK-C	Release of contaminated water to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E0
I-242S-5-CMP-A	Release of aerosols through the risers from various tanks due to loss pressure monitoring system caused by glycol in the instrument air and results in failure of pressure gages and inability of operators to detect tank pressurization	Compressor head leaks, tank pressurization event to get a release	F2	E1
I-242S-5-CMP-B	Release of aerosols through the risers from various tanks due to loss of instrument air to pressure monitoring system caused by glycol damage desiccant which plugs the filter, if pressure gages fail, inability for operator to detect tank pressurization	Compressor head leaks, tank pressurization event to get a release	F2	E1
I-242S-5-CMP-C	Release of aerosols through the risers from various tanks due to desiccant plugging filter resulting in loss of instrument air to pressure monitoring system causing pressure gages to fail and inability for operators to detect tank pressurization	Clogged filter cutting off air supply, tank pressurization event to get a release	F2	E1
I-242S-5-CMP-D	Release of aerosols through the risers from various tanks due to release of desiccant into instrument air which damages the pressures gages and causes the inability of operators to detect tank pressurization	Blow out Filter damaging instrument air, tank pressurization event to get a release	F2	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242S-5-FLW-A	Release of aerosols through the risers from various tanks due to loss of instrument air to pressure monitoring system which causes the pressure gages to fail and the inability for operators to detect tank pressurization	Compressor fails, tank pressurization event to get a release	F2	E1
I-242S-5-FLW-B	Release of aerosols through the risers from various tanks due to loss of instrument air to pressure monitoring system which causes pressure gages to fail and the inability for operators to detect tank pressurization	Block valve inadvertently closed, tank pressurization event to get a release	F2	E1
I-242S-5-FLW-C	Release of aerosols through the risers from various tanks due to loss of instrument air to pressure monitoring system which causes pressure gages to fail and the inability for operators to detect tank pressurization	Filter plugged, tank pressurization event to get a release	F2	E1
I-242S-5-PRS-A	Personnel hazard due to rupture of compressed air line	Human error - failure of compressor unloading switch due to incorrect setting during maintenance	F2	E0
I-242T-3-FLW-A	Release of high level waste to the ground surface by overflowing the "new" diversion box caused by opened or leaking valve	Block valve inadvertently opened or leaking	F3	E1
I-242T-4-FLW-A	Release of high level waste to the ground surface from overflowing the "new" diversion box due to failure of 242-T building and rupture of tanks in 242-T	Catastrophic failure of the building due to aging effects	F3	E1
I-BPLANT-1-TMP-A	Release of aerosols from pressurizing receiver tank due to transfer of hot material from Tank 24-1 to receiver tank	Human error - sending steam to Tank 24-1, inadvertently transferring to tank farms	F2	E1
I-BPLANT-2-FLW-C	Release (ground surface) of low level waste from overflow of receiver tank to pits due to transfer of excessive low level waste from B Plant	Human error - filling Tank 24-1 while transferring to tank farms, receiver tank at maximum administrative level	F1	E1
I-PFP-1-LVL-A	Release (underground) of TRU mixed waste at DCRT pit due to potential to send steam vapor to 244 TX DCRT, potential for thermal expansion to damage transfer pipe and leak to encasement pipe which drains to DCRT pit	Human error - failing to stop transfer to 244-TX when Tank D-5 is empty	F3	E1
I-PFP-2-TMP-A	Release of TRU mixed waste at DCRT pit due to potential to send steam vapor to 244 TX DCRT steam jet gassing it out, potential for thermal expansion to damage transfer pipe	Failure of steam reducer causes spray leak	F2	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-PFP-3-FLW-C	Release of TRU mixed waste from 244 TX overfilling due to transfer error	Transferring from Tank D-7 or Tank D-8 to Tank D-5 while transferring from Tank D-5 to 244-TX	F3	E1
I-PUREX-1-TMP-A	Release from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from addition of hot waste to the tank	Human error - adding caustic (sodium hydroxide) to waste or transferring to U-3 via a steam jet and transferring from U-3 to Tank 241-AW-105 before the waste cools	F3	E1
I-PUREX-2-PRS-B	Release of aerosols through cracks in the cover block due to pressurizing the receiver tank from an extended air purge of the transfer line	Extended air purge after transfer (mechanical failure)	F3	E1
I-PUREX-2-PRS-C	Personnel exposure due to vacuum pulling radioactive material back to operating gallery, worker hazard at PUREX (dose concern)	Failure to air purge line after transfer (mechanical failure)	F2	E0
I-PUREX-3-TMP-A	Release of aerosols from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from addition of hot waste	Human error - adding caustic (sodium hydroxide) to waste or transferring to U-3 via a steam jet and transferring from U-3 to Tank 241-AW-105 before the waste cools	F3	E1
I-PUREX-4-PRS-B	Release of aerosols through cracks in the cover block due to pressurizing the receiver tank from an extended air purge of the transfer line	Extended air purge after transfer (mechanical failure)	F3	E1
I-PUREX-4-PRS-C	Personnel exposure due to vacuum to pulling radioactive material back to operating gallery, worker hazard at PUREX (dose concern)	Failure to air purge line after transfer (mechanical failure)	F2	E0
I-PUREX-5-FLW-A	Release of aerosols through cracks in cover block due to pressurizing receiver tank caused by transferring waste with steam which heats the waste	Multiple deactivation locks removed and valves opened or multiple valves leaking	F3	E1
I-PUREX-5-FLW-B	Release of aerosols from receiver tank due to fire caused by transfer of organic from PUREX	Organic material present in Tank R-8	F2	E1
I-PUREX-6-FLW-B	Release (ground surface) of liquid waste in Catch Tank 302-A diluted with flush water due to overfilling the tank and the pump pit and/or the diversion box due to improper valve line up of flush water	Multiple flush water block valves inadvertently opened or leaking	F2	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-PUREX-6-FLW-C	Release of high level tank waste due to overfilling Tank 302-A into the diversion box and into an open nozzle which directs the flow to other tanks in the tank farm	Multiple flush water block valves inadvertently opened or leaking	F2	E1
I-TPLANT-1-TMP-A	Release of aerosols from pressurizing receiver tank due to transfer of hot material from Tank 15-1 to receiver tank	Human error - sending steam to Tank 15-1 and inadvertently transferring to tank farms	F2	E1
I-TPLANT-2-FLW-B	Release of low level waste from overflow of receiver tank to pits due to transfer of excessive low level waste from T Plant	Human error - filling Tank 15-1 while transferring to tank farms and receiver tank at maximum administrative level	F1	E1
I-UPLANT-1-RAN-A	Release of contaminated rain water to the ground surface from overfilling catch tank and diversion box due to severe rain	Severe Rain	F2	E1
ITK-01	Radioactive and/or hazardous material release from point of in-tank access (non-fire, non-explosion) due to intrusive activity	Chemical/thermal reaction of materials in equipment/waste	F2	E1
ITK-01-I	Release of radioactive and/or hazardous material from point of in-facility access due to chemical/thermal reaction (non-fire, non-explosion)	Chemical/thermal reaction of materials in equipment/waste	F3	E1
ITK-02	Radioactive and/or hazardous material release from point of in-tank access (non-fire, non-explosion) due to intrusive activity	Pressurized equipment fails in tank and increases tank pressure	F2	E1
ITK-02-I	Release of radioactive and/or hazardous material from point of in-facility access due to equipment pressurization release event (non-fire, non-explosion)	Pressurized equipment fails in facility and increases facility pressure	F1	E1
ITK-03	Release of radioactive and/or hazardous material from point of in-tank access (non-fire, non-explosion) due to intrusive activity	Contaminated equipment removed or reused	F3	E1
ITK-03-I	Release of radioactive and/or hazardous material from point of in-facility access due to equipment removal (non-fire, non-explosion)	Contaminated equipment removed or reused	F3	E1
ITK-04	Release of radioactive and/or hazardous material from point of in-tank access (non-fire, non-explosion) due to earthquake or high wind with open access	Seismic event or high wind when access open	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
ITK-04-I	Release of radioactive and/or hazardous material from point of in-facility access due to seismic event or high wind (non-fire, non-explosion)	Seismic event or high wind when access open	F2	E1
ITK-07	Radioactive and/or hazardous material release from tank below grade (non-fire, non-explosion) due to intrusive activity	Dropped equipment in tank from human error or equipment failures (also see crane operations) Penetration of tank with linear-force, high pressure, or rotational equipment from human error or equipment failure	F3	E3
ITK-07-IA	Release of radioactive and/or hazardous material from facility below grade due to breach of facility confinement (non-fire, non-explosion)	Dropped equipment in facility from human error or equipment failures (also see crane operations) Penetration of facility confinement with linear-force, high pressure, or rotational equipment from human error or equipment failure	F2	E1
ITK-07-IB	Release of radioactive and/or hazardous material from facility at surface due to breach of facility confinement (non-fire, non-explosion)	Dropped equipment in facility from human error or equipment failures (also see crane operations) Penetration of facility confinement with linear-force, high pressure, or rotational equipment from human error or equipment failure	F2	E2
ITK-FR-01	Release of radioactive or hazardous material from flex receiver due to flushing with insufficient drainage	Riser not drained correctly or drain clogged causing plugging of riser	F3	E1
ITK-FR-02	Release of radioactive or hazardous material from flex receiver due to equipment jam in riser and non-procedural efforts to dislodge	Equipment becomes lodged in riser upon retrieval and non-procedural efforts to remove provide release path for tank material and/or flush water	F3	E1
ITK-FR-05	Release of radioactive or hazardous material from flex receiver due to structural failure	Human error tears flex receiver bag	F3	E1
ITK-FR-06	Release of radioactive or hazardous material from flex receiver due to structural failure	Equipment failure/misalignment tears flex receiver bag (crane operation, hydraulic jack stand)	F3	E1
ITK-FR-07	Release of radioactive or hazardous material from flex receiver due to structural failure	Structural degradation	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
ITK-FR-09	Release of radioactive or hazardous material from flex receiver due to mechanical equipment failure	Failure of automatic cinch or inappropriate tightening of cables, condition goes unnoticed and receiver is sheared	F2	E1
ITK-FR-10	Release of radioactive or hazardous material from flex receiver due to mechanical equipment failure	Failure of cinching cables causing loss of containment after receiver is sheared	F2	E1
ITK-FR-11	Release or radioactive or hazardous material from flex receiver due to loss of hydraulics	Hydraulic power is lost while bag is being sealed resulting in failure of seal and leak path from bag	F1	E1
ITK-FR-12	Release or radioactive or hazardous material from flex receiver due to loss of hydraulics	Mechanical failure or inadequate operating pressure of hydraulics while bag is being sealed resulting in failure of seal and leak path from bag	F1	E1
ITK-FR-14	Release of radioactive or hazardous material from flex receiver due to leak from flanges	Non-acceptable torque on bolts connecting bellows - torque too low not enough pressure for adequate seal, to high destroys seal material	F3	E1
ITK-FR-15	Release of radioactive or hazardous material from flex receiver due to errors in installation	Incorrect installation of receiver provides release path (misalignment of bellows)	F3	E1
ITK-FR-16	Release of radioactive or hazardous material from flex receiver due to containment failure during transfer	Failure of cinched end/receiver material and secondary containment bag during transfer of equipment to trailer	F2	E1
ITK-FR-17	Release of radioactive or hazardous material from flex receiver due to leak from bag	Flaw in bag construction provides leak path for material	F2	E1
ITK-FR-18	Release of radioactive or hazardous material from flex receiver due to damage from operation of hydraulic jacks	Hydraulic jacks on assembly stand are operated while assembly is bolted to flange damaging flex receiver or riser creating release path	F3	E1
ITK-FR-20	Release of radioactive or hazardous material from flex receiver due to wrong bag being used	Containment bag is too short to hold equipment being withdrawn from tank, condition goes unnoticed until containment is lost	F3	E1
ITK-FR-21	Release of radioactive or hazardous material from flex receiver due to operation in extreme weather	Operation in cold weather compromises strength of flex receiver, equipment breaks providing release path	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
ITK-FR-23	Release of radioactive or hazardous material from flex receiver due to equipment failure	Plexiglass window on receiver breaks causing release path	F3	E1
ITK-FR-24	Release of radioactive aerosols from flex receiver due to cutter misoperation damaging metal housing	Cutter cuts through containment (metal housing), venturi effect spread aerolized waste outside of containment (cutter not turned off in time, water pressure/flow too high, or cutting spread increased because of abrasive characteristics)	F2	E0
ITK-FR-25	Release of radioactive or hazardous vapors due to pump or water supply failure	Loss of cutting water due to pump or water supply failure provides open pathway from tank through silica hopper	F2	E0
ITK-FR-26	Release of radioactive or hazardous material from flex receiver due to leak from bag	Equipment mispositioned in receiver bag creating inappropriate seal and leak	F3	E1
ITK-FR-27	Release of radioactive or hazardous material from flex receiver due to containment breach during transfer	Unable to lock lifting ring onto skid, equipment falls off skid ripping bag and creating a release path	F2	E1
ITK-FR-28	Release of radioactive or hazardous material from flex receiver due to containment breach during transfer	Receiver trailer falls over with bagged equipment attached ripping bag and creating release path	F3	E1
LDUA 1-10	Worker exposure due to leak of waste into LDUA components	Line plug	F3	E0
LDUA 1-11	Worker exposure due to leak of waste into LDUA components	Line break	F3	E0
LDUA 1-34	Worker exposure due to operation error or mechanical failure	Operator error or mechanical failure	F3	E0
LDUA 2-13	Worker exposure due to leak of waste into LDUA components	Line plug	F3	E0
LDUA 2-14	Worker exposure due to leak of waste into LDUA components	Line break	F3	E0
LDUA 2-50	Worker injury due to equipment damage	Human error, software bug	F3	E0
LDUA 2-53	Worker exposure due to contamination in LDUA	LDUA contamination - due to in-tank activities	F3	E0
LDUA 2-54	Worker injury due to industrial accidents	Industrial accidents	F3	E0

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
LDUA 3-1	Release of radioactive aerosols from the TRIC due to filter plug and pressurization	TRIC filter inlet plugs (dust, ice, etc.)	F3	E1
LDUA 3-15	Release of radioactive aerosols from the TRIC due to filter plug and pressurization	HEPA filter plugs with frozen condensation	F3	E1
LDUA 3-19	Worker injury due to general industrial hazards	General industrial hazards (e.g. during end effector change out)	F3	E0
LDUA 3-2	Release of contamination from LDUA due to loss of containment	Door not sealed, loss of glove	F3	E1
LDUA 3-20	Worker injury due to electric shock	Electric shock hazards during hook-up and maintenance	F3	E0
LDUA 3-21	Release of contamination to ground from LDUA due to impact from pressurized water/decontamination system	500-psi water (from decontamination system) causes impact hazards	F3	E1
LDUA 3-22	Release of contamination from riser and TRIC due to loss of confinement	Riser valve open while end effectors being placed in TRIC	F3	E1
LDUA 3-23	Release or radioactive aerosols from riser due to spark igniting flammable gas	Plug gauge (carbon steel) becomes stuck in riser during riser characterization	F3	E1
LDUA 3-24	Release of contamination from TRIC due to load drop	TRIC dropped from crane	F3	E1
LDUA 3-25	Release of contamination from LDUA due to incorrect installation	VPM adapter, HEPA, Gloves, Door, incorrectly installed/sealed (leaks)	F3	E1
LDUA 3-28	Release of contamination from riser due to high winds	High winds stress riser	F3	E1
LDUA 3-4	Worker exposure due to purge system overpressure - increased contamination in TRIC	Purge system overpressure (VPM auxiliary hookup)	F3	E0
LDUA 3-5	Worker exposure due to loss of decontamination water flow	Loss of decontamination water flow	F3	E0
LDUA 3-7	Worker exposure due to plug in decontamination line resulting in poor decontamination	Decontamination water line plugs due to solids	F3	E0

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
LDUA 4-10	Worker exposure due to ignition of flammable gas inside VPM	Loss of supply air from VPM outer tube.	F3	E0
LDUA 4-11	Worker injury due to blow out of housing panel	Supply pressure on with the VPM housing gate closed	F3	E0
LDUA 4-27	Release of contamination due to thermal degradation of VPM housing	Thermal expansion/contraction of atmosphere in housing while in storage	F3	E1
LDUA 4-30	Release of contamination due to corrosion of VPM	Poor decontamination, caustic waste contacts arm, causes corrosion of VPM	F3	E1
LDUA 4-39	Worker exposure due to loss of computer controls/ requires manual retrieval of mast	Loss of computer	F3	E0
LDUA 4-40	Worker exposure due to insufficient decontamination	Mast tubes not sufficiently decontaminated prior to removal	F3	E0
LDUA 4-43	Worker injury due to industrial hazards	Industrial hazards during maintenance	F3	E0
LDUA 4-8	Worker exposure due to leak of waste into LDUA components	Line plug	F3	E0
LDUA 4-9	Worker exposure due to leak of waste into LDUA components	Line break	F3	E0
LDUA 5-17	Worker injury due to inadvertent motion of valve	Operator error, improperly positioned valves	F3	E0
LDUA 5-21	Worker injury due to shock load damaging equipment	Shock load causes damage	F3	E0
LDUA 5-23	Release of hazardous material to environment from truck battery due to inadvertent spill/potential ignition	Truck battery acid spill, deflagration	F3	E1
LDUA 5-29	Release of contamination from LDUA or riser due to spark igniting flammable gas	Truck backs into tank farm equipment (e.g., riser, pump pit)	F3	E1
LDUA 5-30	Release of contamination from LDUA or riser due to damage from vehicles	Truck moves after setup	F3	E1
LDUA 5-31	Release of contamination due to transport vehicle accident.	Vehicle accident during transport	F3	E1
LDUA 5-32	Worker injury due to vehicle engine fire	Vehicle engine fire	F3	E0

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
LDUA 5-33	Release of contamination from LDUA or riser due to damage from vehicles	Failure to deploy outriggers or premature retraction of outriggers	F3	E1
LDUA 5-35	Worker exposure due to misalignment of mast arm during insertion creating external contamination	Misaligning during insertion	F3	E0
LDUA 5-36	Release of contamination from LDUA or riser due to damage from improper operation	Attempting to lower VPM to horizontal while arm is in riser	F3	E1
LDUA 5-39	Release of contamination from LDUA or riser due to equipment failure causing riser damage	Brakes not operating as designed	F3	E1
LDUA 5-41	Release of contamination from TRIC and tank riser due to damage during seismic event	Seismic event	F3	E1
LDUA 5-42	Release of contamination from LDUA or riser due to damage from vehicle operation resulting in fire	Other truck impact	F3	E1
LDUA 5-44	Release of contamination from LDUA or riser due to damage from vehicle operation	Heavy rain or ponded surface water or flood	F3	E1
LDUA 6-28	Worker injury due to communication failure	Communication failure between control locations and TRIC during maintenance	F3	E0
LDUA 6-29	Worker injury due to lifting	Lifting injuries in moving heavy cable	F3	E0
LDUA 6-30	Worker injury due to electric shock	Electrical malfunction	F3	E0
LDUA 6-5	Worker injury due to fire	Fire	F3	E0
LDUA 6-7	Worker injury due to electric shock	Impact, severing of cable by heavy equipment	F3	E0
LDUA 7-12	Worker injury due to accident when parking trailer	Collision with obstacles during parking of trailer	F3	E0
LDUA 7-13	Worker injury due to electric shock	Improper grounding - bonding	F3	E0
LDUA 7-14	Worker injury due to electric shock	Electrical shock hazards during hook-up	F3	E0

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
LDUA 7-16	Worker injury due to electric shock	Dust in electronic distribution disconnects and junction box	F3	E0
LDUA 7-3	Worker injury due to slipping hazard	Slipping hazards	F3	E0
LDUA 7-4	Worker injury due to fire	Fire in trailer	F3	E0
LDUA 7-6	Worker injury due to trailer falling over	Wind	F3	E0
LDUA 7-7	Worker injury due to trailer falling over	Seismic event	F3	E0
LDUA/EREE 1-10	Worker exposure due to leak of waste into EREE	Line break	F3	E0
LDUA/EREE 1-29	Worker exposure due to operator error/mechanical failure	Operator error or mechanical failure	F3	E0
LDUA/EREE 1-30	Worker exposure due to operator error/mechanical failure	Operator error or mechanical failure	F3	E0
LDUA/EREE 1-8	Worker exposure due to leak of waste into EREE	Compressor fails	F2	E0
LDUA/EREE 1-9	Worker exposure due to leak of waste into EREE	Line plug	F3	E0
NP-01	Radioactive and hazardous material release from tanks and ventilation system due to loss of electric power	Lightning strikes power distribution system	F3	E1
NP-06	Radioactive and hazardous material releases from tanks, nearby ground surfaces, and ventilation systems due to above ground disturbances	High wind	F3	E1
NP-09	Radioactive and hazardous material releases from tanks due to seismic event	Seismic event results in tank leaks or below grade tank ruptures	F1	E3
NP-10	Radioactive and hazardous material releases from tanks due to loss of power to ventilation systems	Ash fall from volcanic activity	F2	E1
NP-12	Radioactive and hazardous material releases from tanks due to ventilation system failures	Dust storms/dust devils	F3	E1
NP-14	Radioactive and hazardous material releases from tanks due to loss of power to ventilation systems	Severe hail	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
OGT-FLOW1-01	Personnel exposure to radioactive or hazardous material in the primary pipe due to pump failure	Pump failure, material settles in line (crystallization) and plugs line prohibiting transfer/waste is sitting in line and creates increased exposure to personnel	F3	E0
OGT-FLOW2-01A	Release of radioactive or hazardous material from the primary pipe due to leak caused by incorrect pump installed	Incorrect pump installed creates excessive flow and isolation valve closed on secondary pipe, erosion of EPDM and pressurization of secondary pipe causing leaks from flanges gasket within concrete shield	F2	E2
OGT-FLOW2-03A	Release of radioactive or hazardous material from the primary pipe due to leak caused by incorrect pump installed	Installation of incorrect pump, failure of inner pipe and isolation valves closed on secondary pipe drains causing leak from failed welds on flange within the concrete shield	F1	E2
OGT-INTEG3-01	Release of radioactive or hazardous material from overflow of pit due to leak caused by loss of primary pipe integrity from aging	Primary pipe failure due to radiation/chemical age related damage, leak of primary pipe, flow to pit from secondary pipe drains when pipe drains are in open position with pipe drains open and insufficient drainage from pit	F1	E1
OGT-OPS1-01	Release of radioactive or hazardous material from the primary pipe due to line crushing from equipment drop	Drop shield blocks on transfer line during disassembly after pumping complete, potential to break primary and secondary line	F3	E1
OGT-SPEC1-01	Personnel exposure to radioactive or hazardous material in the primary pipe due to loss of electrical supply	Loss of flow leading to line plug and the need to remove/replace, unclog line	F3	E0
OGT-TEMP1-01	Personnel exposure to radioactive or hazardous material from the primary pipe due leak caused by low ambient temperature	Plugging of pipe due to crystallization or due to freezing for very low temperature	F1	E0
PB-L01	Release of tank headspace and HEPA contamination	Release of radioactive and/or toxic materials from 241-AW tanks to the environment caused by HEPA dislodgement/unfiltered release	F2	E1
RAD-01	Exposure to radioactive and/or toxic materials from pits or risers due to radiation monitoring failure	Failure to monitor		

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RAD-01-I	Injury of worker from exposure to radioactive materials due to failure to monitor radiation	Failure to monitor	NA	E1
RAD-02	Exposure to radioactive and/or toxic materials from pits or risers due to radiation monitoring failure	Failure of monitoring instrument		
RAD-02-I	Injury of worker from exposure to radioactive materials due to radiation monitoring failure	Failure of monitoring instrument	NA	E1
RAD-03	Exposure to radioactive and/or toxic materials from pits or risers due to radiation monitoring failure	Improper calibration of monitoring instrument		
RAD-03-I	Injury of worker from exposure to radioactive materials due to radiation monitoring failure	Improper calibration of monitoring instrument	NA	E1
RCSTS-01-FLOW01	Release of radioactive slurry or supernate to the the soil surface from overflow of the 244-S catch station due to reverse flow	Reverse flow to 244-S catch station caused by improper valve lineup	F3	E1
RCSTS-03-FLOW01	Release of radioactive slurry or supernate to the SY flush pit from transfer line due to backflow	Reverse flow to flush pit caused by improper valving sequence	F3	E1
RCSTS-03-PRES01	Release of radioactive material to atmosphere from SY valve pit due to over-pressurization event in Tank 241-SY-102	Pressure event in Tank 241-SY-102 with loss of valve pit seal loop water	F3	E1
RCSTS-08-AIR01	Personnel exposure to radioactive vapors in the diversion box atmosphere from accumulated waste in diversion box due to pipe encasement draining	Draining of the encasement	F3	E0
RCSTS-08-AIR02	Exposure to chemical vapors and liquids in diversion box due to the spill or leak of chemicals in confined space	Chemicals brought in for decontamination and maintenance	F3	E0
RCSTS-08-AIR03	Personnel exposure to radioactive vapors in the diversion box atmosphere due to waste being present in box	Leak of waste solution	F3	E0
RCSTS-08-AIR04	Personnel exposure to chemical waste in diversion box from leak of waste solution	Leak of waste solution	F3	E0

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-08-OCC01	Worker injury due to welding gas bottle becoming a missile in diversion box	Damage from welding gas bottle during maintenance activity in diversion box	F3	E0
RCSTS-08-OCC02	Worker discomfort from cold temperatures in diversion box	Running an exhauster during cold weather	F3	E0
RCSTS-08-RAD01	Personnel exposure to radioactive material in the diversion box from transfer piping due to encasement draining	Draining of the encasement	F3	E0
RCSTS-08-RAD03	High radiation dose to worker from the diversion box due to the presence of residual radioactive contamination	Holdup of radionuclides due to trapped radioactive material in pumps or pipes	F3	E0
RCSTS-09-AIR01	Personnel exposure to radioactive vapors in the vent station atmosphere from accumulated waste in vent station due to pipe encasement draining	Draining of the encasement	F3	E0
RCSTS-09-AIR02	Personnel exposure to radioactive vapors in the vent station atmosphere due to waste being present in station	Leak of waste solution	F3	E0
RCSTS-09-AIR03	Exposure to chemical vapors and liquids in vent station due to the spill or leak of chemicals	Chemicals brought in for decontamination and maintenance	F3	E0
RCSTS-09-AIR04	Personnel exposure to chemical waste in diversion box from leak of waste solution	Leak of waste solution	F3	E0
RCSTS-09-OCC01	Worker injury due to welding gas bottle becoming a missile in vent station	Damage from welding gas bottle during maintenance activity in vent station	F3	E0
RCSTS-09-OCC02	Worker discomfort from cold temperatures in vent station	Running an exhauster during cold weather	F3	E0
RCSTS-09-RAD01	Personnel exposure to radioactive material in the vent station from transfer piping due to encasement draining	Draining of the encasement	F3	E0
RCSTS-09-RAD03	High radiation dose to worker from the vent station due to the presence of residual radioactive contamination	Holdup of radionuclides due to trapped radioactive material in pipes	F3	E0
RCSTSFS-LEVEL01	Personnel exposure to caustic solution in the sump pit from the water flush tank due to over filling of tank	Operator error - overfill of caustic material	F3	E0

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTSFS-LEVEL02	Personnel exposure to caustic solution and radionuclides in the sump pit from the water flush tank due to over filling of tank	Flush tank receives radioactive waste from transfer line during drainback process. Jumper block valves and raw water block valves opened during the drainback of waste from vent station of the cross site transfer line.	F3	E0
RCSTSFS-LEVEL04	Personnel exposure to caustic solution in the sump pit from the water flush tank due to human error	Human error - drain valve left open	F3	E0
RCSTS-4FS-FLOW02	Personnel exposure to caustic material in the caustic storage area from caustic drum due to handling error	Materials handling accident	F3	E0
RCSTS-5FS-FLOW03	Personnel exposure to radioactive material in water flush tank due to loss of flush system pump operation	Loss of pump pressure during flush operation causing back flow of waste	F3	E0
RCSTS-GENERAL-PRES	Release of radioactive material to the soil surface from supernate or slurry piping due to encasement breach (pipe is considered empty except for residual contamination)	Pneumatic leak testing	F3	E1
RSR-01	Release of radioactive and/or toxic material upon opening of riser due to human error	Human error - improper contamination control, failure to monitor (rad or sniff), improper monitoring	F3	E1
RSR-01-I	Release of radioactive and/or toxic material from the vapor space due to opening of riser	Human error - improper contamination control, failure to monitor (rad or sniff), improper monitoring	F3	E1
RSR-02	Asbestos hazard from gasket materials during access to riser	Failure to follow asbestos procedures		
RSR-02-I	Injury of worker from exposure to asbestos from gasket materials during access to riser due to failure to follow procedures	Failure to follow asbestos procedures	NA	E1
RSR-03	Asbestos hazard from gasket materials during access to riser	Failure of mask or fresh air (if appropriate)		
RSR-03-I	Injury of worker from exposure to asbestos from gasket materials during access to riser due to failure of PPE or fresh air supply	Failure of mask or fresh air (if appropriate)	NA	E1
RSR-04	Direct radiation exposure from open riser due to human error	Failure to follow procedures, failure to monitor or improper monitoring		

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RSR-04-I	Injury of worker from exposure to direct radiation exposure from open riser due to failure to follow procedures	Failure to follow procedures, failure to monitor or improper monitoring	NA	E1
RSR-05-IA	Facility confinement breach from dropped equipment (tools, mirrors) into facility	Failure to attach lanyard or other position limiting device Failure of lanyard or device	F2	E1
RSR-05-IB	Facility confinement breach from dropped equipment (tools, mirrors) into facility	Failure to attach lanyard or other position limiting device Failure of lanyard or device	F2	E2
RSR-08-I	Injury of worker from falling into facility due to large access opening and human error	Human error	NA	E1
SFF-01	Release of radioactive and/or toxic materials during sniff sampling due to human error or instrument failure	Improper sniffing technique or instrument failure, failure to perform radiation monitoring, improper monitoring, or instrument failure	F3	E1
SFF-01-I	Injury of worker from exposure to toxic materials due to sniff sampling failure	Improper sniffing technique or instrument failure	NA	E1
VEH-04	Personnel receive radiation exposure from casks during transport due to human error	Personnel drive the vehicles or work near the cask transport vehicle		
VEH-04-I	Injury of worker from radiation exposure from casks during transport due to inappropriate ALARA practices	Driver receives unexpected exposure or personnel work near the cask transport vehicle	NA	E1
VEH-05	Vehicle impact with electrical power pole	Loss of control of vehicle or lack of attention to driving		
VEH-05-I	Injury of worker from impact with electrical power pole due to vehicle accident	Loss of control of vehicle or lack of attention to driving	NA	E1
VEH-06	Personnel are pinched or crushed between vehicle and solid structure	Vehicle moves exerting pressure on personnel between vehicle and solid structure		
VEH-06-I	Injury of worker from being pinched or crushed between vehicle and solid structure due to inattention to situation	Vehicle exerts pressure on personnel located between the vehicle and solid structure	NA	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
VSU-01	Release of residual contamination and/or hazardous material from VSU due to VSU lid being left off	VSU lid is left off due to human error, wind blows	F3	E1
VSU-02	Release of residual contamination and/or hazardous material from VSU due to VSU lid being left off	VSU lid is left off due to human error, rain/snow melt seeps out bottom of VSU	F3	E1
VSU-03	Release of residual contamination and/or hazardous material from VSU due to VSU wall degradation	VSU wall degradation over time	F3	E1
VSU-04	Release of residual contamination and/or hazardous material from VSU due to internal VSU pressurization	Covered VSU pressurizes due to ambient temperature heat-up	F3	E1
VSU-05	Tripping hazard	Exposure above ground level		
VSU-06	Falling hazard	VSU without a lid and not capped		
W030-01	Release of radioactive/hazardous process vapor from ventilation system to the atmosphere due to seismic event	Ducting failure, drain line failure, seal pot failure, etc. caused by seismic event	F2	E1
W030-02	Release of radioactive/hazardous process condensate from ventilation system to the soil due to seismic event	Ducting failure, drain line failure, seal pot failure, etc. caused by seismic event	F2	E1
W030-03	Release of radioactive/hazardous process vapor from ventilation system to the atmosphere due to tornado/high winds	Ducting failure, drain line failure, seal pot failure, etc. caused by tornado/high winds	F2	E1
W030-04	Release of radioactive/hazardous process condensate from ventilation system to the soil due to tornado/high winds	Ducting failure, drain line failure, seal pot failure, etc. caused by tornado/high winds	F2	E1
W030-05	Release of unfiltered radioactive/hazardous process vapor from ventilation system to the atmosphere due to damage from externally generated missiles	Ducting failure, drain line failure, seal pot failure, etc. due to externally generated missiles caused by compressed gas failure resulting in unfiltered release	F2	E1
W030-06	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to damage from externally generated missiles	Ducting failure, drain line failure, seal pot failure, etc. due to externally generated missiles caused by compressed gas failure resulting in pool leak	F2	E1
W030-07	Release of unfiltered radioactive/hazardous process vapor from ventilation system to the atmosphere due to corrosion	Ducting failure, drain line failure, seal pot failure, etc. due to corrosion resulting in unfiltered release	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-08	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to corrosion	Ducting failure, drain line failure, seal pot failure, etc. due to corrosion resulting in pool leak	F3	E1
W030-09	Release of unfiltered radioactive/hazardous process vapor from ventilation system to the atmosphere due to fatigue failure	Ducting failure, drain line failure, seal pot failure, etc. due to component fatigue resulting in unfiltered release	F3	E1
W030-10	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to fatigue failure	Ducting failure, drain line failure, seal pot failure, etc. due to component fatigue resulting in pool leak	F3	E1
W030-11	Release of unfiltered radioactive/hazardous process vapor from ventilation system to the atmosphere due to damage from internally generated missiles	Ducting failure, drain line failure, seal pot failure, etc. due to internally generated missiles caused by fan blade failure resulting in unfiltered release	F3	E1
W030-12	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to damage from internally generated missiles	Ducting failure, drain line failure, seal pot failure, etc. due to internally generated missiles caused by fan blade failure resulting in pool leak	F3	E1
W030-13	Release of radioactive/hazardous process vapor from ventilation system to the atmosphere due to damage from overburden	Ducting failure, drain line failure, seal pot failure, etc. due to external overburden	F3	E1
W030-14	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to damage from overburden	Ducting failure, drain line failure, seal pot failure, etc. due to external overburden	F3	E1
W030-15	Release of radioactive/hazardous process vapor from ventilation system to the atmosphere due to damage from external dropped equipment	Ducting failure, drain line failure, seal pot failure, etc. due to external dropped equipment	F3	E1
W030-16	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to damage from external dropped equipment	Ducting failure, drain line failure, seal pot failure, etc. due to external dropped equipment	F3	E1
W030-17	Release of radioactive/hazardous process vapor from ventilation system to the atmosphere due to excavation	Ducting failure, drain line failure, seal pot failure, etc. due to excavation operations	F3	E1
W030-18	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to excavation	Ducting failure, drain line failure, seal pot failure, etc. due to excavation operations	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-19	Release of unfiltered radioactive/hazardous process vapor from ventilation system to the atmosphere due to ground creep	Ducting failure, drain line failure, seal pot failure, etc. due to ground creep movement resulting in unfiltered release	F3	E1
W030-20	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to ground creep	Ducting failure, drain line failure, seal pot failure, etc. due to ground creep movement resulting in pool leak	F3	E1
W030-21	Release of radioactive/hazardous process vapor from ventilation system to the atmosphere due to vehicular collision	Ducting failure, drain line failure, seal pot failure, etc. due to vehicular collision with above grade ventilation system components	F3	E1
W030-22	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to vehicular collision	Ducting failure, drain line failure, seal pot failure, etc. due to vehicular collision with above grade ventilation system components	F3	E1
W030-23	Release of unfiltered radioactive/hazardous process vapor from ventilation system to the atmosphere due to temperature extremes	Ducting failure, drain line failure, seal pot failure, etc. due to freezing and thawing of ventilation system components that contain liquid resulting in unfiltered release	F3	E1
W030-24	Release of radioactive/hazardous process condensate from ventilation system to the soil surface due to temperature extremes	Ducting failure, drain line failure, seal pot failure, etc. due to freezing and thawing of ventilation system components that contain liquid resulting in pool leak	F3	E1
W030-38A	Release of radioactive material in process stream from ventilation cooling system to the soil surface due to corrosion	Corrosion of shell or tubes in the chiller or condenser in the exhaust ventilation system causes pool leak	F1	E1
W030-38B	Release of hazardous material in process stream from ventilation cooling system to the soil surface due to corrosion	Corrosion of shell or tubes in the chiller or condenser in the exhaust ventilation system causes pool leak	F1	E1
W030-39	Release of radioactive/hazardous material from tank headspace to the atmosphere due to HEPA filter failure	Filter AZ-K1-4-1A failure due to excessive HEPA filter loading, excessive system moisture carryover, high tank pressure, etc.	F1	E1
W030-40A	Release of radioactive/hazardous material from tank headspace to the atmosphere due to damaged HEPA filter	HEPA filter failure caused by external fire in the vicinity of the HEPA filters	F1	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-40B	Release of radioactive/hazardous material from tank headspace to the atmosphere due to damaged HEPA filter	HEPA filter failure from fire in the ventilation system caused by flammable gas buildup and ignition	F1	E1
W030-40C	Release of radioactive/hazardous material from tank headspace to the atmosphere due to damaged HEPA filter	HEPA filter failure caused by fire from electrical failure of the heaters in the common exhaust system, etc.	F1	E1
W030-40D	Release of radioactive/hazardous material from tank headspace to the atmosphere due to damaged HEPA filter	Damage to HEPA filters from an external event, dropping of a heavy load, etc.	F1	E1
W030-41A	Release of radioactive/hazardous material from tank headspace to the atmosphere due to HEPA filter failure	Failure of HEPA AZ-K1-4-2A due to seal failure, defective parts, deterioration, etc.	F1	E1
W030-41B	Release of radioactive/hazardous material from tank headspace to the atmosphere due to HEPA filter failure	Failure of HEPA AZ-K1-4-1A due to seal failure, defective parts, deterioration, etc.	F3	E1
W030-41C	Release of radioactive/hazardous material from tank headspace to the atmosphere due to HEPA filter failure	Failure of HEPA AZ-K1-4-2B due to seal failure, defective parts, deterioration, etc.	F1	E1
W030-41D	Release of radioactive/hazardous material from tank headspace to the atmosphere due to HEPA filter failure	Failure of HEPA AZ-K1-4-1B due to seal failure,. defective parts, deterioration, etc.	F3	E1
W030-42	Release of accumulated radiological material from ventilation system HEPA filters to atmosphere exposing facility worker	Occupational radiation exposure caused by mishandling contaminated HEPA filter during replacement or repair	F3	E0
W030-X01A	Release of radioactive/hazardous material from tank head space to atmosphere due to seismic event	Seismic event damages Stack 296-A-42 (55 foot stack is leveled)	F1	E1
W030-X01B	Release of radioactive/hazardous material from tank head space to atmosphere due to vehicle impact	Vehicle impact damages Stack 296-A-42 (55 foot stack is severely damaged)	F1	E1
W030-X03	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Ventilation ducting isolation valve MK-AZK105-1A2 fails closed and prevents flow, pressurizing tank causing unfiltered release through tank connections	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-X04	Release of radioactive/hazardous material from tank head space to atmosphere due to HEPA damage	Fan AZ-K1-5-1A fails to run or has overspeed damaging HEPA filter	F3	E1
W030-X05	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK1-1A1 fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X06	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK1-2A fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X10	Release of radioactive/hazardous material from tank head space to atmosphere due to HEPA damage	Heater AZ-K1-2-1 fails to remove moisture from ventilation system causing HEPA damage	F3	E1
W030-X11	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve fails MK-AZK1-1A closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X12	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK105-1B2 fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X13	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Fan AZ-K1-5-1B fails to run or has overspeed (low flow or high flow) causing unfiltered release	F3	E1
W030-X14	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK1-1B1 fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X15	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK1-2B in ducting fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X19	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Heater AZ-K1-2-1B fails off not removing the moisture from the ventilation system resulting in HEPA damage and unfiltered release	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-X20	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK1-1B in ducting fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X22	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK109-1A in ducting fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X23	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK108-1B in ducting fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X24	Release of radioactive/hazardous material from tank head space to atmosphere due to HEPA damage	Condenser AZ-K1-8-1 fails to remove moisture causing HEPA filter damage	F3	E1
W030-X25	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK109-1C in ducting fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X26	Release of radioactive/hazardous material from tank head space to atmosphere due to unfiltered release	Isolation valve MK-AZK108-1C in ducting fails closed preventing flow, pressurizing tank causing unfiltered release through tank connections	F3	E1
W030-X35	Personnel injury due to fire	Fire in switch gear room caused by electrical short or overloading	F2	E0
W030-X36	Personnel injury due to electrical shock	High energy (electrical conductors) in switch gear room	F3	E0
W030-X37	Personnel injury and equipment damage due to diesel fire	Spill of diesel fuel and subsequent ignition	F2	E0
W030-X75	Release of radiological material from tank to atmosphere due to unfiltered release	Malfunction of chiller resulting in moisture freezing in condenser blocking flow causing overpressurization event in tank and unfiltered release	F3	E1
W151-02	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to high winds	F1	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-04	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank ventilation ducting to atmosphere due to unfiltered release	F2	E1
W151-06	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank ventilation ducting to atmosphere due to unfiltered release	F2	E1
W151-11	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release	F1	E1
W151-15	Leak to annulus	Release of radioactive/hazardous material from primary tank to annulus due to mixer pump missiles	F1	E0
W151-16	Leak to annulus	Release of radioactive/hazardous material from primary tank to annulus due to erosion	F1	E0
W151-18	Leak of waste to pit	Personnel exposure to radioactive/hazardous material due to leak of waste into pit	F2	E0
W151-20	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to HEPA filter failure	F3	E1
W151-23	Increased exposure to personnel	Personnel exposure to increased ionizing radiation due to mixer pump operation	F3	E0
W151-39	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to unfiltered release through tank connections	F3	E1
W151-43	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to unfiltered release through tank connections	F3	E1
W151-47	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to unfiltered release through tank connections	F1	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-51	Release of radioactive/hazardous material in tank headspace and contamination in ductwork	Release of radioactive/hazardous material from ventilation ductwork to atmosphere due to excavation	F3	E1
W151-53		Personnel injury due to high pressure leak	F3	E0
W151-54	Contamination on equipment	Personnel exposure to radioactive/hazardous material due to the spill of radioactive material during equipment removal operations	F3	E0
W151-55	Release through open riser	Personnel exposure to radioactive/hazardous aerosols from open riser due to air flow reversal	F3	E0
W320-ABCD-CHILL01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to exceedance of loop seal vacuum	Excessive cooling from process chiller causing vacuum in tank from ventilation system which results in exceedance of inlet filter loop seal vacuum and unfiltered release	F2	E2
W320-ABCD-TRANS14a	Personnel exposure to ionizing radiation due to flooding	Raw water line rupture uncovers transfer lines	F2	E0
W320-ABCD-TRANS14b	Personnel exposure to ionizing radiation due to flooding	Natural flooding uncovers transfer lines	F2	E0
W320-ABCD-TRANS15	Personnel exposure to ionizing radiation due to high winds	High winds uncover transfer lines	F0	E0
W320-ABCD-TRANS16	Personnel exposure to ionizing radiation due to excavation	Mistake in excavation uncovers transfer lines	F1	E0
W320-ABCD-VENT01	Release of toxic gas to the atmosphere from Tank 241-AY-102 due to failure of ventilation system	Loss of ventilation causes gradual rise in waste temperature resulting in toxic gas release from tank and to workers	F1	E0
W320-ALL-VENT01	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to ammonium nitrate fire/deflagration	Buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc causing a breach in the ducting (assumes ventilation system failure)	F1	E2

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-ALL07	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Flammable gas collects in pit where it is ignited causing the displacement and fall of the cover block which strikes a riser-liner joint resulting in an unfiltered release from dome space	F3	E2
W320-B-ALL14	Release of radioactive aerosols from pit to the atmosphere due to high winds	High winds/dust devil during plug removal from pit cover	F3	E2
W320-B-TERM01	Release of toxic ammonia gas from tank to atmosphere due to burp which exposes facility personnel to toxic gases	Inadequate prediction of waste behavior	F2	E0
W320-B-TRANS13	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Flammable gas collects/ignites in tank pit resulting in the cover blocks being displaced, falling into pit, striking riser-liner joint causing an unfiltered release from dome space	F2	E2
W320-BCD-FLUSH03*	Personnel exposure to ionizing radiation from flush tank of transfer truck due to flush tank filling with radioactive material	Start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line, flush tank fills with radioactive material	F3	E0
W320-D-TRANS03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to tank dome breach from impact	During high velocity sluicing operations sluicer moves debris in waste impacting drop leg in tank which breaches dome causing unfiltered release (assumes ventilation system failure)	F2	E2
W320-D-TRANS04	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to increased head space pressure	High temperature in Tank 241-AY-102 causes high temperature sluice water resulting in increased head space pressure with increased errant flow (assumes ventilation system failure)	F2	E2
W320-D-VENT07	Release of radioactive aerosols from Tank 241-C-105/C-106 ventilation system to atmosphere due to ventilation system leak	Ducting corrosion or seal deterioration undetermined during sluicing (assumes ventilation system failure)	F2	E2
W320-D-VENT08	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum in tank from new ventilation system resulting in loop seal failure and unfiltered release	F3	E2

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT10	Personnel exposure to toxic gas from Tank 241-AY-102 due to inadequate ventilation from W030	Inadequate ventilation from W030 resulting in high waste temperature, increased toxic gas release and facility worker inhalation of toxic gases	F1	E0
W320-D-VENT11	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum from current ventilation system resulting in loop seal failure and unfiltered release	F3	E2
W320-E-TERM02	Release of toxic hydrogen cyanide gas from Tank 241-AY-102 due to burp	Inadequate prediction of waste behavior	F1	E0
XS-01-FLOW04	Release of liquid radioactive waste due to overflow from 244 TX DCRT to annulus	Human error (leaving water on after extended flush) causes overflow to annulus	F2	E1
XS-01-PRES02	Release of liquid radioactive waste from transfer pipe due to damaged saltwell pump	Leak from pump or seal from various causes	F3	E2
XS-01-TEMP02	Release of steam-aerosol from transfer piping in pump pit due to steam hammer and resulting pipe damage	Extended recirculation and consequential heating of saltwell liquid with sudden opening of valve when cover block is in place	F3	E1
XS-02-FLOW01	Release of headspace aerosols from 244 TX DCRT into PFP due to jumper misalignment	Jumper misalignment allowing PFP steam jet or ventilation system to pull vapors DCRT	F2	E1
XS-02-FLOW06	Release of liquid radioactive waste from DCRT due to overflowing of PFP sending tank (in facility)	Reverse flow caused by jumper misalignment	F3	E1
XS-03-LEVE	Release of radioactive liquids from DCRT "annulus" (vault) due to DCRT leak	Corrosion or structural failure of DCRT or associated piping	F3	E2
XS-03-PRES01	Release of toxic vapors from DCRT due to increased concentrations in DCRT atmosphere	Tank isolated from forced ventilation with gas evolution	F3	E1
XS-03-PRES01A	Release of radioactive aerosols from DCRT headspace due to positive pressure	Loss of ventilation flow due to failure of ventilation fans causes positive pressure in tank	F3	E1
XS-03-PRES02	Release of radioactive aerosols from DCRT headspace due to positive pressure	Dampers inadvertently closed causing positive pressure in tank	F3	E1

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-03-PRES03	Release of radioactive aerosols from DCRT headspace due to positive pressure in DCRT	Ductwork damage due to external event causes positive pressure in DCRT	F3	E1
XS-03-PRES04	Release of radioactive aerosols from DCRT headspace due to positive pressure	Loss of power causes positive pressure in tank	F3	E1
XS-03-TEMP04	Release of radioactive aerosols from 244 TX DCRT due to fire	Burning of flammable gas in DCRT	F1	E1
XS-03-TEMP05	Release of radioactive aerosols from DCRT headspace due to positive pressure	Excessive agitation-pumping causes positive pressure and generates aerosols	F3	E1
XS-03-TEMP06	Release of toxic vapors from DCRT headspace due to positive pressure in DCRT	Excessive agitation-pumping causes positive pressure	F3	E1
XS-03-TEMP07	Release of radioactive aerosols from DCRT headspace due to positive pressure	Loss of ventilation flow due to HEPA filter blockage in cold weather causes positive pressure in tank	F3	E1
XS-03-TEMP08	Release of radioactive aerosols from DCRT headspace due to positive pressure	Loss of ventilation flow plus high heat waste causes positive pressure in tank	F3	E1
XS-06-FLOW06	Release of radioactive aerosols from DCRT annulus due to a spill of radioactive liquid	Overfilling DCRT due to a misrouting causes spill into DCRT annulus	F3	E1
XS-12-FLOW01	Release of toxic gas from diversion box due to accumulation of toxic vapors from catch tank	Chemical reaction of catch tank material with backflow of vapors via diversion box drain line	F3	E1
XS-12-FLOW04	Release of toxic gas from diversion box due to accumulation of toxic vapors from catch tank	Radiolysis of catch tank material with backflow of vapors via diversion box drain line	F3	E1
XS-12-FLOW06	Release of radioactive waste to the soil from diversion box drain due to a spill of radioactive liquid into 241-U-152 diversion box	Leak of diversion box drain line upstream of catch tank	F3	E2
XS-20-FLOW02	Release of radioactive aerosols from T-Plant tank due to chemical reaction	Transfer of incompatible waste to T-Plant due to improper valve lineup	F2	E2
XS-20-FLOW06	Release of radioactive aerosols from T-Plant tank due to positive pressure	Chemical reaction of 244-S material with contents of T-Plant tank due to misrouting causes positive pressure in tank	F2	E2

Table D-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (54 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-20-FLOW07	Release of toxic vapors from T-Plant due to chemical reaction with incompatible material in 244 S DCRT	Mixing contents of 244-S with contents of T-Plant tank due to misrouting causes chemical reaction	F2	E2
XS-26-PRES01A 102AW-02-PRES	Release of radioactive aerosols from Tank 241-SY-102 due to positive pressure	Blockage of exhaust path causes pressure in tank	F3	E1
XS-26-PRES02A 102AW-02-PRES	Release of radioactive aerosols from Tank 241-SY-102 due to positive pressure	Failure of ventilation fans causes pressure in tank	F3	E1
XS-26-PRES03	Release of radioactive aerosols from Tank 241-SY-102 due to positive pressure	Use of hot water to decontaminate equipment in tank atmosphere - generate aerosols and pressurizes the tank	F3	E1
XS-26-PRES03 102AW-02-PRES	Release of radioactive aerosols from Tank 241-SY-102 due to positive pressure	Loss of power to ventilation system causes positive pressure in tank	F3	E1
XS-26-TEMP 102AW-08-TEMP	Release of radioactive aerosols from Tank 241-SY-102 annulus due to leak of tank contents to annulus	Exceeding design temperature of tank due to high heat waste and loss of primary ventilation system	F1	E1
XS-26-TEMP02	Release of radioactive aerosols from Tank 241-SY-102 annulus due to leak of tank contents to annulus	Exceeding design temperature of tank due to failure of annulus ventilation	F1	E1
XS-41B-LEVE02	Release of toxic gas from vent station access pit via valve operator seals due to liquid accumulation in vent station nozzle pit	Overflow of vent station catch tank into nozzle pit causes tank gas accumulation	F3	E1
XS-41B-LEVE04	Release of radioactive liquid from vent station access pit via valve operator seals due to liquid accumulation in vent station nozzle pit	Overflow of vent station catch tank into nozzle pit	F3	E1
XS-41C-LEVE02	Release of radioactive aerosols from catch tank pit due to presence of liquid from collapse of catch tank	Intrusion plus plugged drain creating external load on catch tank	F1	E1
XS-41C-LEVE03	Release of toxic gas from vent station catch tank pit due to presence of liquid waste in pit	Backflow from cross-site piping encasement leak causes tank gas accumulation	F3	E1

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-01-FLOW 102AW-02-PRES	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by chemical reaction of incompatible wastes	Misrouting to destination other than intended creates chemical incompatibility	F0	E3
102AW-01-FLOW 102AW-04-PRES	Release of radioactive aerosol from transfer pipe which runs from DCRT to Tank 241-AW-102 due to spray leak into open underground structure	Piping leak due to thermal stress of transferring hot solution in cold pipe	F3	E2
102AW-01-FLOW01	Release of liquid radioactive waste aerosols from transfer pipe to Tank 241-AW-102 due to spray leak into open underground structure	Piping leak due to corrosion caused by transferring high temperature waste	F2	E2
102AW-01-FLOW02	Release of radioactive waste to soil from transfer piping which runs to Tank 241-AW-102 due to leak from primary pipe and encasement	Excavation accident fails primary pipe and encasement	F3	E2
102AW-01-FLOW03	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Corrosion of inner and outer pipe cause failure of primary pipe and encasement	F3	E2
102AW-01-FLOW04	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	High structural loading from traffic or cranes fails primary pipe and encasement	F3	E2
102AW-01-FLOW05	Release of radioactive waste to soil from transfer piping to Tank 241-AW-102 due to leak from primary pipe and encasement	Seismic event fails primary pipe and encasement	F2	E2
102AW-01-FLOW06	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Undermining due to leak of nearby pipes cause failure of primary pipe and encasement	F3	E2
102AW-01-FLOW07	Release of radioactive waste to soil from transfer pipe to Tank 241-AW-102 due to leak of radioactive waste from primary pipe and encasement	Water hammer cause failure of primary pipe and encasement	F3	E2
102AW-01-FLOW10	Release of liquid radioactive waste from Tank 241-AW-102 due to overflow	Misrouting of waste from reverse flow caused by the combination of an incorrectly wired pump and a full transfer pipe	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-01-FLOW11	Release of liquid radioactive waste to the ground surface from Tank 241-AW-102 due to overflow of Tank 241-AW-102 or underground structure	Misrouting to destination other than intended causes overflow	F3	E2
102AW-01-TEMP	Release of liquid radioactive waste aerosols from transfer pipe to Tank 241-AW-102 due to spray leak of liquid waste from transfer pipe leak	Piping leak due to exceeding the design temperature of the pipe by transferring high temperature waste	F1	E3
102AW-01-TEMP01	Release of liquid radioactive waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to corrosion caused by transferring high temperature waste	F2	E2
102AW-01-TEMP01A	Release of liquid waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to thermal stress of transferring hot solution in cold pipe	F2	E2
102AW-01-TEMP02	Release of liquid radioactive waste from transfer pipe to Tank 241-AW-102 due to leaks overflowing from underground structure	Piping leak due to exceeding the design temperature of the pipe by transferring high temperature waste	F2	E2
102AW-02-LEVE02	Release of liquid radioactive waste from Tank 241-AW-102 due to leak of primary and secondary tank	Structural failure of primary tank when annulus leaks	F1	E3
102AW-02-LEVE03	Release of radioactive liquid from Tank 241-AW-102 due to overfilling	Failure to stop transfer causes overfilling of tank	F3	E2
102AW-02-LEVE04	Release of radioactive liquid from Tank 241-AW-102 due to overfilling	Misrouting causes overfilling of tank	F3	E2
102AW-02-LEVE05	Release of radioactive liquid from Tank 241-AW-102 to the soil column due to gross overfilling of tank (Pool)	Misrouting causes overfilling of tank	F3	E2
102AW-02-LEVE06	Release of radioactive liquid to soil column from Tank 241-AW-102 annulus due to leakage	Primary tank leakage from various causes combined with annulus leakage	F1	E3
102AW-02-PRES 102AW-02-TEMP	Release of radioactive aerosols from Tank 241-AW-102 due to pressurization	Evaporator dump when intrusive activity is occurring which causes pressurization	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-02-PRES01	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in waste tank (Dome Collapse)	Flammable concentration of gases in tank vapor space with spark source	F2	E2
102AW-02-PRES02	Release of toxic gases from Tank 241-AW-102 due to chemical reaction in waste	Transfer of incompatible waste to Tank 241-AW-102 causes tank gas accumulation	F3	E2
102AW-02-PRES03	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Blocked ventilation inlet causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES04	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Condensation of vapors causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES05	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Sub-cooling of vapor during equipment flushing causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES06	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Ventilation imbalance causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-PRES07	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive vacuum	Wrong size portable ventilator chosen for support work causes excessive vacuum leading to dome collapse	F0	E3
102AW-02-TEMP01	Release of radioactive aerosols from Tank 241-AW-102 due to boiling waste	High heat waste causing boiling	F2	E2
102AW-02-TEMP02	Release of radioactive aerosols from Tank 241-AW-102 due to tank bump	High heat waste combined with loss of ventilation contributes to tank bump	F2	E2
102AW-03-LEVE01	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus	Flammable concentration of gases in annulus vapor space due to waste leak into annulus and spark source	F2	E2
102AW-03-LEVE02	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus	Flammable concentration of gases in annulus vapor space due to waste mis-transfer into annulus and spark source	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-03-LEVE03	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by floating the primary tank within the annulus	Misrouting of liquid waste to the annulus causes floating of primary tank and subsequent dome collapse	F1	E3
102AW-03-TEMP01	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by an fire/explosion in the annulus	Fire/ Explosion of flammable liquid spilled into annulus via a riser	F2	E3
102AW-03-TEMP02	Release of radioactive aerosols from Tank 241-AW-102 due to fire/explosion in annulus damaging primary tank	Flammable concentration of gases in annulus vapor space due to spill of fuel into annulus and spark source	F2	E2
102AW-04-STRU01A	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive dome loading	Equipment drop during crane work causes excessive dome loading	F3	E3
102AW-04-STRU02	Release of liquids, solids and/or vapors from Tank 241-AW-102 due to dome collapse caused by excessive dome loading	Violation of limits on dome loading	F3	E3
102AW-04-STRU04	Release of liquid radioactive waste from Tank 241-AW-102 central pump pit due to leak to soil	Piping leak and leak from pump pit due to equipment drop	F2	E2
102AW-04-STRU05	Release of liquid radioactive waste from Tank 241-AW-102 central pump pit due to leak to soil	Piping leak and leak from pump pit due to seismic event	F1	E2
102AW-08-COMP02	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Misrouting of waste creates critical mass	F1	E2
102AW-08-COMP02A	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Human error - addition of excess fissile material to Tank 241-AW-102 creates critical mass	F1	E2
102AW-08-COMP03	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Non-uniform distribution of fissile material (horizontally) creates critical mass	F1	E2
102AW-08-COMP04	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Non-uniform distribution of fissile material (vertically) due to addition of "rich" layer	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102AW-08-COMP05	Release of fission product gases and aerosols from Tank 241-AW-102 due to criticality	Over concentration of waste creates critical mass	F0	E2
102AW-09-COMP01	Release of combustion product aerosols from Tank 241-AW-102 due to fire in separable organic layer in waste tank causing dome collapse	Organic reaching flash point or being aerosolized plus ignition source	F2	E3
102AW-09-COMP02	Release of radioactive waste aerosols from Tank 241-AW-102 due to fire in fuel spilled in waste tank causing dome collapse	Spill of fuel from external source plus fuel reaching flash point or being aerosolized plus ignition source	F2	E3
102AW-09-TEMP01	Release of radioactive aerosols from Tank 241-AW-102 atmosphere due to tank bump	High heat waste plus loss of cooling and/or mixing pump (not yet installed) operation	F2	E2
102AW-13-FLOW01	Release of radioactive waste aerosols due to spray leak of waste from flush pit	Backflow of waste to flush pit with valve or pipe leak and cover block off	F1	E3
102S-01.a1	Radioactive/hazardous liquid released to soil surface from tank diversion box/access pit to the ground surface due to misrouting a transfer.	Human error (jumper/blank installation) + Mistransfer to Tank 241-S-102 (450-600 Kgal) overfills tank	F2	E2
102S-01.b2	Radioactive liquid released to soil surface from Tank 241-S-102 pump pit due to leak in jumpers connecting tank transfer lines SL-140, SN-242 during saltwell pumping.	Jumper failure + Drain plugged	F2	E2
102S-01.b3	Radioactive liquid released to the soil subsurface from leaks in transfer lines SL-140, SN-242. (Plume)	Line leak during saltwell pumping (corrosion)	F3	E2
102S-02.b2	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to flammable gas from tank igniting in pump pit and burning paint off pump pit	H2 /Ammonia production migrates into pump pit + Spark (pumps not operating)	F2	E2
102S-03.b3	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into waste tank due to ignition of fuel from ruptured gas tank.	Vehicle drives into open riser puncturing gas tank + Ignition	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102S-03.b4	Release of radioactive aerosols to atmosphere from Tank 241-S-102 due to burning fuel flowing into waste tank causing dome collapse	Vehicle drives into open riser puncturing gas tank + Ignition + Flammable organic vapors in tank	F3	E3
102S-04.a1b	Release of radioactive contaminants in Tank 241-S-102 liquid waste to the soil due to crack in tank with water intrusion	Structural or other stresses	F3	E2
102S-04.a1bb	Release of radioactive contaminants in Tank 241-S-102 liquid waste to the soil due to crack in tank with water intrusion	Corrosion	F3	E2
102S-04.c	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to ignition of flammable gas in tank causing HEPA failure	Concentration of H2 or Ammonia (or other flammable gasses) above LFL + Ignition source	F1	E3
102S-04.d1	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to the atmosphere due to low pressure causing dome collapse	Misoperation of exhauster during saltwell pumping	F0	E3
102S-04.e1b	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to due to ignition of flammable gas in tank causing HEPA failure	Concentration of H2 or Ammonia (or other flammable gasses) above LFL + Ignition source	F2	E2
102S-04.e3	Release of radioactive aerosols contained in Tank 241-S-102 vapor space to atmosphere due to generation of excessive heat leading to dome collapse	Addition of incompatible waste/chemical (misroute)	F0	E3
102S-05.a1a	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Excess gravel overburden	F3	E3
102S-05.a1aa	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Large vehicle traffic over tank	F3	E3
102S-05.a2	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Seismic event (common mode failure)	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
102S-05.a3	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Past thermocycling of tank	F1	E3
102S-05.a3a	Release of radioactive aerosols from Tank 241-S-102 to atmosphere due to dome collapse	Long term aging	F1	E3
106C-01A	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Air inlet plugged due to icing/dust	F0	E3
106C-01B	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Inlet air valve closed	F0	E3
106C-01C	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage, and dome collapse due to tank low pressure	Exhauster damper positioned incorrectly	F0	E3
106C-01D	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Wrong sized portable exhauster	F0	E3
106C-01E	Release of radioactive and/or hazardous material from Tank 241-C-106, structural damage and dome collapse due to tank low pressure	Subcooling of tank vapor space due to water addition of flushing	F2	E3
106C-01F	Release of radioactive and/or hazardous material from Tank 241-C-106, blown out HEPA filters and/or discharge out cover blocks due to high tank pressure	Blockage of inlet, outlet and cascade lines	F2	E2
106C-01I	Release of radioactive and/or hazardous material from Tank 241-C-106 due to possible dome collapse caused by tank high pressure	Fire in waste tank	F2	E3
106C-01J	Release of radioactive and/or hazardous material from Tank 241-C-106 due to high pressure in tank and possible dome collapse	Fire/explosion in waste tank	F2	E3
106C-01Ma	Release of radioactive and/or hazardous material from Tank 241-C-106 due to flammable gas fire/explosion in tank caused by high temperature (dome collapse)	Chemical reaction in tank	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-01N	Release of radioactive and/or hazardous material from Tank 241-C-106 to atmosphere due to criticality	Criticality in waste tank from high temperature	F1	E2
106C-01Ra	Release of radioactive and/or hazardous material from Tank 241-C-106, due to high dT in tank from cold water addition resulting in thermal stress and cracks causing tank leaks	Water addition temperature cold	F2	E3
106C-01Sa	Release of radioactive and/or hazardous material from Tank 241-C-106, due to low tank level because of tank leak	Waste tank leak	F3	E3
106C-01X	Release of radioactive and/or hazardous material from Tank 241-C-106, dome structural damage and/or personnel injury due to overload of tank dome	Overweight vehicles over top of tank	F3	E3
106C-01Y	Release of radioactive and/or hazardous material from Tank 241-C-106, dome structural damage and/or personnel injury due to overload of tank dome	Flooding over top of tank	F2	E3
106C-02A	Release of radioactive and/or hazardous material from Tank 241-C-106 due to dome collapse caused by ignition of high flammable gas content in tank	High waste temperature	F2	E3
106C-02B	Release of radioactive and/or hazardous material from Tank 241-C-106 due to ignition of high flammable gas content in tank and possible dome collapse	Ventilation system failure	F2	E3
106C-02C	Release of radioactive and/or hazardous material from Tank 241-C-106 due to dome collapse caused by ignition of high flammable gas content in tank	Tank burp, release of trapped gas	F2	E3
106C-04A	Release of radioactive and/or hazardous material from Tank 241-C-106 due to tank damage caused by flammable gas fire/explosion because of high flammable gas content in the tank (dome collapse)	High flammable gas content due to chemical reaction in sludge layer	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
106C-04B	Release of radioactive and/or hazardous material from Tank 241-C-106 due to fire/explosion caused by ignition of flammable gas released from radiolysis in tank sludge	Radiolysis in sludge layer allows release of trapped gas to vapor space	F2	E3
106C-10J	Release of radioactive and/or hazardous material from Tank 241-C-106 due to tank structural damage, HEPA damage caused by high temperature	Fire in or around ventilation system	F2	E3
106C-11E	Release of unfiltered tank atmosphere from Tank 241-C-106 due to damaged ductwork	Damage to ventilation ductwork upstream of filters	F3	E2
106C-12F	Release of radioactive and/or hazardous material from Tank 241-C-106 tank due to waste reaction in tank	Added chemicals to tank instead of normal water addition	F2	E2
106C-12G	Release of radioactive and/or hazardous material from Tank 241-C-106 due to high dT in tank because cold water addition caused thermal stress and cracks resulting in tank leaks	Tank truck water temperature cold	F3	E3
106C-13A	Release of radioactive and/or hazardous material from Tank 241-C-106 due to possible dome collapse, tank damage caused by high temperature	Fire in Tank 241-C-105 propagates into Tank 241-C-106	F2	E3
107AN-01-LEVE01	Release of caustic material from truck tank due to leak (aerosol spray)	Open valve on truck with pressurized tank transfer.	F3	E2
107AN-01-LEVE02	Release of caustic material from truck tank due to leak (aerosol spray)	Truck tank leak	F2	E2
107AN-01-LEVE03	Release of caustic material from truck tank due to leak	Failure to secure truck	F3	E2
107AN-01-TEMP02	Spray release of caustic material from truck tank due to high temperature	Fire in gas tank	F1	E2
107AN-02-FLOW01	Release of radioactive aerosols from Tank 241-AN-107 due to surface chemical reaction	Transfer of incompatible chemical to tank via chemical addition system due to vendor or paperwork error	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
107AN-02-FLOW02	Release of toxic vapors from Tank 241-AN-107 due to surface chemical reaction	Transfer of incompatible chemical to tank via chemical addition system due to vendor or paperwork error	F3	E2
107AN-02-FLOW03	Release of concentrated caustic solution to surface from transfer piping due to leak	Caustic solution transfer line leak	F2	E2
107AN-02-PRES	Release of caustic aerosol from caustic truck transfer piping due to spray leak	Piping/hose leak initiated by various causes	F3	E2
114SX-02.b	Radioactive liquid released from tank pump pit to the ground surface due to inadvertent pumping activity (pool)	Human error (not normal activity)	F1	E2
114SX-04.a.2	Radioactive aerosols released from failed tank dome due to vacuum produced by valving error.	Human error: Valve out flammable watch list (Tank 241-SX-109) butterfly valve	F0	E3
114SX-04.a.3	Release of radioactive aerosols from Tank 241-SX-114 to atmosphere due to high temperatures causing dome concrete strength loss	No ventilation flow High ambient temperature conditions Resulting in tank degradation	F1	E3
114SX-04.b.1.a.2	Release of radioactive material from Tank 241-SX-114 to atmosphere due to high temperature in the dome leading to dome collapse (long term closure of butterfly valve)	Human error: Closure of Tank 241-SX-114 exhaust butterfly valve isolating tank from exhaust plenum Resulting in tank degradation	F1	E3
114SX-04.b.1.a.3	Release of radioactive liquids to the soil from Tank 241-SX-114 due to tank bottom failure	Human error: Closure of Tank 241-SX-114 exhaust butterfly valve isolating tank from exhaust plenum Resulting in tank degradation	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
114SX-04.b.1.b.2a	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to heat induced tank dome collapse	Ducting failure due to bad welds	F1	E3
114SX-04.b.1.b.2b	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to heat induced tank dome collapse	Ducting failure due to seismic activity coupled with failure to respond Resulting in tank degradation	F1	E3
114SX-04.b.1.b.3a	Release of radioactive liquids to the soil from Tank 241-SX-114 due to tank bottom failure	Ducting failure due to bad welds reduces heat removal rate Resulting in tank degradation	F2	E2
114SX-04.b.1.b.3b	Release of radioactive liquids to the soil from Tank 241 SX-114 due to tank bottom failure (leak to soil)	Tank failure due to seismic activity Resulting in tank degradation	F1	E2
114SX-04.b.1.c.2	Release of radioactive aerosols to atmosphere from Tank 241-SX-114 waste due to dome collapse	Exhauster failure Fan failure Filter rupture (low differential pressure shutdown) Resulting in tank degradation	F0	E3
114SX-04.b.1.c.3	Release of radioactive liquids to the soil from Tank 241-SX-114 due to tank bottom failure (from high heat)	Exhauster failure Fan failure Filter rupture (low differential pressure shutdown) Resulting in tank degradation	F2	E2
114SX-04.b.1.d.2	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Filter plugging results in lack of heat removal with high temperatures degrading dome strength	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
114SX-04.b.1.d.3	Release of radioactive liquids to the soil from Tank 241-SX-114 due to tank bottom failure	Filter plugging results in lack of heat removal with high temperatures degrading dome strength	F2	E2
114SX-04.b.3b	Release of radioactive aerosols from head space of Tank 241-SX-114 to atmosphere through exhaust HEPA filter due to flammable gas ignition in the headspace (dome collapse)	Flammable gas fire/explosion in Tank 241-SX-114 {Note: Tank 241-SX-114 is NOT currently identified as a Flammable Gas Watch List Tank} Requires spark to be present	F1	E2
114SX-04.c.1	Release or radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to mechanical failure of exhauster HEPA filter	Plenum structure failure pierces filter	F2	E2
114SX-04.c.2.a	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter seal failure	HEPA filter seal failure	F3	E2
114SX-04.c.2.b	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster defective HEPA filter	Defective HEPA filter	F3	E2
114SX-04.c.2.c	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter deterioration	Deteriorated HEPA filter	F3	E2
114SX-04.c.2.d	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter installation errors	Improper installation (human error)	F2	E2
114SX-05.b.1	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to flammable gas ignition resulting in dome collapse	Radiolysis creating bubbles of gases in waste	F2	E3
114SX-05.b.2	Release of radioactive aerosols from Tank 241-SX-114 head space to atmosphere due to sudden flashing of water added to tank for cooling	Flashing (adding cold liquid to hot tank contents)	F0	E2
114SX-05.b.3	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse caused by sudden vacuum in tank	Quenching (adding cold liquid to hot tank contents) creating a vacuum	F0	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
114SX-05.c.2b	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Chemical reaction caused by addition of chemical/solution. Resulting in tank degradation	F1	E3
114SX-06.a.1a	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere due to dome collapse	Gravel overburden Large vehicle	F3	E3
114SX-06.a.1b	Release of radioactive aerosols from Tank 241-SX-114 waste to atmosphere as a result of a dome collapse	Deflagration of H2 (Implies gas generation with spark)	F1	E3
114SX-06.a.2	Release of radioactive liquids to the soil due to failure of Tank 241-SX-114 from corrosion	Corrosion and the addition of liquid	F3	E2
114SX-06.a.3	Release of radioactive aerosols from Tank 241-SX-114 waste to the atmosphere due to dome collapse caused by loss of strength due to aging	Long term aging resulting in tank degradation	F1	E3
204AR-01H	Release of airborne and waterborne contaminates outside building on track spur, and potential contamination in unloader room from rail car due to spilling rail car contents	Rail car rupture due to collision with other or a derailment	F2	E2
204AR-01I	Release of airborne and waterborne contaminates outside building on track spur, and potential contamination in unloader room from rail car due to leak	Rail car leak due to tanker corrosion or other degradation	F2	E2
204AR-07A	Release of liquid radioactive waste and high airborne in unloading room from the Tank 241-AY-102 due to reverse pumping of Tank 241-AY-102 contents back to 204-AR	Pump in pit 02D starts and pumps back to the 204-AR building through the transfer piping and leaks	F2	E2
204AR-09A	Release of airborne and waterborne contamination from the sump pit due to ruptured piping during transfer.	Rupture of transfer piping section above the sump pit	F2	E2
204AR-09B	Release of airborne and radiation contamination in the unloader room from trailer or rail car leak due to high level in sump pit	Catastrophic leak from a large liquid source such as a trailer or rail car	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
204AR-09C	Release of airborne and radiation contamination in the unloader room from rail car due to gross overfilling of catch tank	Gross overfilling of catch tank either from large source such as the trailers or rail cars or continual pumping of transfer water through a leaky pipe	F2	E2
244AR-01.c.09	Release of radioactive aerosols from vessel headspace into canyon atmosphere due to flammable gas ignition	Ignition of flammable gas that has collected in piping and tank dome	F2	E2
244AR-02.a.03	Release of radioactive liquid in the form of aerosols contained in a cell to the exterior of the 244-AR facility due to ignition of flammable gas	Fire/explosion from hydrogen buildup	F1	E2
244AR-02.a.06	Release of radioactive liquid contained in a cell due to leak pathways in the cell structure	Rain or snow water intrusion	F3	E2
244AR-02.a.07	Release of radioactive aerosols from vessel headspace to building atmosphere with eventual release outside facility due to overfilling of sump causing tank failure	Rain or snow water intrusion	F1	E2
244AR-02.a.09	Release of radioactive liquid to soil from leaking sump filled by leaking jumper	Jumper leak (general)	F3	E2
244AR-02.a.11	Release of radioactive liquid to soil from leaking sump filled by leaking jumper	Jumper (B Plant to AY Tank Farm through cell) leak	F3	E2
244AR-02.a.13	Release of radioactive liquid to soil from leaking sump filled by leaking tank	Tank leak	F3	E2
244AR-02.a.14	Release of radioactive aerosols from waste contained in tanks (4) and building due to earthquake	Seismic event collapses building and four tanks	F1	E3
244AR-03.a.04	Release of radioactive aerosols into cell due to ignition of flammable gas in 244-AR Vault tank headspace	Fire/explosion due to ignition of accumulated flammable gas	F2	E2
244AR-03.a.05	Release of radioactive aerosols from tanks headspace due to ventilation system blockage	Ventilation and risers blocked while jetting occurring	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
244AR-03.a.08	Release of radioactive aerosols created by boiling waste to the cell atmosphere	Steam being supplied to tank heating/cooling coils	F3	E2
244AR-03.a.09	Release of radioactive aerosols created by criticality to the cell atmosphere	Criticality in waste	F1	E2
244AR-05.a.02	Release of radioactive material from facility due to seismic event which causes building collapse without cell collapse	Seismic event damages facility structure	F2	E2
CCF-01	Radioactive and hazardous release from tanks due to extended loss of ventilation (over 6 months)	Sustained loss of offsite power	F1	E2
CCF-07	Release of radioactive and hazardous materials from tank due to overfill	Disabled or unavailable staff to terminate transfer	F3	E2
CCF-16	Subsurface releases of radioactive or hazardous material due to leaks in multiple tanks	Tanks, tank penetrations and tank components deteriorate due to corrosion	F3	E3
CCF-17	Release of radioactive and hazardous materials from tank due to dome collapse	Corrosion of rebar in concrete SST domes	F1	E3
CCF-18	Release of radioactive and hazardous materials from tanks due to dome collapses	Fire in tank propagates to connecting tank and both tanks collapse during cooldown from negative tank pressure	F0	E3
CCF-19	Release of radioactive and hazardous materials from tanks due to dome collapses	Fire in tank causes pressure transient that leads to GRE in connecting tank with subsequent fire and tank collapses from negative tank pressure	F0	E3
CDP-04	Release of radioactive contamination to soil surface from inactive pond due to flooding of inactive pond	Flooding	F3	E2
CDP-07	Release of liquid radioactive contamination to soil surface from active pond due to unspecified phenomena	Unspecified phenomena	F3	E2
CDP-10	Release of radioactive contamination to soil surface from excavation or drilling in cribs, ditches or ponds that disturbs radioactive material	Excavation or drilling	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
COB-01	Release of radioactive and/or hazardous material from COB due to spray leak	Flange, gasket or valve, spray leak with COB lid removed	F3	E2
COB-02	Release of radioactive and/or hazardous material from COB due to spray leak	Flange, gasket or valve, spray leak with COB lid in place	F3	E2
COB-03	Release of radioactive and/or hazardous material from COB due to spray leak	Piping leak into COB due to chemical reaction degrading pipe, lid in place	F3	E2
COB-04	Release of radioactive and/or hazardous material from COB lid due to overflow of COB during transfer (pool)	Leak into COB with floor drain plugged, leak detector failed	F3	E2
COB-08	Release of radioactive and/or hazardous material from COB due to over filling of COB (pool)	Transfer pipe or riser rupture, backfilling lower part of COB then filling COB via the floor drain	F3	E2
CP-GRT-02	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error AND Mechanical failure of push pipe integrity inside the transfer line	F1	E3
CP-MSP-01	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations	F1	E2
CP-MSP-02	Release of radioactive or toxic material to soil (plume) remaining subsurface from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations	F3	E3
CP-MSP-03	Release of radioactive or toxic material to soil (plume) remaining subsurface from inactive transfer line due to puncture	Human error caused puncture to transfer line during push operations	F3	E2
CP-MSP-04	Release of radioactive or toxic material to soil (plume) remaining subsurface from waste tank due to puncture of tank	Human error - Undetected deflection of drill string pipe causes breach of tank	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CP-MSP-05	Release of radioactive or toxic material to atmosphere from waste tank due to flammable gas deflagration	Human error AND Flammable gas is present in tank AND Mechanical failure of the pipe and probe (ignition source)	F1	E3
CP-MSP-06	Release of radioactive or toxic material to atmosphere due to flammable gas deflagration caused by puncture and ignition of flammable gas in transfer line which propagates to the waste tank	Human error AND Flammable gas is present in transfer pipe AND Spark from probe tip (ignition source)	F1	E3
CP-MSP-07	Release of radioactive or toxic material to soil (plume) remaining subsurface from Miscellaneous Inactive Storage Facility (MISF) due to puncture of tank	Human error	F3	E3
CP-MSP-08	Release of radioactive or toxic material to atmosphere from MISF Miscellaneous Inactive Storage Facilities due to flammable gas deflagration	Human error AND Mechanical failure of probe	F2	E2
CP-RMV-01	Release of radioactive or toxic material to soil (plume) remaining subsurface from inactive transfer line damaged during push operations	Human error caused puncture to inactive transfer line during push operations	F3	E2
CP-RMV-03	Release of radioactive or toxic material from transfer line through the push pipe during removal activities	Human error	F1	E3
CP-SET-04	Release of radioactive or toxic material from waste tank due to dome collapse	Excessive weight on tank dome (static load of platform)	F2	E3
CP-SET-05	Release of radioactive or toxic material from waste tank due to dome collapse caused by load drop	Mechanical failure of equipment causes load drop	F2	E3
CP-SET-06	Release of radioactive or toxic material from waste tank due to dome collapse caused by load drop	Human error causes load drop	F3	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CP-SSP-01	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations.	F1	E3
CP-SSP-02	Release of radioactive or toxic material to soil (plume) remaining subsurface from transfer line due to puncture of line during transfer	Human error caused puncture to transfer line during push operations	F3	E3
CP-SSP-03	Release of radioactive or toxic material to soil (plume) remaining subsurface from inactive transfer line due to puncture	Human error caused puncture to transfer line during push operations	F3	E2
CP-SSP-04	Release of radioactive or toxic material to soil (plume) remaining subsurface from waste tank due to puncture of tank	Human error - Undetected deflection of drill string pipe causes breach of tank	F1	E3
CP-SSP-05	Release of radioactive or toxic material to soil (plume) remaining subsurface from MISF due to puncture of tank	Human error	F3	E3
CP-SSP-16	Release of radioactive or toxic material to soil surface (pool) from transfer line due to puncture of line during transfer	Human error AND Mechanical failure of push pipe integrity inside the transfer line	F1	E3
CRN-03	Release of radioactive and/or toxic materials from tank due to dome collapse	Human error results in excessive weight on dome	F3	E3
CRN-03-IB	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Human error results in excessive weight on top of containment	F3	E2
CRN-04	Release of radioactive and/or toxic materials from tank due to dome collapse	Crane or rigging failures drop load resulting in large impact to dome	F3	E3
CRN-04-IB	Release of radioactive and/or toxic materials from facility due to MISF containment collapse	Crane or rigging failures drop load resulting in large impact to top of containment	F2	E2
CRN-05	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Human error in positioning crane load	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CRN-06	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Mechanical failure in positioning crane load	F3	E2
CRN-07	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Crane hits electrical lines/supplies	F3	E2
CRN-08	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Lightning	F3	E2
CRN-09	Release of radioactive and/or toxic materials from ventilation system due to crane damage	Human error in positioning crane load	F3	E2
CRN-10	Release of radioactive and/or toxic materials from ventilation system due to crane damage	Mechanical failure in positioning crane load	F3	E2
CRN-11	Radioactive or toxic material release from tank due to boom failure and tank/equipment damage and dome collapse	Human error: improper load assembly, rigging, crane overloaded	F3	E3
CRN-11-IC	Release of radioactive and/or toxic materials from facility due to containment top collapse damage by boom failure (pool)	Human error: improper load assembly, rigging, crane overloaded	F3	E2
CRN-12	Radioactive or toxic material release from tank due to boom failure and tank/equipment damage and dome collapse	Mechanical failure: corrosion, faulty materials	F3	E3
CRN-12-IC	Release of radioactive and/or toxic materials from facility due to containment top collapse by boom failure (pool)	Mechanical failure: corrosion, faulty materials	F2	E2
CRN-13-IC	Release of radioactive and/or toxic materials from facility due to containment top collapse damage by boom failure	High wind or seismic event	F2	E2
CRN-13-a	Release of radioactive or toxic material from tank/equipment damage and dome collapse due to boom failure	High wind	F3	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
CRN-13-b	Release of radioactive or toxic material from tank/equipment damage and dome collapse due to boom failure	Seismic event	F1	E3
CRN-21	Release of radioactive or toxic materials from tank due to loss of vertical load control, dropping crane load into tank, onto tank bottom (subsurface leak)	Human error: improper load assembly, rigging, positioning error	F3	E3
CRN-21-IA	Release of radioactive or toxic materials from underground facility bottom due to loss of vertical load control, dropping crane load into facility (subsurface leak)	Human error: improper load assembly, rigging, positioning error	F3	E2
CRN-21-IB	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility (surface pool)	Human error: improper load assembly, rigging, positioning error	F3	E2
CRN-22	Release of radioactive or toxic materials from tank due to loss of vertical load control, dropping crane load into tank, onto tank bottom (subsurface leak)	Mechanical failure: corrosion, faulty materials, hydraulics	F2	E3
CRN-22-IA	Release of radioactive or toxic materials from facility bottom due to loss of vertical load control, dropping crane load into facility	Mechanical failure: corrosion, faulty materials, hydraulics	F2	E2
CRN-22-IB	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility (surface pool)	Mechanical failure: corrosion, faulty materials, hydraulics	F2	E2
CRN-23	Release of radioactive or toxic materials from tank due to loss of vertical load control, dropping crane load into tank, onto tank bottom (subsurface leak)	High wind or seismic event	F3	E3
CRN-23-IB	Release of radioactive or toxic materials from aboveground facility bottom due to loss of vertical load control, dropping crane load into facility	High wind or seismic event	F2	E2
DCN-04-I	Decontamination personnel are contaminated, release of aerosol outside immediate area from equipment being decontaminated due to wind	Wind/tornado	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
EE-01	Release of radioactive and toxic materials from tanks due to external force and fire	Aircraft crash	F1	E3
EE-04-a	Release of radioactive and hazardous materials from SST tank due to external fires	Vehicle accident involving propane, diesel or gasoline delivery	F2	E3
EE-04-b	Release of radioactive and hazardous materials from DST tank due to external fires	Vehicle accident involving propane, diesel or gasoline delivery	F2	E3
EE-05-a	Release of radioactive or hazardous materials from SST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	E3
EE-05-b	Release of radioactive or hazardous materials from DST tank due to external fires	Run-away vehicle or truck shears off one or more risers, ruptures gasoline tank	F3	E3
EE-10	Release of radioactive and hazardous materials from tanks due to loss of tank integrity	Water line breaks, saturates subsurface, and hydrostatic head causes tank to float	F0	E3
EE-11	Release of radioactive and hazardous materials from tank due to overfilling	Water line breaks and overfills tank	F2	E2
EE-16	Release of radioactive and hazardous material from transfer line spray leak due to excavation error	Excavation into waste transfer line during a transfer	F3	E2
I-222S-1-CMP-C	Release (potential spray leak) of 222-S lab waste to atmosphere in diversion box or 244 S Pump Pit due to increased corrosion from failure to add sodium hydroxide	Human error - failure to add sodium hydroxide	F3	E2
I-222S-1-CMP-E	Release of radioactive aerosols to the atmosphere from 244 S or receiver tank due to over pressurization of tank caused by organic fire	Human error - upset of 222-S Lab operations	F3	E3
I-222S-1-LVL-A	Release (steam) of aerosols and entrained particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to tank farm	Human error - failing to shut off steam after Tank 219-S-102 is empty	F3	E2
I-222S-1-RXN-A	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste	Transfer of incompatible waste	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-222S-2-FLW-C	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste	Human error - incorrect valve line up	F2	E2
I-222S-2-LEK-B	Release of 222-S lab waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	E2
I-222S-2-LEK-C	Release of 222-S lab waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	E2
I-222S-2-LEK-E	Release of 222-S lab waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from a seismic event	Seismic event	F2	E2
I-222S-2-PRS-A	Release (steam) of aerosols and particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to tank farm	Steam reducer valve fails open	F3	E2
I-242A-1-FLW-A	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from dead heading	Valves fail to regulate (closed position) which fails pump and creates ignition source, sufficient hydrogen accumulation for fire/ explosion.	F2	E3
I-242A-1-FLW-B	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source	Feed pump fails and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3
I-242A-1-FLW-C	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from dead heading	Plugged line which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3
I-242A-1-FLW-D	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source	Pump plugged which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3
I-242A-1-FLW-E	Release of radioactive material from Feed Tank 241-AW-102 due to fire/explosion caused by igniting hydrogen gas when pump is damaged and possibly becomes an ignition source from pump cavitation	Empty feed tank which fails pump and causes ignition source, sufficient hydrogen accumulation for fire/explosion	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242A-1-LEK-B	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	E2
I-242A-1-LEK-C	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line causes spray leak	F2	E2
I-242A-1-LEK-E	Release of waste from Feed Tank 241-AW-102 to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak	F2	E2
I-242A-2-CMP-B	Release to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank	Steam block valves inadvertently opened or left open	F2	E3
I-242A-2-FLW-A	Release of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank and possible structural damage to the tank	Human error - pump is run at maximum speed	F3	E2
I-242A-2-FLW-B	Release of aerosols to the atmosphere through 12 inch opening in inlet station due to over pressurization of the receiver tank and possible structural damage to the tank	Human error - pump is run at maximum speed	F3	E2
I-242A-2-LEK-B	Release of slurry tank waste to the atmosphere due to spray leak at the diversion boxes or pump pit, caused by corrosion in the pipe	Corrosion in pipe line	F1	E2
I-242A-2-LEK-C	Release of slurry tank waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line causes spray leak	F2	E2
I-242A-2-LEK-E	Release of slurry tank waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes leak	F2	E2
I-242A-2-VSC-A	Release of aerosols in receiver tank due to tank burp from over concentration, potential to generate conditions similar to Tank 241-SY-101, "Tank Burp" due to hydrogen being trapped in thick solution (lower energy than tank bump)	Human error - over concentration of slurry at evaporator	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242A-3-FLW-A	Release of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the feed tank and possible structural damage to the tank	Uncontrolled pot dump at evaporator (loss of electricity or air)	F3	E2
I-242A-3-FLW-B	Release of aerosols to the atmosphere through 12 inch opening in inlet station due to over pressurization of the feed tank and possible structural damage to the tank	Uncontrolled pot dump at evaporator (loss of electricity or air)	F3	E2
I-242A-4-TMP-A	Release of radioactive material from Tank 241-AW-102 caused by ignition of organics in Tank C-100 which pressurizes the drain line and propagates the fire down the line to Feed Tank 241-AW-102	Faulty control of vacuum to CA-1 vessel causing pot to boil with organic layer available	F0	E3
I-242A-6-CMP-A	Release (steam) of aerosols to the atmosphere through unsealed cracks in the cover blocks due to over pressurization of the receiver tank	Human error - steam block valve inadvertently left opened	F3	E3
I-242A-6-FLW-B	Release of diluted high level tank waste from Feed Tank 241-AW-102 caused by overfilling Tank 241-AW-102 and annulus, aggravated by an uncontrolled evaporator dump when a raw water leak occurs in evaporator condenser room	Rupture of raw water line in condenser/pump room	F3	E2
I-242A-7-FLW-A	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Compressor fails and 241-AW Tank Farm air supplied from 242-A	F1	E2
I-242A-7-FLW-B	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Valve inadvertently closed, 241-AW Tank Farm air supplied from 242-A	F1	E2
I-242A-7-FLW-C	Release of aerosols through the risers due to loss of instrument air which causes an uncontrolled evaporator dump and failure to detect changes in feed tank pressure	Filter plugged, 241-AW Tank Farm air supplied from 242-A	F1	E2
I-242S-2-FLW-A	Release of tank waste diluted with contaminated fire water to the soil due to flooding the pump room from a fire main break and pumping the water to Tank 241-SY-102 which overfills the tank and floods pit through risers	Break in fire main	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-242S-2-FLW-E	Release of high level waste to the ground outside the 242-S building due to unmitigated reverse flow to the pump room from Tank 241-SY-102	Human error - incorrect valve line up	F2	E2
I-242S-2-LEK-B	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-242S-2-LEK-C	Release of contaminated water to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-242S-2-LEK-E	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event	F2	E2
I-242S-4-FLW-C	Release of high level waste to the ground outside the 242-S building due to unmitigated reverse flow to the condenser room	Human error - incorrect valve line up	F2	E2
I-242S-4-FLW-D	Release of tank waste diluted with contaminated water to the soil due to flooding the condenser room which is pumped to Tank 241-SY-102 and overfills the tank and floods pit through risers	Break in fire main	F1	E2
I-242S-4-LEK-E	Release of contaminated water to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from an seismic event	Seismic event causes spray leak	F2	E2
I-BPLANT-1-CMP-B	Release (spray leak) of low level waste at diversion box from transfer of low pH material resulting in increased corrosion in pipe	Human error - failure to add sodium hydroxide leads to corrosion and leak in pipe	F3	E2
I-BPLANT-1-CMP-E	Release of tank waste due to fire in receiver tank from transferring organics from B Plant	Human error - tank containing organics in B Plant rupture and spills organics to the drains which eventually end up in Tank 24-1 and an inadvertent transfer to tank farms	F1	E3
I-BPLANT-2-FLW-D	Release of aerosols and/or toxic vapors from receiver tank due to transfer of incompatible waste from B Plant	Human error - communication error between B Plant and TWRS causes transfer of incompatible waste	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-BPLANT-2-LEK-B	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-BPLANT-2-LEK-C	Release of low level waste to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-BPLANT-2-LEK-E	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	E2
I-PFP-1-AGT-A	Release of fission product gases and aerosols from receiver tank due to potential for solids to collect in D-5, If mixed later, potential for composition of next batch to exceed Criticality Prevention Specifications (CPS); potential "Criticality Issue"	Human error or agitator fails results in criticality	F3	E2
I-PFP-1-CMP-B	Release of fission product gases and aerosols from receiver tank due to, potential for localized concentration of fissile materials in receiver tank from failure to add ferric nitrates; potential "Criticality Issue"	Failure to add ferric nitrates, results in criticality	F3	E2
I-PFP-1-CMP-D	Release of fission product gases and aerosols from receiver tank due to excess fissile material in waste, potential to exceed criticality prevention specification requirements for shipment; potential "Criticality Issue"	Excess fissile content added to waste results in criticality	F3	E2
I-PFP-1-CMP-E	Release of high level waste from receiver tank due to fire from organics transferred from PFP	Excess organic material added to waste results in fire	F2	E3
I-PFP-2-LEK-B	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-PFP-2-LEK-C	Release of TRU mixed waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	E2
I-PFP-2-LEK-E	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak.	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-PFP-2-TMP-B	Release (steam) of aerosols and entrained particulate from 244 TX ventilation system due to saturating HEPAs with steam sending higher pressure steam to steam jet, gassing it out	Failure of steam reducer	F2	E2
I-PFP-3-LEK-B	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-PFP-3-LEK-C	Release of TRU mixed waste to the atmosphere due to spray leak at the rupture of the line	Inadvertent excavation of line	F2	E2
I-PFP-3-LEK-E	Release of TRU mixed waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections	Seismic event causes spray leak	F2	E2
I-PUREX-1-AGT-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error or mechanical failure - agitator fails or is not turned on	F3	E2
I-PUREX-1-CMP-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error - failure to add sodium hydroxide to low level waste results in corrosion and causes spray leak	F3	E2
I-PUREX-1-LVL-A	Release of aerosols from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from transfer of steam	Human error - failure to shut off steam jet when U-3 is empty	F3	E2
I-PUREX-2-LEK-B	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-PUREX-2-LEK-C	Release of TRU waste from PUREX to the atmosphere due to spray leak at the rupture of the line from inadvertent excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-PUREX-2-LEK-E	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by seismic event	Seismic event causes spray leak	F2	E2
I-PUREX-2-PRS-A	Release (steam) of aerosols and particulates through cracks in the cover block from the receiver tank due to tank pressurization which gases out the steam jet	Steam reducer fails	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-PUREX-3-AGT-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Agitator fails or is not turned on results in corrosion and causes spray leak	F3	E2
I-PUREX-3-CMP-B	Release (spray leak) of TRU waste from PUREX at diversion box due to leak from increased corrosion caused by transfer of acidic waste	Human error - failure to add sodium hydroxide to low level waste results in spray leak	F3	E2
I-PUREX-3-CMP-E	Release of fission product gases and aerosols from receiver tank due to criticality caused by exceeding Criticality Prevention Specifications for shipment from PUREX	Transfer of L Cell sump water to Tank F-18 and eventually to the Tank Farms	F3	E2
I-PUREX-3-LVL-A	Release of aerosols from Tank 241-AW-105 through cracks in the cover block due to pressurizing tank from transfer of steam	Human error - failure to shut off steam jet when U-3 is empty	F3	E2
I-PUREX-4-FLW-B	Release (ground surface) of high level tank waste diluted with flush water from the receiver tank due to overfilling from sending excess water	Block valve on flush water inadvertently left opened or leaking	F3	E2
I-PUREX-4-LEK-B	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by corrosion in the pipe	Corrosion in pipe line causes spray leak	F1	E2
I-PUREX-4-LEK-C	Release of TRU waste from PUREX to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-PUREX-4-LEK-E	Release of TRU waste from PUREX to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	E2
I-PUREX-4-PRS-A	Release of aerosols and particulates through cracks in the cover block from the receiver tank due to tank pressurization which gases out the steam jet	Steam reducer fails	F2	E2
I-TPLANT-1-CMP-B	Release (spray) of low level waste at diversion box from transfer of lower pH material resulting in increased corrosion in pipe	Human error - failure to add sodium hydroxide causes corrosion and associated spray leak	F3	E2
I-TPLANT-2-CMP-A	Release (steam) of aerosols and entrained particulates to atmosphere through ventilation due to over pressurization of 244 S DCRT caused by sending just steam to the tank farm	Human error - steam block valve inadvertently opened or failure to close valve when Tank 15-1 is low	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
I-TPLANT-2-LEK-B	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit	Corrosion in pipe line causes spray leak	F1	E2
I-TPLANT-2-LEK-C	Release of low level waste to the atmosphere due to spray leak at the rupture of the line from excavation	Inadvertent excavation of line causes spray leak	F2	E2
I-TPLANT-2-LEK-E	Release of low level waste to the atmosphere due to spray leak at the diversion box or pump pit, caused by rupture at pipe connections from seismic event	Seismic event causes spray leak	F2	E2
I-UPLANT-1-LEK-B	Release of low level waste to the ground at the rupture of the line	Inadvertent excavation of line	F1	E2
ITK-06	Release of radioactive and/or hazardous material from point of in-tank access (non-fire, non-explosion) due to criticality	Intrusive activity causes critical mass	F1	E2
ITK-06-I	Release of radioactive and/or hazardous material from point of in-facility access due to criticality within the in-facility waste during intrusive activity (non-fire, non-explosion)	Criticality from intrusive activity	F1	E2
ITK-07	Radioactive and/or hazardous material release from tank below grade (non-fire, non-explosion) due to intrusive activity	Dropped equipment in tank from human error or equipment failures (also see crane operations) Penetration of tank with linear-force, high pressure, or rotational equipment from human error or equipment failure	F3	E3
ITK-07-IB	Release of radioactive and/or hazardous material from facility at surface due to breach of facility confinement (non-fire, non-explosion)	Dropped equipment in facility from human error or equipment failures (also see crane operations) Penetration of facility confinement with linear-force, high pressure, or rotational equipment from human error or equipment failure	F2	E2
ITK-08	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Exothermic reaction of incompatible materials in tank	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
ITK-08-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Exothermic reaction of incompatible materials in facility	F2	E2
ITK-09	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Failure to bond components or incorrect bonding	F3	E2
ITK-09-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Failure to bond components or incorrect bonding	F2	E2
ITK-10-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Spark from equipment or tools provide an ignition source	F3	E2
ITK-10-a	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	F3	E2
ITK-10-b	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	F3	E2
ITK-11	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Lightning, range fire, or seismic event ignites tank vapors	F2	E2
ITK-11-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during intrusive activity	Lightning, range fire, or seismic event ignites facility vapors	F1	E2
ITK-FR-03	Release of radioactive aerosols from tank and/or receiver due to equipment jam in riser	Equipment becomes lodged in riser, efforts to remove pull riser out of tank causing breach of tank & receiver containment	F1	E2
ITK-FR-04	Release of radioactive aerosols from tank due to tank collapse	Equipment becomes lodged in riser, efforts to remove pull riser out of tank causing loss of structural integrity leading to tank collapse	F1	E3
ITK-FR-08	Release of radioactive aerosols/vapors from flex receiver due to structural failure	High winds tear flex receiver bag	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
ITK-FR-13	Release of radioactive aerosols/vapors from flex receiver due to buildup and ignition of flammable gas in receiver	Hydrogen gas buildup in tank/riser that travels into receiver with ignition source (spark from herculite or equipment)	F1	E2
ITK-FR-19	Release of radioactive aerosols from tank due to dome collapse	Hydraulic jacks on assembly stand are operated while assembly is bolted to flange tearing out riser and destroying tank integrity leading to dome collapse	F1	E3
ITK-FR-22	Release of radioactive aerosols from flex receiver due to tank gas release	Tank gas release pressurizes bag and causes bag to rupture	F1	E2
LDUA 1-25	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Fire (electrical, lighting)	F2	E3
LDUA 1-32	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	During planned intrusive activities, sampling triggers GRE	F3	E3
LDUA 1-33	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Non-arm end effectors (OVS, OSVS) dropped down riser	F2	E3
LDUA 1-33A	Release of liquid waste to the soil due to the dropping of non-arm end effector down riser which penetrates tank bottom	Non-arm end effectors (OVS, OSVS) dropped down riser	F2	E3
LDUA 2-2	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of hydraulic fluid	Structural failure of hydraulic system	F2	E3
LDUA 2-20	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Combustible source of gas located near the compressor intake.	F3	E3
LDUA 2-51	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Supervisor error - arm in wrong mode, Electric remains on after air purge fault, flammable gas enters arm, spark ignites gas	F1	E3
LDUA 5-43	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Lightning strikes VPM in raised position	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
LDUA 5-45	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Helicopter/airplane crash	F1	E3
LDUA 6-24	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Wrong setting on safety interlock for electric shutdown on loss of purge air	F3	E3
LDUA/EREE 1-22	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Electrical Short in LDUA Lighting short	F2	E3
LDUA/EREE 1-28	Release of aerosolized waste to the atmosphere from headspace of single shell tank due to ignition of flammable gas	Electrical Short in LDUA/ EREE Lighting short	F3	E3
NP-03	Radioactive and hazardous material releases from tanks due to fire in tanks	Lightning strikes riser in tank farm	F2	E2
NP-05	Radioactive and hazardous material release from tanks, nearby ground surfaces, and ventilation systems due to above grade disturbances	High winds	F1	E2
NP-07	Radioactive and hazardous material releases from tanks and ventilation systems due to seismic event	Seismic event collapses domes	F1	E3
NP-08	Radioactive and hazardous material releases from transfer pipes due to seismic event (possible spray leak)	Seismic event shears pipes and encasements during transfer	F2	E2
NP-09	Radioactive and hazardous material releases from tanks due to seismic event	Seismic event results in tank leaks or below grade tank ruptures	F1	E3
NP-11	Radioactive and hazardous material releases from tank farms due to lava flow	Eruption of molten lava from fissures	F0	E3
NP-13	Radioactive and hazardous material releases from tanks due to excessive weight on dome	Accumulations of heavy snow followed by heavy rain	F2	E3
OGT-EXT3-01A	Release of radioactive or hazardous aerosols from the primary pipe due to spray leak caused by truck crash into piping system	Human error, line struck by truck	F3	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
OGT-EXT3-01B	Release of radioactive or hazardous material from the primary pipe due to leak caused by truck crash into piping system	Human error, line struck by truck	F2	E2
OGT-FLOW1-02	Release of radioactive or hazardous material from pit overflow due to primary pipe leak caused by over-rated pump	Incorrect pump installed creates excessive flow and pressure on OGT system eroding EPDM pipe causing leak to secondary pipe with drain in pit plugged	F2	E2
OGT-FLOW1-03A	Release of radioactive or hazardous aerosols from the primary pipe due to spray leak caused by misdirected flow	Spray leak caused by JR-1 (3-way valve) mispositioned to flush, two check valves fail, flush disconnect fails (check valve), reverse flow to external flush fixture and release to the environment	F1	E3
OGT-FLOW1-03B	Release of radioactive or hazardous material from the primary pipe due to misdirected flow of waste through flush line	JR-1 (3-way valve) mispositioned to flush, two check valves fail, flush disconnect fails (check valve), and reverse flow to water truck, drum or onto ground	F1	E2
OGT-FLOW1-04	Release of radioactive or hazardous material from the primary pipe due to valve failure resulting in misdirected flow of waste through flush line to flush water supply truck	JR-1 leak (bleed-by), two check valves fail, and flush disconnect fails and pump started causing reverse flow to flush water truck tank	F1	E2
OGT-FLOW1-06	Release of radioactive or hazardous material from the DCRT due to overflow	Exceed volume available in DCRT/insufficient volume available, condition goes unnoticed until overflow occurs	F2	E2
OGT-FLOW2-01A	Release of radioactive or hazardous material from the primary pipe due to leak caused by incorrect pump installed	Incorrect pump installed creates excessive flow and isolation valve closed on secondary pipe, erosion of EPDM and pressurization of secondary pipe causing leaks from flanges gasket within concrete shield	F2	E2
OGT-FLOW2-01B	Release of radioactive or hazardous material from the primary pipe due to leak caused by incorrect pump installed	Incorrect pump installed creates excessive flow and isolation valve closed on secondary pipe, erosion of EPDM and pressurization of secondary pipe causing leaks from flanges gasket within concrete shield	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
OGT-FLOW2-02	Release of radioactive or hazardous aerosols from the primary pipe due spray leak caused by over-rated pump	Installation of incorrect pump and failure of inner pipe, failure of weld on flange of outer pipe, isolation valves closed on secondary pipe drains and no concrete shield in place	F2	E2
OGT-FLOW2-03A	Release of radioactive or hazardous material from the primary pipe due to leak caused by incorrect pump installed	Installation of incorrect pump, failure of inner pipe and isolation valves closed on secondary pipe drains causing leak from failed welds on flange within the concrete shield	F1	E2
OGT-FLOW2-03B	Release of radioactive or hazardous material from the primary pipe due leak caused by incorrect pump installed	Installation of incorrect pump, failure of inner pipe and isolation valves closed on secondary pipe drains causing leak from failed welds on flange within the concrete shield	F1	E2
OGT-NP3-01	Release of radioactive or hazardous aerosols from the primary pipe due spray leak caused by seismic event	Failure of line and concrete shielding during seismic event	F1	E2
OGT-NP3-02	Release of radioactive or hazardous aerosols from the primary pipe due to leak caused by high wind	Pipe is blown off supports and no concrete shielding in place	F1	E2
OGT-PRES1-01	Release of radioactive or hazardous material from overflow of pit due to leak caused by high pressure	Heat up of hydro test by heat tape or high ambient temperature, high pressure results from captive fluid heat up, inner pipe damaged, leaks to secondary pipe and drains back to pits and insufficient drainage in pit	F1	E2
OGT-REAC1-01	Release of radioactive or hazardous material from overflow of pit due to primary pipe leak cause by chemical reaction	Pumping from multiple tanks to single OGT, potential for adverse chemical reactions in pipeline damaging inner pipe, leaks to secondary pipe and drains back to pits and insufficient drainage in pit	F1	E2
OGT-TEMP1-02	Release of radioactive or hazardous vapors/aerosols from the primary pipe due to spray leak caused by high temperatures	Vehicle accident above ground starts fire, melt the EPDM hose causing a leak to secondary pipe, pumping occurring, fire fails gasket and facilitates a release to atmosphere	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
OGT-TEMP1-03	Release of radioactive or hazardous material from overflow of pit due to leak caused by high temperature	High temperature flush water fails inner pipe causing leak to secondary pipe, drain to pit with insufficient drainage in pit	F1	E2
PB-D07.03	Release of toxic materials to the environment	Release of fuel oil from package boiler storage tank to the soil surface due to vehicle impact, no ignition source present	F2	E2
PB-D07.04	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to in-tank fuel fire	F2	E3
PB-D07.07	Release of toxic materials to the environment	Release of fuel oil from package boiler storage tank to the soil surface due to high winds, no ignition source present	F1	E2
PB-D07.08	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to high winds	F1	E2
PB-J01	Release of toxic materials to the environment	Release of fuel oil from refueling truck to the soil surface due to truck rollover, no ignition source present	F1	E2
PB-J01a	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tank in 241-AW to atmosphere due to in-tank fuel fire	F1	E2
PB-J01b	Release of radioactive and/or toxic materials in double-shell tank	Release of radioactive and/or toxic materials from double shell tanks in 241-AW to atmosphere due to in-tank fuel fire involving multiple tanks	F0	E3
PB-J01c	Release of radioactive and/or toxic materials in double shell tank	Release of radioactive and/or toxic materials from double shell tanks in 241-AW to atmosphere due to dome collapse	FO	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality	Mistransfer of material containing organic extractant from east area via the supernate piping route	F1	E3
RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of 102-SY tank due to mistransfer	Mistransfer of material from east area via the supernate piping route	F3	E2
RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible material from east area via the supernate piping route	F2	E3
RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic	Human error	F2	E3
RCSTS-03-FLOW/INTEG01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error)	F3	E2
RCSTS-03-FLOW/INTEG02 a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error)	F3	E2
RCSTS-03-FLOW/INTEG02 b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure	F2	E2
RCSTS-03-FLOW/INTEG02 c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion	F2	E2
RCSTS-03-FLOW/INTEG03 a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG03 b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-03-FLOW/INTEG03 c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW/INTEG04 a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG04 b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure	F2	E3
RCSTS-03-FLOW/INTEG04 c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-03-INTEG02	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2
RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	E3
RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3
RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E2
RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Seismic event	F1	E2
RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer	F3	E2
RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer	F3	E2
RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2
RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-08-FLOW01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-08-FLOW02	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	E2
RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	E2
RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	E2
RCSTS-08-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-08-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	External leak of valve or valves to the diversion box	F3	E3
RCSTS-08-FLOW09	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Failure of piping due to corrosion	F2	E2
RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-08-INTEG03	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2
RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Failure of piping due to material defect	F2	E2
RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	F1	E2
RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Seismic event	F1	E2
RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Seismic event	F1	E2
RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of piping due to corrosion	F2	E3
RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	F2	E3
RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of piping due to material defect	F2	E3
RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	F1	E3
RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Seismic event	F1	E3
RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Seismic event	F1	E3
RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to corrosion plus mitigative features failure	F2	E2
RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to unrecognized material flaw	F2	E2
RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-08-PRES01	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E3
RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Water hammer	F3	E2
RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak	Water hammer	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Water hammer	F3	E3
RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Water hammer	F3	E3
RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to freezing	F1	E2
RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Flow of slurry to vent station due to incomplete closing of vent valves after venting	F3	E2
RCSTS-09-FLOW02	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-09-FLOW03	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	External leak of valve or valves to the vent station	F3	E2
RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	External leak of valve or valves to the vent station	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Flow of supernate to vent station due to incomplete closing of vent valves after venting	F3	E2
RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E2
RCSTS-09-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-09-FLOW09	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	External leak of valve or valves to the vent station	F3	E3
RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E3
RCSTS-09-INTEG01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG03	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	F2	E2
RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Seismic event	F1	E2
RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Seismic event	F1	E2
RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of piping due to corrosion	F2	E3
RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3
RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of piping due to material defect	F2	E3
RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Seismic event	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Seismic event	F1	E3
RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Water hammer	F3	E2
RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Water hammer	F3	E2
RCSTS-09-PRES03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E3
RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Water hammer	F3	E3
RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Water hammer	F3	E3
RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A lift station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	F3	E2
RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A lift station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F2	E2
RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2
RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to flammable gas explosion in primary piping	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTSFS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	F2	E2
RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3
RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3
RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping break	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3
RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A lift station due to piping break	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-24-FLOW/INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG04	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Failure of jumper due to misalignment	F3	E2
RCSTS-24-FLOW/INTEG06	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Failure of jumper due to misalignment	F3	E2
RCSTS-24-FLOW/INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E3
RCSTS-24-FLOW/INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to gasket failure	F3	E3
RCSTS-24-FLOW/INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Failure of jumper due to misalignment	F3	E3
RCSTS-24-FLOW/INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Failure of jumper due to misalignment	F3	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	External event (airplane crash, etc)	F0	E2
RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	External event (airplane crash, etc)	F0	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Seismic event	F1	E2
RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Seismic event	F1	E2
RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2
RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak	Seismic event	F1	E3
RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak	Seismic event	F1	E3
RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak	Water hammer	F3	E2
RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A lift station due to piping system leak	Water hammer	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line break (upstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line break (downstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2
RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure	Caustic injection pressure relief valve failure	F3	E2
RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break	Flush line break due to structural failure	F2	E2
RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2
RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break	Flush line break due to structural failure	F2	E2
RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions	Freezing weather with loss of heat trace function	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open	Pressure relief valve fails open	F2	E2
RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open	Back pressure valve fails in closed position	F2	E2
RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package	Line failure/leak due to structural failure	F2	E2
RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak	Caustic drain valve leak	F2	E2
RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open	Pressure relief valve fails open on caustic injection system	F2	E2
RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line	Back pressure relief valve fails in closed position	F3	E2
RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break	Line break due to structural failure	F2	E2
RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break	Line plug due to debris buildup causing pressure buildup resulting in pipe failure	F2	E2
RSR-05	Release of radioactive and toxic materials from tank (below grade) due to tank breach from dropped equipment (tools, mirrors, gauge plugs) into tank	Failure to attach lanyard or other position limiting device Failure of lanyard or device	F3	E3
RSR-05-IB	Facility confinement breach from dropped equipment (tools, mirrors) into facility	Failure to attach lanyard or other position limiting device Failure of lanyard or device	F2	E2
RSR-06-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during riser removal activity	Failure to bond components or incorrect bonding allows electrostatic spark	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
RSR-07-I	Release of radioactive or toxic material from facility due to in-facility fire or explosion during riser removal activity (chosen to represent all organic nitrate tanks)	Spark from failure to use non-sparking tools or sparks from welding, cutting, grinding, etc.	F3	E2
TFS-1	Release of radioactive or hazardous waste liquid from overflow of 244 S vault to the 244 S pump pit due to syphon effect on Tank 241-SY-102 (pump does not overflow)	Human Error - failure to close isolation valve (or valve malfunction) following waste transfer which allows flow to continue (syphon) when pump is stopped	F3	E2
VEH-01	Release of radioactive or toxic materials from cask due to fire caused by vehicle operation	Vehicle catches on fire	F3	E2
VEH-01-I	Release of radioactive or toxic materials from vehicle carrying MISF samples or contaminated equipment due to vehicle fire	Vehicle catches on fire	F2	E2
VEH-03	Release of radioactive or toxic material from cask due to damage to transport casks during a high wind/tornado	High wind/tornado	F2	E2
VEH-03-I	Release of radioactive or toxic material from MISF samples in transport casks due to high wind/tornado damage	High wind/tornado	F2	E2
W030-25	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of the tank recirculation system fan resulting in tank bump	F3	E3
W030-26	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of one of the main ventilation system exhaust fans resulting in tank bump	F3	E3
W030-27	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank cooling due to failure of both of the main ventilation system fans resulting in tank bump	F2	E3
W030-28	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse/damage caused by tank bump	Loss of tank ventilation due to loss of AC power resulting in tank bump	F0	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-29A	Release of radioactive/hazardous material from Tank 241-AZ-101 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AZ101-K1-3-1 or HEPA AZ101-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-29B	Release of radioactive/hazardous material from Tank 241-AZ-102 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AZ102-K1-3-1 or HEPA AZ102-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-29C	Release of radioactive/hazardous material from Tank 241-AY-101 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AY101-K1-3-1 or HEPA AY101-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-29D	Release of radioactive/hazardous material from Tank 241-AY-102 to the atmosphere due to tank bump	Loss of ventilation due to Pre-filter AY102-K1-3-1 or HEPA AY102-K1-4-1 plug; failure to pass air causes excess negative pressure in tank resulting in tank bump	F3	E3
W030-30	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of exhaust system HEME AZ-K1-9-1 resulting in tank bump	F3	E3
W030-31A	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of the exhaust system HEPA/HEGA filters (AZ-K1-10-1A) resulting in tank bump	F3	E3
W030-31B	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	Loss of ventilation due to failure/blockage of the exhaust system HEPA/HEGA filters (AZ-K1-10-1B) resulting in tank bump	F3	E3
W030-32	Release of radioactive/hazardous material from tank to the atmosphere due to dome collapse caused by tank bump	Loss of ventilation due to failure of the seal pot allowing water to back up to HEME and/or exhaust system condenser resulting in tank bump	F3	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-33	Release of radioactive/hazardous material from tank headspace to atmosphere due to dome collapse/damage caused by flammable gas deflagration	Accumulation of flammable gas from steady state generation with ignition source present resulting in fire/deflagration	F3	E3
W030-34	Release of radioactive/hazardous material from tank headspace to atmosphere due to dome collapse/damage caused by flammable gas deflagration	Accumulation of flammable gas from a gas release event (GRE) with ignition source present resulting in fire/deflagration	F3	E3
W030-35A	Release of radioactive material from Tank 241-AZ-101 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3
W030-35B	Release of radioactive material from Tank 241-AZ-102 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3
W030-35C	Release of radioactive material from Tank 241-AY-101 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3
W030-35D	Release of radioactive material from Tank 241-AY-102 to atmosphere due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather caused by icing, dust, failure of flow control valve, failure of inlet heater, etc. resulting in excessive vacuum damaging tank structure	F0	E3
W030-36	Release of radioactive material from tank to atmosphere due to dome failure or collapse caused by excessive vacuum	Ventilation imbalance causes excessive vacuum resulting in dome failure/collapse	F0	E3
W030-37	Release of radioactive material from tank to atmosphere due to dome collapse caused by excessive pressure	Excessive air supply to air lift circulators causes excessive pressure in tank causing dome collapse/damage	F0	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W030-43	Release of radioactive material from ventilation ducting to atmosphere due to criticality	Buildup of fissile material in ventilation ducting until criticality occurs	F0	E3
W030-44	Release of radioactive/hazardous material from the tank to the soil surface due to overflow	Coolant leakage from recirculation cooling unit leaks into tank until it exceeds tank operating levels	F3	E3
W058-FLOW01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected plus mitigative features failure	F3	E2
W058-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit plus mitigative features failure	F2	E2
W058-FLOW05a	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error) plus mitigative features failure	F3	E2
W058-FLOW05b	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure plus mitigative features failure	F2	E2
W058-FLOW05c	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion plus mitigative features failure	F2	E2
W058-FLOW07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Computer failure or human error causing misrouting of material when flow path is not completely connected plus mitigative features failure	F3	E2
W058-FLOW09	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	External leak of valve or valves to the valve pit plus mitigative features failure	F2	E2
W058-FLOW11a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to misalignment (human error) plus mitigative features failure	F3	E2
W058-FLOW11b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to gasket failure plus mitigative features failure	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-FLOW11c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Failure of jumper due to corrosion plus mitigative features failure	F2	E2
W058-FLOW13	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Open path for pool leak from test riser	F3	E2
W058-FLOW15	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
W058-FLOW16	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit	F2	E3
W058-FLOW17a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error) plus mitigative features failure	F2	E3
W058-FLOW17b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure plus mitigative features failure	F2	E3
W058-FLOW17c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion plus mitigative features failure	F2	E3
W058-FLOW18	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
W058-FLOW19	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External leak of valve or valves to the valve pit plus mitigative features failure	F2	E3
W058-FLOW20a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to misalignment (human error) plus mitigative features failure	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-FLOW20b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to gasket failure plus mitigative features failure	F2	E3
W058-FLOW20c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Failure of jumper due to corrosion plus mitigative features failure	F2	E3
W058-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2
W058-INTEG01c	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG01d	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2
W058-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F2	E2
W058-INTEG03b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F2	E2
W058-INTEG05a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-INTEG05b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	E2
W058-INTEG07a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F3	E2
W058-INTEG07b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	E2
W058-INTEG09a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
W058-INTEG09b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
W058-INTEG11a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	E2
W058-INTEG11b	Release of radioactive slurry to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	E2
W058-INTEG13a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG13b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-INTEG13c	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to corrosion plus mitigative features failure	F2	E2
W058-INTEG13d	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to unrecognized material flaw plus mitigative features failure	F2	E2
W058-INTEG14a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc) plus mitigative features failure	F2	E2
W058-INTEG14b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc) plus mitigative features failure	F2	E2
W058-INTEG16a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	E2
W058-INTEG16b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (excavation accident) plus mitigative features failure	F3	E2
W058-INTEG18a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	E2
W058-INTEG18b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity) plus mitigative features failure	F2	E2
W058-INTEG20a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-INTEG20b	Release of radioactive supernate to the soil surface from overflow of a diversion box due to piping system leak	Failure of primary and encasement piping due to freezing	F1	E2
W058-INTEG22	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak	Failure of primary and encasement piping due to seismic event plus mitigative features failure	F1	E2
W058-INTEG24	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E2
W058-INTEG26	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	Seismic event plus mitigative features failure	F1	E2
W058-INTEG28	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E2
W058-INTEG30	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Seismic event	F1	E2
W058-INTEG32	Release of radioactive supernate or slurry aerosols to the atmosphere due to a spray leak from test risers located near SY-A and SY-B valve pits	Failure of primary piping and path for spray leak from test riser plus mitigative features failure	F2	E3
W058-INTEG34	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E3
W058-INTEG35	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3
W058-INTEG36	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	External event (airplane crash, etc)	F1	E3
W058-INTEG37	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak	Seismic event	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W058-PRES01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer plus mitigative features failure	F3	E2
W058-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool)	Water hammer plus mitigative features failure	F3	E2
W151-01	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to filter failure	F3	E2
W151-03	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to unfiltered release through failed filter	F0	E2
W151-05	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank ventilation ducting to atmosphere due to unfiltered release	F2	E2
W151-07	Release of radioactive material to the atmosphere	Release of radioactive/hazardous material from failed HEPA filter to the atmosphere due to flammable gas deflagration	F1	E2
W151-08	Release of radioactive material to the atmosphere	Release of radioactive/hazardous material from failed HEPA filter to the atmosphere due to flammable gas deflagration	F1	E2
W151-09	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release	F1	E2
W151-10	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F3	E2
W151-12	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to flammable gas ignition	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-13	Leak to soil surface	Release of radioactive/hazardous material from tank to soil surface due to tank overflow	F2	E2
W151-14	Leak to soil surface and release to atmosphere	Release of radioactive/hazardous material from tank to soil surface due to load drop	F1	E3
W151-17	Unfiltered release from pit	Release of radioactive/hazardous material from tank inlet station or pit to the atmosphere due to flammable gas release with ignition	F1	E2
W151-19	Release to the environment	Release of radioactive/hazardous material from tank to atmosphere and leak to soil due to flammable gas deflagration	F2	E3
W151-21	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to atmosphere due to HEPA filter failure	F2	E2
W151-22	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F2	E2
W151-24	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank headspace to atmosphere due to unfiltered release through failed filters	F3	E2
W151-25	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to the atmosphere through failed HEPA filter due to material rollover	F0	E2
W151-26	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to the atmosphere through failed HEPA filter due to flammable gas deflagration	F2	E2
W151-27	Release of radioactive/hazardous material in headspace	Release of radioactive/hazardous material from tank to the atmosphere through failed HEPA filter due to high temperatures	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-28	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to flammable gas deflagration	F1	E2
W151-29	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the soil subsurface due to tank breach	F2	E3
W151-30	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to waste redistribution	F3	E2
W151-31	Criticality	Release of radioactive/hazardous material from tank to the atmosphere due to criticality	F1	E3
W151-32	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to dome overload resulting in collapse	F2	E3
W151-36	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F2	E2
W151-37	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to high pressure	F3	E2
W151-38	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	F3	E2
W151-40	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F0	E2
W151-41	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to high pressure	F0	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W151-42	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	F0	E2
W151-44	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to flammable gas deflagration	F1	E2
W151-45	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere through failed filters due to high pressure	F1	E2
W151-46	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to the atmosphere due to tank bump	F1	E2
W151-48	Release of radioactive/hazardous material in tank and contaminated material plugging stack	Release of radioactive/hazardous material from tank to soil subsurface and contaminated material from stack to atmosphere due to flammable gas deflagration	F1	E3
W151-49	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to atmosphere through failed filters due to flammable gas deflagration	F2	E2
W151-50	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to atmosphere through failed filters due to fan overspeed	F3	E2
W151-52	Release of radioactive/hazardous material in tank	Release of radioactive/hazardous material from tank to atmosphere through failed filters due to excessive moisture buildup	F3	E2
W320-A-TRANS01a	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to a large steam bump	Increase in waste temperature due to flowmeters fault, operator error, level indication fault, or Tank 241-C-106 T/C fault during sluice	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-A-TRANS01b	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to a large steam bump	Increase in waste temperature due to inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump	F2	E2
W320-A-TRANS02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Lowering of tank level with temperature out of spec due to equipment fault/failure or operator error resulting in tank bump	F3	E2
W320-A-TRANS03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to steam bump	Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump resulting in high waste temperature during slurry transfer and resulting steam bump	F3	E2
W320-A-TRANS04	Large release of radioactive aerosols from Tank 241-C-106 due to flammable gas fire/deflagration in dome space	High waste temperature during slurry transfer causing a steam bump which induces a flammable gas release/ignition resulting in dome fire	F0	E2
W320-A-TRANS05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Temperature out of specification causing a steam bump when level is lowered resulting in release/ignition of a flammable gas	F0	E3
W320-A-TRANS06	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Waste temperature out of specification during start of slurry transfer in tank and subsequent ignition of organics	F0	E3
W320-ABCD-ALL01a	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL01b	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL02a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL02b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-ALL03a	Release of radioactive aerosols from tank to atmosphere due to excessive weight causing dome collapse	Raw water line rupture causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL03b	Release of radioactive aerosols from tank to atmosphere due to excessive weight causing dome collapse	Heavy rainfall causing flood on top of tank resulting in dome collapse due to excessive load	F0	E3
W320-ABCD-ALL04	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Water intrusion into Tank 241-C-106 causing water level to exceed maximum operating level, tank unsound above, waste leaks behind liner (via surface water flood, system water inleakage, excessive transfer, etc) resulting in steam bump	F3	E2
W320-ABCD-ALL05	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Water intrusion into Tank 241-C-106 with water level exceeding top of liner level, leaking behind liner (via surface water flood, system water inleakage, excessive transfer, etc) and resulting steam bump	F2	E2
W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 to the soil surface due to tank overflow	Large water intrusion (raw water, surface flood, cascade) or excessive transfer causing overflow of tank	F1	E3
W320-ABCD-ALL08*	Release of radioactive liquid from Tank 241-C-106 to soil surface due to tank overflow	Siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	F1	E3
W320-ABCD-CHILL01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to exceedance of loop seal vacuum	Excessive cooling from process chiller causing vacuum in tank from ventilation system which results in exceedance of inlet filter loop seal vacuum and unfiltered release	F2	E2
W320-ABCD-CHILL02	Release of radioactive aerosols from covered pit or deadened pipe to atmosphere due to propylene glycol fire	Piping or tubing leak causes propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome	F1	E2
W320-ABCD-CHILL03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Excessive cooling from process chiller restricts inflow, loop seal fails to operate and vacuum is formed which damages tank structure	F0	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-TRANS01	Release of liquid waste from Tank 241-C-106 to the soil and aerosols to the atmosphere due leak into tank liner gap resulting in steam bump	Inadvertent operator action directing sluicer nozzle jet at tank wall resulting in wall breach and water leaking into liner gap where steam vapor forms, steam bump breaches tank bottom	F3	E2
W320-ABCD-TRANS02	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Unavoidable operator action causing loss of sluicer arm control in tank resulting in jet striking tank liner with liner being breached, water leakage into liner gap and steam formation resulting in breach of tank bottom from steam bump	F2	E2
W320-ABCD-TRANS03	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Buildup of solids in openings or equipment casualty causes siphoning of waste from Tank 241-AY-102 to Tank 241-C-106 exceeding maximum operating level resulting in water leakeage into liner gap, steam formation and bump breaching tank	F1	E2
W320-ABCD-TRANS05	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer hose break resulting in jet striking tank liner with liner being breached, water leakeage into liner gap, steam formation, and breach of tank bottom from steam bump	F2	E2
W320-ABCD-TRANS06	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicing arm breaks off penetrating tank liner resulting in water leakeage into liner gap, steam formation and bump breaching tank bottom	F0	E2
W320-ABCD-TRANS07	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner, water leakeage under tank bottom, steam formation and bump breaching tank bottom	F2	E2
W320-ABCD-TRANS08	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakeage into liner gap, steam formation and bump breaching of tank bottom	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-TRANS09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High temperature sluice water from Tank 241-AY-102 causes excessive waste temperature change rate, liner breaches, water leakage under tank bottom, steam formation and bump breaching tank bottom	F1	E2
W320-ABCD-TRANS11	Release of radioactive aerosols from transfer piping in Tank 241-AY-102 pit to atmosphere due to spray leak	Line break due to flammable gas ignition in pit causing cover blocks to fall onto piping resulting in spray leak	F2	E3
W320-ABCD-TRANS11*	Release of radioactive aerosols from Tank 241-AY-102 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F2	E3
W320-ABCD-TRANS12	Release of radioactive aerosols from Tank 241-AY-102 distributor pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach in distributor pit with cover block off during slurry transfer	F2	E3
W320-ABCDF-ALL01*	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration in pit	Flammable gas generation from tank waste builds up in pit drain pipe and is ignited	F1	E3
W320-ALL-TRANS01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to moisture buildup	Moisture buildup on filters from natural causes	F2	E2
W320-ALL-TRANS02	Release of radioactive aerosols from ventilation ducting due to high winds or tornado	High winds or tornado resulting in failed ventilation ducting and unfiltered release	F2	E2
W320-ALL-VENT01	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to ammonium nitrate fire/deflagration	Buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc causing a breach in the ducting (assumes ventilation system failure)	F1	E2
W320-B-ALL01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Volcanic event results in buildup of ashfall on top of tank; weight of ash exceeds design limit and causes dome collapse	F0	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-ALL02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Volcanic event results in buildup of ashfall on top of tank; weight of ash exceeds design limit and causes dome collapse	F0	E3
W320-B-ALL03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Extreme snow fall results in large amounts of snow accumulating on top of tank; weight of snow on tank exceeds design limits and causes dome collapse	F0	E3
W320-B-ALL04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Extreme snow fall results in large amounts of snow accumulating on top of tank; weight of snow on tank exceeds design limits and causes dome collapse	F0	E3
W320-B-ALL05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive weight causing dome collapse	Maintenance error or procedure violation result in overloading tank dome past design limits resulting in dome collapse	F0	E3
W320-B-ALL06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive weight causing dome collapse	Maintenance error or procedure violation result in overloading tank dome past design limits resulting in dome collapse	F0	E3
W320-B-ALL07	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Flammable gas collects in pit where it is ignited causing the displacement and fall of the cover block which strikes a riser-liner joint resulting in an unfiltered release from dome space	F3	E2
W320-B-ALL08a	Large release of radioactive aerosols from Tank 241-AY-102 due to flammable gas fire/deflagration	Raw water leak causes a large water intrusion that induces a flammable gas release event which is ignited resulting in a dome space fire	F0	E3
W320-B-ALL08b	Large release of radioactive aerosols from Tank 241-AY-102 due to flammable gas fire/deflagration	Surface water flood causes a large water intrusion that induces a flammable gas release event which is ignited resulting in a dome space fire	F0	E3
W320-B-ALL09	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to organic waste fire	Formation of organic layer in tank during slurry distribution and subsequent ignition of organics	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-ALL10	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Formation of organic layer in tank during sluicing and subsequent ignition of organics	F1	E3
W320-B-ALL11	Release of radioactive liquid waste from Tank 241-C-106 to soil subsurface due to large water intrusion	Large water intrusion resulting in high hydrostatic pressure and tank breach (raw water, surface flood, excessive transfer, or cascade)	F2	E2
W320-B-ALL13	Release of radioactive liquid from Tank 241-AY-102 to soil surface due to tank overflow	Large water intrusion causing overflow of tank (raw water, surface flood, or ventilation system water inleakage)	F1	E2
W320-B-ALL14	Release of radioactive aerosols from pit to the atmosphere due to high winds	High winds/dust devil during plug removal from pit cover	F3	E2
W320-B-FLUSH01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through breached filters due to ignition of flammable gas plume	Ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank	F0	E2
W320-B-FLUSH02	Release of radioactive aerosols from Tank 241-C-106 through failed filters due to a large steam bump	Flush water spray condenses dome vapors causing high tank vacuum that results in a large steam bump	F0	E2
W320-B-FLUSH03	Release of radioactive aerosols from Tank 241-AY-102 through failed filters due to a large steam bump	Flush water spray through antisiphon holes causing high condensation rate in tank and high tank vacuum resulting in large steam bump	F0	E2
W320-B-FLUSH04	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Flushing water spray through sluice nozzle resulting in excessive tank vacuum damaging tank	F0	E3
W320-B-FLUSH05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Flushing water spray thru antisiphon holes resulting in excessive tank vacuum and tank breach	F0	E2
W320-B-FLUSH06	Release of radioactive liquid from overflow of pit on Tank 241-AY-102 to soil surface due to transfer line leak	Pipe break in pit with the high capacity drain cover on resulting in overflow of pit	F2	E2
W320-B-FLUSH07	Release of radioactive liquid from overflow of pit to the soil surface due to pipe break during flushing	Pipe break in pit during flushing and drain plug cover on resulting in overflow of pit	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-PUMP01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due steam bump	Overheating of waste due to equipment fault/failure or operator error and subsequent steam bump	F3	E2
W320-B-TRANS01	Release of radioactive aerosols from the annulus of Tank 241-AY-102 through failed filters due to steam pulses from boiling waste	Corrosion of primary tank due to new waste composition causes leak into annulus, steam pulses from boiling waste in annulus region resulting in failure of annulus filters	F0	E2
W320-B-TRANS02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Low slurry flow, piling of waste at base of distributor and resulting tank bump	F1	E2
W320-B-TRANS03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to condensation of vapor in head space	Condensation of vapor in head space of Tank 241-C-106 which resulted from the breaking off of sluicer head (sluicer failure, water hammer, thermal shock, corrosion or fatigue)	F0	E2
W320-B-TRANS04	Release of radioactive aerosols from Tank 214-C-106 to atmosphere through failed filters tank bump	High slurry transfer rate and high waste temperature due to equipment fault/failure or operator error resulting in tank bump	F1	E2
W320-B-TRANS05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to steam bump and increased head space vapor pressure	Buildup of solids pile under distributor as a result of low slurry flow which results in steam bump and increased head space vapor pressure	F1	E2
W320-B-TRANS06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive slurry flow	Excessive slurry flow resulting in increased aerosol generation and errant flow release (assumes filter failure)	F2	E2
W320-B-TRANS07	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to release of vapor from waste	Startup of slurry flow to distributor resulting in air being bubbled through waste and release of vapor (assumes filter failure)	F2	E2
W320-B-TRANS08	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to equipment failure	Distributor breaks off resulting in excessive aerosol generation in head space and release through HEPAs	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS09	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to steam bump and increased head space vapor pressure	Buildup of solids pile under distributor as a result of the distributor nozzle breaking off which causes steam bump	F1	E2
W320-B-TRANS10	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to equipment failure	Distributor breaks off resulting in excessive aerosol generation in head space and release through HEPAs	F1	E2
W320-B-TRANS11	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to excessive heat loading	Excessive corrosion and heat loading from new waste cause aerosol release (assumes HEPA plugging)	F2	E2
W320-B-TRANS12	Release of radioactive aerosols from interconnected tanks to atmosphere due to increased heat loading of Tank 241-AY-102	Increased heat loading of Tank 241-AY-102 and loss of vacuum due to inadequate ventilation or waste behavior prediction (assumes HEPA plugging)	F2	E2
W320-B-TRANS13	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Flammable gas collects/ignites in tank pit resulting in the cover blocks being displaced, falling into pit, striking riser-liner joint causing an unfiltered release from dome space	F2	E2
W320-B-TRANS14	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Low slurry flow to distributor resulting in solids piling up, flammable gas generation, LFL being reached and ignition occurs resulting in a dome space fire	F0	E3
W320-B-TRANS15	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Air is injected into the waste from the startup of slurry flow from the distributor, gas is scrubbed from the waste, LFL is reached in dome space and ignition occurs resulting in dome space fire	F0	E3
W320-B-TRANS16	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Distributor nozzle breaks off causing solids to pile up generating significant amounts of flammable gas, LFL is reached and an ignition source is present resulting in a dome space fire	F0	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS17	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due flammable gas fire/deflagration	The sluicer hose breaks impinging into the solids releasing a region of retained flammable gas which is then ignited	F0	E2
W320-B-TRANS18	Large release of radioactive aerosols from Tank 241-C-106 to the atmosphere due flammable gas fire/deflagration	Sluice water transfer rate being excessive causing waste level to be lowered quickly with waste temperature too high resulting in a large steam bump, flammable gas release and plume burn	F0	E2
W320-B-TRANS22a	Release of radioactive liquid from transfer line to the soil surface due to local flooding during transfer	Raw water leak resulting in line being uncovered and breached during transfer	F3	E2
W320-B-TRANS22b	Release of radioactive liquid from transfer line to the soil surface due to local flooding during transfer	Natural flow resulting in line being uncovered and breached	F3	E2
W320-B-TRANS23	Release of radioactive aerosols from Tank 241-AY-102 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach in pump pit with cover block off during sluicing	F2	E3
W320-B-TRANS24	Release of radioactive aerosols from Tank 241-C-106 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	F2	E3
W320-B-TRANS25	Release of radioactive aerosols from Tank 241-C-106 sluice pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	F2	E3
W320-B-TRANS26	Release of radioactive aerosols from Tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F2	E3
W320-B-TRANS27	Release of radioactive aerosols from Tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas fire/deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in spray release	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS28	Release of radioactive aerosols from Tank 241-AY-102 distributor pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-TRANS29	Release of radioactive aerosols from Tank 241-AY-102 pump pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-TRANS30	Release of radioactive aerosols from Tank 241-C-106 pump pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-TRANS31	Release of radioactive aerosols from Tank 241-C-106 sluice pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	F3	E2
W320-B-TRANS32	Release of radioactive aerosols from transfer line to atmosphere due to spray leak	Transfer line break due to light aircraft strike on underground transfer line berm	F0	E3
W320-B-VENT01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Volcanic ashfall prevents air intake through existing ventilation and W030 ventilation upgrade system resulting in excessive vacuum and tank breach	F0	E2
W320-B-VENT02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Volcanic ashfall which prevents air intake through W030 ventilation upgrade system resulting in excessive vacuum and tank breach	F0	E2
W320-B-VENT03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through W030 ventilation upgrade and results in excessive vacuum causing tank damage	F0	E2
W320-B-VENT04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through existing exhaust system with W030 intake and results in excessive vacuum	F0	E2
W320-B-VENT05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Cold water spray into tank which results in excessive vacuum and tank breach, possible result of slurry distribution	F0	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-VENT06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Ice storm prevents air inflow through existing ventilation system and results in excessive vacuum	F0	E2
W320-B-VENT07	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Volcanic ashfall prevents air inflow into tank through existing ventilation system resulting in excessive vacuum and tank breach	F0	E2
W320-B-VENT08	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	F0	E3
W320-B-VENT09*	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	F0	E3
W320-BCD-ALL01	Release of radioactive aerosols from covered pit on Tank 241-C-106 to atmosphere due to propylene glycol fire	Piping or tubing leak	F1	E2
W320-BCD-ALL02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to vacuum induced tank damage	Closing of W030 ventilation system inlet damper, build up of excessive vacuum with PCV failure resulting in tank damage	F0	E3
W320-BCD-ALL03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Ventilation system fan overspeed with failure of tank loop seal failure results in excessive vacuum and tank damage	F0	E3
W320-BCD-ALL04	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Fan controller failure resulting in excessive vacuum in tank, loop seal actuation and tank damage	F0	E2
W320-BCD-ALL05	Small release of radioactive aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	F0	E2
W320-BCD-ALL06	Small release of radioactive aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	F0	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-ALL07a	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Raw water leak causing water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching tank	F1	E2
W320-BCD-ALL07b	Release of liquid waste from Tank 241-C-106 to the soil and aerosol to the atmosphere due to steam bump in liner gap	Surface water flood causing water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation and bump breaching tank bottom	F1	E2
W320-BCD-ALL08	Release of liquid waste from Tank 241-C-106 to the soil and aerosols to the atmosphere due to steam bump in liner gap	Inadequate prediction of waste behavior causes excessive corrosion because of waste disturbance in tank resulting in leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2
W320-BCD-ALL10	Small release of aerosols from the transfer line to the atmosphere due to flammable gas fire/deflagration, transfer started	Plugging of transfer line occurs, flammable gas builds up and is ignited resulting in a breach of transfer line; pumping is started (collection in pit)	F1	E2
W320-BCD-FLUSH01	Release of radioactive aerosols from line in pit to atmosphere due to spray leak from mispositioned valve, cover plug removed	3-way valve left in flush position after flushing, cover plug is lifted out of cover block on initiation of sluicing process	F3	E3
W320-BCD-FLUSH02*	Release of radioactive aerosols from flush tank of transfer truck to atmosphere due to spray leak from starting submersible pump in Tank 241-C-106 during the flush of slurry transfer line	Submersible pump in Tank 241-C-106 is started during the flush of slurry transfer line, flush tank is filled and pressurized resulting in rupture of flush tank or flush transfer line	F3	E3
W320-BCD-PUMP03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Submersible pump raised to high in tank, winch lifting strap fails, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-PUMP04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Submersible pump raised too high in tank, winch lifting strap fails, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	E3
W320-BCD-PUMP05	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Immersible pump raised too high in tank, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables	F1	E2
W320-BCD-PUMP08	Release of liquid waste to the annulus of Tank 241-C-106 and aerosol release to atmosphere due to penetration of tank and steam bump in liner gap	Submersible pump raised too high, winch lifting strap fails, pump falls and penetrates primary tank liner resulting in waste and steam bump	F0	E2
W320-BCD-PUMP09	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to flammable gas fire/deflagration	Immersible pump raised too high in tank, winch lifting strap breaks, pump falls into waste resulting in a flammable gas release which is ignited by broken electrical cables	F0	E2
W320-BCD-TRANS01	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank pump vortices	Accumulation of material in the pump vortices until critical mass condition are met	F1	E2
W320-BCD-TRANS02a	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Flushing valve misposition	F0	E2
W320-BCD-TRANS02b	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Excessive solids in slurry flow	F0	E2
W320-BCD-TRANS03	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Primary failure of distributor	F0	E2
W320-BCD-TRANS04	Release of ionizing radiation and radioactive gas from Tank 241-C-106 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation during sluicing activities	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-TRANS05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Condensation of vapors due to failure of distributor causing vacuum in headspace and tank bump failing filters	F0	E2
W320-BCD-TRANS06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Breaking off of distributor head causing tank bump and failed filters	F0	E2
W320-BCD-TRANS07	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to large steam bump	Filter breach from failure of T/C Tree, sluicing outside of temperature specs and large steam bump	F3	E2
W320-BCD-TRANS08	Release of radioactive aerosols from Tank 241-C-106 to atmosphere through failed filters due to tank bump	Undetected high waste temperature with many objects in waste resulting from high pressure sluice causing tank bump	F1	E2
W320-BCD-TRANS09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 exceeds maximum operating water level resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2
W320-BCD-TRANS10	Release of radioactive liquid from overflow of pit on Tank 241-AY-102 to the soil surface due to blank flange left off flushing connection	Blank flange left off flushing connection in pit and drain cover left on resulting in overflow of pit during sluicing	F2	E2
W320-BCD-TRANS11	Release of radioactive aerosols from transfer line in Tank 241-C-106 pit to atmosphere due to spray leak in transfer connection	Blank flange left off flushing connection in pit after flushing, cover plug is lifted out of cover block on initiation of sluicing	F3	E3
W320-BCD-TRANS12	Release of radioactive aerosols from transfer line in Tank 241-AY-102 pit to atmosphere due to spray leak in transfer connection	Blank flange left off flushing connection in pit after flushing, cover plug is lifted out of cover block on initiation of sluicing	F3	E3
W320-BCD-TRANS13	Release of radioactive aerosols from line in pit to atmosphere due to spray leak from mispositioned valve, cover plug in place	3-way valve left in flush position after flushing, cover plug remains in place on initiation of sluicing process, high capacity drain cover left on and pit overflows	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-ALL01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to a steam bump	Human error or activation of ALCs during high temperature conditions causing steam bump	F3	E2
W320-D-ALL02a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing tank bump	F1	E2
W320-D-ALL02b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing tank bump	F1	E2
W320-D-ALL03a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2
W320-D-ALL03b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2
W320-D-ALL04a	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with ventilation balance upset or sudden barometric pressure change causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2
W320-D-ALL04b	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	High waste temperature condition with low intensity seismic event causing bump in interconnected tank resulting in a tank bump and filter breach	F0	E2
W320-D-ALL05	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Long term loss of ventilation system resulting in tank bump and blowout of filters	F2	E2
W320-D-ALL06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to seismic event	Seismic event induces a steam bump in tank resulting in failure of filters or ducting	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-ALL07	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Seismic event releases flammable gas from the waste and after shocks cause mechanical sparks which ignite the flammable gas mixture	F2	E3
W320-D-ALL08	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Human error or activation of ALCs during high temperature condition causes GRE above LFL	F1	E3
W320-D-ALL09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Seismic event breaches liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2
W320-D-CHILL01	Release of radioactive aerosols from damaged Tank 241-C-106 to the atmosphere due to propylene glycol fire/deflagration	Piping or tubing leak of propylene glycol from pit chiller into tank with ignition source	F0	E3
W320-D-CHILL02	Release of radioactive aerosols from damaged Tank 241-C-106 to the atmosphere due to propylene glycol fire/deflagration	Piping or tubing leak of propylene glycol from pit chiller into tank with ignition source	F0	E3
W320-D-PUMP01	Release of radioactive aerosols from Tank 241-AY-102 transfer pit to atmosphere due to spray leak from break in jumper connectors, cover block is off	Immersible pump being positioned to high resulting in air entrainment in transfer line, booster pump torques in reaction to air in transfer line and jumper connectors break, cover block is off	F1	E3
W320-D-PUMP03	Release of radioactive aerosols from Tank 241-C-106 transfer pit to atmosphere due to spray leak from break in jumper connectors, cover block is off	Immersible pump being positioned too high resulting in air entrainment in transfer line, booster pump torques in reaction to air in transfer line and jumper connectors break, cover block is off	F1	E3
W320-D-PUMP04	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to flammable gas fire/deflagration	Pumping of more solids than anticipated, annulus cooling mod not completed, waste is overheated causing a tank bump that results in large flammable gas release/ignition	F0	E3
W320-D-PURGE01	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to nitrogen line break	Nitrogen line break accompanied by loss of vacuum in system	F0	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-TERM01	Release of ionizing radiation and radioactive gas from Tank 241-AY-102 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation in tank due to natural conditions	F1	E2
W320-D-TRANS01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to tank bump	Rapid waste level change, high waste temperature and resulting tank bump	F1	E2
W320-D-TRANS02	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive sluicer flow	Excessive sluicer flow resulting in radioactive aerosols release through HEPAs	F2	E2
W320-D-TRANS03	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to tank dome breach from impact	During high velocity sluicing operations sluicer moves debris in waste impacting drop leg in tank which breaches dome causing unfiltered release (assumes ventilation system failure)	F2	E2
W320-D-TRANS04	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to increased head space pressure	High temperature in Tank 241-AY-102 causes high temperature sluice water resulting in increased head space pressure with increased errant flow (assumes ventilation system failure)	F2	E2
W320-D-TRANS05	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	GRE causes head space gas concentration above LFL in tank and start of pumping ignites	F1	E3
W320-D-TRANS06	Large release of radioactive aerosols from Tank 241-C-106 to the atmosphere due to flammable gas fire/deflagration	Slurry transfer rate being excessive causing a rapid reduction in the hydrostatic pressure in tank resulting in flammable gas release	F0	E2
W320-D-TRANS07	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Sluice water transfer rate is excessive causing the level of waste to be lowered quickly with the waste temperature too high resulting in a large steam bump and flammable gas release/ignition	F1	E3
W320-D-TRANS08	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to large steam bump	Excessive fluffing of waste in tank resulting in large steam bump and unfiltered release	F1	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-TRANS09	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High pressure sluice induces movement of debris present in waste which impact and breach the tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	F2	E2
W320-D-TRANS10	Release of radioactive aerosols from pit to atmosphere due to spray leak from jumper	Seismic event damages jumper and breaches cover block by ground motion resulting in spray release	F2	E3
W320-D-TRANS11	Release of radioactive aerosols from transfer line to the atmosphere due spray leak	Seismic event damages transfer line by ground motion resulting in spray release	F1	E3
W320-D-VENT01	Release of radioactive aerosols from Tank 241-AY-102 ventilation system to atmosphere due to filter breach from in tank fire/deflagration	Filter breach due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc	F1	E2
W320-D-VENT02	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to steam bump	Inadequate ventilation from W030 resulting in increased waste temperature, steam bump and filter breach	F3	E2
W320-D-VENT03	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters in the 702A ventilation system due to tank bump	Severe ice storm causes excessive tank vacuum resulting in tank bump	F2	E2
W320-D-VENT04	Release of radioactive aerosols from Tank 241-AY-102 through failed filters due to tank bump	Cold water spray into tank (possible result of slurry distribution) tank vacuum and resulting tank bump	F0	E2
W320-D-VENT05	Release of radioactive aerosols from tank to atmosphere through failed filters in the W030 ventilation system due to tank bump	Severe ice storm causes excessive tank vacuum resulting in tank bump	F2	E2
W320-D-VENT06	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due to large steam bump	Volcanic ashfall causes excessive vacuum resulting in large steam bump and filter blowout	F0	E2
W320-D-VENT07	Release of radioactive aerosols from Tank 241-C-105/C-106 ventilation system to atmosphere due to ventilation system leak	Ducting corrosion or seal deterioration undetermined during sluicing (assumes ventilation system failure)	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT08	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum in tank from new ventilation system resulting in loop seal failure and unfiltered release	F3	E2
W320-D-VENT09	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to loss of primary or annulus ventilation	Extended loss of power or severe ventilation casualty causes loss of primary or annulus ventilation which results in steam release	F1	E2
W320-D-VENT11	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum from current ventilation system resulting in loop seal failure and unfiltered release	F3	E2
W320-D-VENT12	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure and tank collapse	F0	E3
W320-D-VENT13	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable fire/deflagration	Influx of cold water spray into tank causing excessive vacuum with a large flammable gas release as a result of slurry distribution; gas is ignited causing dome fire	F0	E3
W320-D-VENT14	Small release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due flammable gas fire/deflagration in the annulus	Loss of primary or annulus ventilation for an extended period resulting in a gradual rise in waste temperature, leak of flammable gas into annulus and ignition resulting in the annulus being breached	F0	E2
W320-D-VENT15	Small release of radioactive aerosols from standpipes in Tank 241-AY-102 due to flammable gas fire/deflagration in pipe	Natural occurrence of flammable gas generation and collection under proper conditions with ignition source present	F2	E2
W320-D-VENT16	Large release of aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration in the dome space	Loss of primary or annulus ventilation for an extended period resulting in a gradual rise in waste temperature, buildup of flammable gas to the LFL and ignition resulting in a dome space fire	F0	E3
W320-D-VENT17	Release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Ice storm prevents air inflow into tank causing excessive tank vacuum, flammable gas release with ignition source resulting in fire/deflagration	F1	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT18	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration in the tank dome space	Volcanic event causes buildup up of ash on top of tank preventing air inflow, excessive vacuum develops and flammable gas is released to the dome space which is ignited resulting in dome space fire	F0	E3
W320-D-VENT19	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere through failed filters due large tank bump	Extended loss of power or severe ventilation casualty causes loss of primary or annulus ventilation for extended period of time resulting in rise in waste temperature and large tank bump	F0	E2
W320-D-VENT20	Release of radioactive aerosols from Tank 241-C-106 to atmosphere due to vacuum induced tank damage	Incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure	F0	E3
W320-E-TERM01	Release of radioactive aerosols from Tank 241-AY-102 to atmosphere due to tank structural damage	Excessive fluffing of waste resulting in tank structural damage	F0	E2
W320-E-TERM03	Large release of radioactive aerosols from Tank 241-AY-102 to the atmosphere due to flammable gas fire/deflagration	Lack of controls on operation of tank after it has been turned into a FG group 1 tank, ignition occurs from lightning strike or other event resulting in a dome space fire	F0	E3
W320-F-TERM05	Release of liquid waste from Tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	Error in calculations cause high heat load after completion of sluicing process resulting in the need for water addition to tank with deteriorated tank liner, water leakage into liner gap, steam formation and bump breaching tank bottom	F1	E2
XS-01-FLOW01	Release of radioactive aerosols from 244 TX DCRT due to ignition of flammable gas atmosphere	Pressure drop in transfer line releases flammable gas into DCRT atmosphere and ignition source causes deflagration	F2	E2
XS-01-FLOW02	Release of liquids, solids and/or vapors from single shell tank due to dome collapse caused by flammable gas burn	Loss of pump prime results in overheated pump that ignites flammable gas	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-01-FLOW03	Release of liquids, solids and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	E3
XS-01-FLOW05	Release of radioactive contaminated liquid from transfer piping to 244 TX DCRT via the raw water system due to reverse flow of liquid waste (pool)	Mis-valving causes mixing of waste into raw water system that causes leak in the flush pit cover block	F2	E2
XS-01-FLOW06	Release of liquid radioactive waste from saltwell pumping transfer piping in DCRT pump pit to surface due to overflow (pool)	Open jumper in single shell tank pump pit leads to overflowing of pump pit	F3	E2
XS-01-FLOW07	Release of liquid radioactive waste to the soil from transfer piping from SST to DCRT due to leakage (plume)	Pipe failure from various causes	F3	E2
XS-01-PRES01	Release of liquid radioactive waste from damaged transfer piping to 244 TX DCRT due to over pressure (pool)	Use of wrong size pump and closed valve causes over pressure and subsequent pipe failure	F2	E2
XS-01-PRES02	Release of liquid radioactive waste from transfer pipe due to damaged saltwell pump	Leak from pump or seal from various causes	F3	E2
XS-01-TEMP01	Release of steam-aerosol from transfer piping in pump pit due to steam hammer and resulting pipe damage	Extended recirculation and consequential heating of saltwell liquid with sudden opening of valve when cover block is open	F3	E2
XS-02-FLOW04	Release of liquid radioactive waste to soil from transfer pipe (non-pool) subsurface plume	Failure to adjust waste pH prior to transfer causes leak	F2	E2
XS-02-FLOW05	Release of liquid radioactive waste to the soil from PFP transfer piping due to pipe break	Pipe break from various causes	F3	E2
XS-03-LEVE	Release of radioactive liquids from DCRT "annulus" (vault) due to DCRT leak	Corrosion or structural failure of DCRT or associated piping	F3	E2
XS-03-LEVE01 XS-21-LEVE (244-S DCRT)	Release of combustion products from 244 TX DCRT due to flammable gas burn in tank atmosphere	Evaporation of DCRT contents causing decreased ability of waste to retain flammable gases and spark source	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-03-LEVE02 XS-21-LEVE (244-S DCRT)	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Evaporation of DCRT contents with increased solids settling on DCRT bottom creates critical mass	F3	E2
XS-03-PRES01 XS-21-PRES (244-S DCRT)	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn in tank atmosphere	Loss of ventilation flow with accumulation of flammable gas and spark source	F2	E2
XS-03-PRES05	Release of toxic vapors from DCRT due to increased concentrations in DCRT atmosphere	Transfer of steam from PFP causing evolution of toxic gases due to heating tank	F2	E2
XS-03-TEMP01 XS-21-TEMP (244-S DCRT)	Release of liquid radioactive waste from DCRT due to flow path to soil	Exceeding structural or corrosion limits on tank due to high temperature waste transfer to DCRT concurrent with vault leak	F3	E2
XS-03-TEMP02 XS-21-TEMP (244-S-DCRT)	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Transfer of material into tank that violates criticality specification	F3	E2
XS-03-TEMP03 XS-21-TEMP (244-S-DCRT)	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn-fire/explosion in tank atmosphere	Buildup of gases, loss of ventilation, and spark source	F2	E2
XS-03-TEMP04 XS-21-TEMP (244-S-DCRT)	Release of liquid radioactive waste from 244 TX DCRT due to overflow	Freezing temperatures causing raw water line break-leak with leakage to tank causes overflow	F3	E2
XS-03-TEMP09	Release of liquid radioactive waste from DCRT due to flow path to soil	Exceeding structural limits on tank due to high temperature caused by transfer of steam from PFP as well as vault leak	F1	E3
XS-05-FLOW02	Release of liquid radioactive waste from DCRT due to flow path to soil	Exceeding structural limit on tank due to replacement of exhaust fan with higher capacity fan and blockage of ventilation inlet concurrent with vault leak	F2	E3

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-05-TEMP01	Release to atmosphere of materials from DCRT ventilation filters and tank due to fire	Fire in ventilation system due to failure of ventilation heater controls	F3	E2
XS-05-TEMP02	Release to atmosphere of materials from DCRT ventilation filters and tank due to filter degradation	Fire in ventilation system due to flammable gas buildup and ignition	F3	E2
XS-06-FLOW01	Release of fission product gases and aerosols from 244 TX DCRT due to criticality	Transfer of inadequately recirculated waste from tank due to failure to appropriately balance flow between recirculation and transfer line causing buildup of solids creating critical mass	F3	E2
XS-06-FLOW02	Release of liquid radioactive waste from DCRT transfer piping to Tank 241-SY-102 due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	E3
XS-06-FLOW03	Release of liquid radioactive waste from transfer piping from PFP to DCRT due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	E3
XS-06-FLOW04	Release of liquid radioactive waste from transfer piping from an SST to a DCRT due to spray leak (SPUTTER) of saltwell liquor from DCRT pump pit	Pipe failure	F2	E3
XS-06-FLOW05	Release of waste from transfer pipe out of 244 TX DCRT to the soil due to flow path to soil	Concurrent failure of transfer piping and encasement	F2	E2
XS-07-FLOW01	Release of radioactive waste to soil from transfer piping out of 244 TX DCRT due to leak in primary pipe and encasement	Excavation accident fails primary pipe and encasement	F3	E2
XS-07-FLOW02	Release of radioactive waste to soil from transfer piping out of 244 TX DCRT due to leak in primary pipe and encasement	Corrosion of inner and outer pipe	F3	E2
XS-07-FLOW03	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	High structural loading from traffic or cranes cause failure of primary pipe and encasement	F3	E2
XS-07-FLOW04	Release of radioactive waste to soil from transfer piping of 244 TX DCRT due to leak in primary pipe and encasement	Seismic event fails primary pipe and encasement	F2	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-07-FLOW05	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	Undermining due to leak of nearby pipes cause failure of primary pipe and encasement	F3	E2
XS-07-FLOW06	Release of radioactive waste to soil from transfer pipe out of 244 TX DCRT due to leak in primary pipe and encasement	Water hammer causes failure of primary pipe and encasement	F3	E2
XS-11-LEVE01	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Plugged drain and misrouting causes overflow	F3	E2
XS-11-LEVE02	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Plugged drain and open jumper causes overflow	F3	E2
XS-11-LEVE03	Release of radioactive waste from diversion box to surface due to overflow	Plugged drain and piping leak causes overflow	F3	E2
XS-12-FLOW05	Release of radioactive waste from diversion box to surface due to overflow of transfer from 244 TX	Backflow from catch tank causes overflow from diversion box	F3	E2
XS-12-FLOW06	Release of radioactive waste to the soil from diversion box drain due to a spill of radioactive liquid into 241-U-152 diversion box	Leak of diversion box drain line upstream of catch tank	F3	E2
XS-13-LEVE	Release of liquid radioactive waste to soil from 241-U-301B catch tank due to leak in catch tank contents to soil	Failure of catch tank due to various causes	F3	E2
XS-13-PRES01	Release of radioactive aerosols from 241-U-301B catch tank due to chemical reaction	Draining of incompatible chemicals to catch tank	F3	E2
XS-13-PRES02	Release of radioactive aerosols from 241-U-301B catch tank due to fire/explosion of flammable gas	Buildup of flammable gas in catch tank and spark source	F2	E2
XS-13-PRES04	Release of fission product gases and aerosols from catch tank 241-U-301B due to criticality	Transfer of excess fissile material to catch tank creates critical mass	F1	E2
XS-20-FLOW01	Release of radioactive aerosols from 244 TX DCRT due to chemical reaction	Transfer of incompatible waste to 244-TX DCRT due to improper valve lineup	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-20-FLOW02	Release of radioactive aerosols from T-Plant tank due to chemical reaction	Transfer of incompatible waste to T-Plant due to improper valve lineup	F2	E2
XS-20-FLOW03	Release of radioactive aerosols from 244 TX DCRT due to positive pressure caused by chemical reaction	Chemical reaction of 244-S material with contents of 244-TX caused by misrouting	F2	E2
XS-20-FLOW04	Release of toxic vapors from 244 TX DCRT due to chemical reaction with incompatible material in 244 S DCRT	Mixing contents of 244-TX and 244-S due to misrouting causes chemical reaction	F2	E2
XS-20-FLOW05	Release of fission product gases and aerosols from 244 S DCRT (not designated solids receiver) due to criticality	Transfer of waste from 244-TX DCRT due to improper valve lineup creates critical mass	F1	E2
XS-20-FLOW06	Release of radioactive aerosols from T-Plant tank due to positive pressure	Chemical reaction of 244-S material with contents of T-Plant tank due to misrouting causes positive pressure in tank	F2	E2
XS-20-FLOW07	Release of toxic vapors from T-Plant due to chemical reaction with incompatible material in 244 S DCRT	Mixing contents of 244-S with contents of T-Plant tank due to misrouting causes chemical reaction	F2	E2
XS-20-FLOW08	Release of radioactive waste from 244 TX DCRT to surface due to overflow	Transfer of excess waste to 244-TX DCRT due to improper valve lineup causes overflow	F3	E2
XS-20-FLOW09	Release of radioactive waste from 244 S DCRT to surface due to overflow	Transfer of waste from 244-TX DCRT due to improper valve lineup causes overflow	F3	E2
XS-26-PRES XS-26-TEMP	Release of toxic vapors from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible waste causes chemical reaction	F3	E2
XS-26-PRES XS-26-TEMP 102-AW-TEMP (FOR TK-102-AW)	Release of fission product gases and aerosols from Tank 241-SY-102 due to criticality	Transfer of critical mass of fissile material and achievement of critical geometry	F1	E2
XS-26-PRES01	Release of radioactive aerosols from Tank 241-SY-102 due to chemical reaction	Mis-transfer of incompatible waste causes chemical reaction	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-26-PRES02	Release of radioactive aerosols from Tank 241-SY-102 due to flammable gas fire/explosion (dome collapse)	Accumulation of flammable gases in vapor space and spark source	F2	E2
XS-26-TEMP01	Release of radioactive aerosols from Tank 241-AW-102 due to tank bump	High heat waste plus loss of cooling contributes to tank bump	F2	E2
XS-35-FLOW01	Release of radioactive liquid waste to soil from 242-S Evaporator due to leak of un-encased direct buried piping (plume)	Corrosion or other causes	F3	E2
XS-35-FLOW02	Release of radioactive waste to surface from 242-S Evaporator sump due to backflow to and overflow	Human error of leaving open flow path after emptying the sump and backflow and subsequent overflow	F3	E2
XS-37-FLOW01	Release of radioactive liquid waste from catch tank to surface due to overfilling (pool)	Leak of transfer piping with drainage to catch tank causes overflow	F3	E2
XS-37-FLOW02	Release of radioactive liquid waste to soil from transfer piping due to leak of liquid waste from concrete encasement (subsurface plume)	Leak of transfer piping with encasement leak or blocked drain to catch tank (liquid oozes out concrete encasement)	F3	E2
XS-41A-FLOW01	Release of radioactive waste from vent station nozzle pit to surface due to overflow	Catastrophic failure of vent piping causes overflow of nozzle pit	F3	E2
XS-41A-FLOW02	Release of radioactive waste to surface from vent station nozzle pit due to overflow	Vent valve left open or leaking during transfer causes overflow	F3	E2
XS-41B-LEVE01	Release of radioactive aerosols from vent station catch tank due to flammable gas fire/explosion in nozzle pit	Failure to empty catch tank with buildup of flammable gas in nozzle pit plus ignition source	F2	E2
XS-41B-LEVE03	Release of radioactive waste to surface from vent station nozzle pit due to overflow	Failure to empty catch tank, causing overflow of tank and pit due to transfer failure	F3	E2
XS-41C-LEVE01	Release of radioactive aerosols from vent station catch tank due to flammable gas fire/explosion in catch tank pit	Leak of catch tank with buildup of flammable gas in catch tank pit plus ignition source	F2	E2
XS-48-FLOW	Release of liquid waste to soil from transfer piping between B-Plant and 241-ER-152 diversion box due to leak (plume)	Piping failure from various causes	F3	E2

Table D-4. Hazardous Conditions With Potential Severe Environmental Consequences (E2 and E3). (96 Sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
XS-52-FLOW01	Release of radioactive waste to surface from transfer piping to Tank 244-CR-003 due to leak (pool)	Failure of pipe from various causes	F2	E2
XS-52-FLOW02	Release of radioactive waste from Tank 244-CR-003 to surface due to overflow (pool)	Mis-valving or valve failure during cross-site transfer causes overflow	F3	E2

Table D-5. Hazardous Conditions With Potential Radiation Exposure Consequence (RP). (6 Sheets)

ID	Hazardous Condition	Cause
102AW-04-PRES.01	Personnel exposure higher than expected	Removal of cover block and pressure release due to loss of fan.
102AW-13-FLOW.01	Personnel exposure due to radiation doses from contaminated pipes	Multiple valving errors and failure of backflow prevention causing reverse flow from valve pit to flush pit
114SX-06.b	Personnel exposed to ionizing radiation due to lack of shielding	Inadvertent removal of tank overburden (gravel)
244AR-06.a.02	High activity radioactive material exposes person to ionizing radiation	Tank ventilation heater coil failure
244AR-07.a.04	Exposure to low concentrations of radioactive material	Excess water used in steam jet flush
244AR-PH03	Contamination of personnel with radioactive material	Radioactive contamination in canyon or sample gallery being disturbed by personnel entry
CP-GRT-01	Personnel exposure to contaminated pipe string due to removal of pipe during grouting	Contaminated soil in pipe
CP-MSP-09	Release of isotope source to the soil surface due to load drop	Human Error caused load drop
CP-MSP-11	Release of radioactive material to the soil surface due to crushed sensor package	Human Error: Heavy load inadvertently set on top of sensor package
CP-RMV-02	Personnel exposure to high level waste contamination on surface of pipe string due contact with leaking waste	Human error caused puncture to inactive transfer line during push operations
CP-RMV-04	Personnel exposure to radiation through push pipe due to puncture of tank dome	Human error results in removal of sample canister containment
CP-SET-09	Release of isotope source from the MSP to the soil surface due to load drop	Human error causes load drop
CP-SET-11	Release of radioactive material from the MSP to the soil surface due to crushing of the sensor package	Human error: Heavy load is inadvertently set on top of the sensor package
CP-SSP-06	Personnel exposure to contaminated soil sample while removing sampling canister from pipe sleeve	Human error
CP-SSP-07	Personnel exposure to contaminated soil sample while removing sampling canister from pipe sleeve	Mechanical failure
CP-SSP-08	Personnel exposure to contaminated soil sample while removing sampling canister from pipe sleeve	High wind

Table D-5. Hazardous Conditions With Potential Radiation Exposure Consequence (RP). (6 Sheets)

ID	Hazardous Condition	Cause
CP-SSP-09	Personnel exposure to contaminated pipe string caused by failure of sampling canister soil catcher to close properly	Mechanical failure
CP-SSP-10	Personnel exposure to puff release of contaminated dust (particulates) caused by air movement as the sample canister is withdrawn from pipe sleeve	Contaminated inner tube
CP-SSP-11	Release of contamination to environment due to dropping of the sample canister during transfer of sample from pipe to the shipping cask	Human error - workers drop sample canister or fail to handle properly
CP-SSP-12	Release of contamination to environment due to dropping of the sample canister during transfer of sample from pipe to the shipping cask	Mechanical failure of the sample canister
CP-SSP-13	Release of contamination to environment due to dropping of the sample canister during transfer of sample from outer push pipe to the shipping cask	High wind
CP-SSP-14	Release of contamination to environment due to dropping of the repackaged soil sample container	Human error - workers drop sample canister or fail to handle properly
CP-SSP-15	Release of contamination to environment due to dropping of the repackaged soil sample container	High wind
CRN-14	Boom failure leads to worker injury or exposure	Human error: improper load assembly, rigging, crane overloaded
CRN-15	Boom failure leads to worker injury or exposure	Mechanical failure: corrosion, faulty materials
CRN-16	Boom failure leads to worker injury or exposure	High wind or seismic event
CVR-06	Person falls in pit sustaining injury or exposed to surface radiation in pit	Failure to erect fence or failure to erect securely
CVR-07	Person falls in pit sustaining injury or exposed to surface radiation in pit	Person leans over fence too far
CVR-08	Person falls in pit sustaining injury or exposed to surface radiation in pit	Fence failure
CVR-09	Person falls in pit sustaining injury or exposed to radiation	Seismic event or high wind/tornado
DCN-01	Decontamination personnel are contaminated or exposed	Failure of PPE
DCN-01-I	Injury of worker from contamination or exposure of decontamination personnel due to failed PPE	Failure of PPE

Table D-5. Hazardous Conditions With Potential Radiation Exposure Consequence (RP). (6 Sheets)

ID	Hazardous Condition	Cause
DCN-06	Personnel exposure higher than expected	More contamination than expected
DCN-06-I	Injury of worker from higher than expected exposure due to unknown contamination	More contamination than expected
I-PUREX-2-PRS-C	Personnel exposure due to vacuum pulling radioactive material back to operating gallery, worker hazard at PUREX (dose concern)	Failure to air purge line after transfer (mechanical failure)
I-PUREX-4-PRS-C	Personnel exposure due to vacuum to pulling radioactive material back to operating gallery, worker hazard at PUREX (dose concern)	Failure to air purge line after transfer (mechanical failure)
LDUA 1-10	Worker exposure due to leak of waste into LDUA components	Line plug
LDUA 1-11	Worker exposure due to leak of waste into LDUA components	Line break
LDUA 1-34	Worker exposure due to operation error or mechanical failure	Operator error or mechanical failure
LDUA 2-13	Worker exposure due to leak of waste into LDUA components	Line plug
LDUA 2-14	Worker exposure due to leak of waste into LDUA components	Line break
LDUA 2-53	Worker exposure due to contamination in LDUA	LDUA contamination - due to in-tank activities
LDUA 3-4	Worker exposure due to purge system overpressure - increased contamination in TRIC	Purge system overpressure (VPM auxiliary hookup)
LDUA 3-5	Worker exposure due to loss of decontamination water flow	Loss of decontamination water flow
LDUA 3-7	Worker exposure due to plug in decontamination line resulting in poor decontamination	Decontamination water line plugs due to solids
LDUA 4-10	Worker exposure due to ignition of flammable gas inside VPM	Loss of supply air from VPM outer tube.
LDUA 4-39	Worker exposure due to loss of computer controls/ requires manual retrieval of mast	Loss of computer
LDUA 4-40	Worker exposure due to insufficient decontamination	Mast tubes not sufficiently decontaminated prior to removal
LDUA 4-8	Worker exposure due to leak of waste into LDUA components	Line plug
LDUA 4-9	Worker exposure due to leak of waste into LDUA components	Line break

Table D-5. Hazardous Conditions With Potential Radiation Exposure Consequence (RP). (6 Sheets)

ID	Hazardous Condition	Cause
LDUA 5-35	Worker exposure due to misalignment of mast arm during insertion creating external contamination	Misaligning during insertion
LDUA/EREE 1-10	Worker exposure due to leak of waste into EREE	Line break
LDUA/EREE 1-29	Worker exposure due to operator error/mechanical failure	Operator error or mechanical failure
LDUA/EREE 1-30	Worker exposure due to operator error/mechanical failure	Operator error or mechanical failure
LDUA/EREE 1-8	Worker exposure due to leak of waste into EREE	Compressor fails
LDUA/EREE 1-9	Worker exposure due to leak of waste into EREE	Line plug
OGT-FLOW1-01	Personnel exposure to radioactive or hazardous material in the primary pipe due to pump failure	Pump failure, material settles in line (crystallization) and plugs line prohibiting transfer/waste is sitting in line and creates increased exposure to personnel
OGT-SPEC1-01	Personnel exposure to radioactive or hazardous material in the primary pipe due to loss of electrical supply	Loss of flow leading to line plug and the need to remove/replace, unclog line
OGT-TEMP1-01	Personnel exposure to radioactive or hazardous material from the primary pipe due leak caused by low ambient temperature	Plugging of pipe due to crystallization or due to freezing for very low temperature
RAD-01	Exposure to radioactive and/or toxic materials from pits or risers due to radiation monitoring failure	Failure to monitor
RAD-01-I	Injury of worker from exposure to radioactive materials due to failure to monitor radiation	Failure to monitor
RAD-02	Exposure to radioactive and/or toxic materials from pits or risers due to radiation monitoring failure	Failure of monitoring instrument
RAD-03	Exposure to radioactive and/or toxic materials from pits or risers due to radiation monitoring failure	Improper calibration of monitoring instrument
RCSTS-01-FLOW01	Release of radioactive slurry or supernate to the the soil surface from overflow of the 244-S catch station due to reverse flow	Reverse flow to 244-S catch station caused by improper valve lineup
RCSTS-03-FLOW01	Release of radioactive slurry or supernate to the SY flush pit from transfer line due to backflow	Reverse flow to flush pit caused by improper valving sequence

Table D-5. Hazardous Conditions With Potential Radiation Exposure Consequence (RP). (6 Sheets)

ID	Hazardous Condition	Cause
RCSTS-03-PRES01	Release of radioactive material to atmosphere from SY valve pit due to over-pressurization event in Tank 241-SY-102	Pressure event in Tank 241-SY-102 with loss of valve pit seal loop water
RCSTS-08-AIR01	Personnel exposure to radioactive vapors in the diversion box atmosphere from accumulated waste in diversion box due to pipe encasement draining	Draining of the encasement
RCSTS-08-AIR03	Personnel exposure to radioactive vapors in the diversion box atmosphere due to waste being present in box	Leak of waste solution
RCSTS-08-RAD01	Personnel exposure to radioactive material in the diversion box from transfer piping due to encasement draining	Draining of the encasement
RCSTS-08-RAD03	High radiation dose to worker from the diversion box due to the presence of residual radioactive contamination	Holdup of radionuclides due to trapped radioactive material in pumps or pipes
RCSTS-09-AIR01	Personnel exposure to radioactive vapors in the vent station atmosphere from accumulated waste in vent station due to pipe encasement draining	Draining of the encasement
RCSTS-09-AIR02	Personnel exposure to radioactive vapors in the vent station atmosphere due to waste being present in station	Leak of waste solution
RCSTS-09-RAD01	Personnel exposure to radioactive material in the vent station from transfer piping due to encasement draining	Draining of the encasement
RCSTS-09-RAD03	High radiation dose to worker from the vent station due to the presence of residual radioactive contamination	Holdup of radionuclides due to trapped radioactive material in pipes
RCSTSFS-LEVEL02	Personnel exposure to caustic solution and radionuclides in the sump pit from the water flush tank due to over filling of tank	Flush tank receives radioactive waste from transfer line during drainback process. Jumper block valves and raw water block valves opened during the drainback of waste from vent station of the cross site transfer line.
RCSTS-5FS-FLOW03	Personnel exposure to radioactive material in water flush tank due to loss of flush system pump operation	Loss of pump pressure during flush operation causing back flow of waste
RCSTS-GENERAL-PRES	Release of radioactive material to the soil surface from supernate or slurry piping due to encasement breach (pipe is considered empty except for residual contamination)	Pneumatic leak testing
RSR-02-I	Injury of worker from exposure to asbestos from gasket materials during access to riser due to failure to follow procedures	Failure to follow asbestos procedures

Table D-5. Hazardous Conditions With Potential Radiation Exposure Consequence (RP). (6 Sheets)

ID	Hazardous Condition	Cause
RSR-03-I	Injury of worker from exposure to asbestos from gasket materials during access to riser due to failure of PPE or fresh air supply	Failure of mask or fresh air (if appropriate)
RSR-04	Direct radiation exposure from open riser due to human error	Failure to follow procedures, failure to monitor or improper monitoring
RSR-04-I	Injury of worker from exposure to direct radiation exposure from open riser due to failure to follow procedures	Failure to follow procedures, failure to monitor or improper monitoring
VEH-04	Personnel receive radiation exposure from casks during transport due to human error	Personnel drive the vehicles or work near the cask transport vehicle
VEH-04-I	Injury of worker from radiation exposure from casks during transport due to inappropriate ALARA practices	Driver receives unexpected exposure or personnel work near the cask transport vehicle
W030-42	Release of accumulated radiological material from ventilation system HEPA filters to atmosphere exposing facility worker	Occupational radiation exposure caused by mishandling contaminated HEPA filter during replacement or repair
W151-18	Leak of waste to pit	Personnel exposure to radioactive/hazardous material due to leak of waste into pit
W151-23	Increased exposure to personnel	Personnel exposure to increased ionizing radiation due to mixer pump operation
W151-54	Contamination on equipment	Personnel exposure to radioactive/hazardous material due to the spill of radioactive material during equipment removal operations
W151-55	Release through open riser	Personnel exposure to radioactive/hazardous aerosols from open riser due to air flow reversal
W320-ABCD-TRANS14a	Personnel exposure to ionizing radiation due to flooding	Raw water line rupture uncovers transfer lines
W320-ABCD-TRANS14b	Personnel exposure to ionizing radiation due to flooding	Natural flooding uncovers transfer lines
W320-ABCD-TRANS15	Personnel exposure to ionizing radiation due to high winds	High winds uncover transfer lines
W320-ABCD-TRANS16	Personnel exposure to ionizing radiation due to excavation	Mistake in excavation uncovers transfer lines
W320-BCD-FLUSH03*	Personnel exposure to ionizing radiation from flush tank of transfer truck due to flush tank filling with radioactive material	Start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line, flush tank fills with radioactive material

Table D-6. Hazardous Conditions With Potential Occupational Safety Consequences. (7 Sheets)

ID	Hazardous Condition	Cause
102AW-02-PRES.01 XS-26-PRES.01	Personnel injured by projectile debris from catastrophic fan failure	Loss of fan due to high pressure causing fan to walk into another object and become airborne
102AW-04-STRU.01	Personnel injured by falling equipment	Equipment drop during crane work
107AN-01-TEMP.01	Thermal hazard to personnel	Caustic in tank heated too hot at source
244AR-05.a.01	Weak roof structure permits person to fall through roof	Aging (roof)
244AR-PH01	Water hammer during setup for jetting	Condensate in the lines coming into contact with steam
244AR-PH02	Asphyxiation due to entry into confined space	Lack of oxygen due to corrosion, decomposition or fire/explosion
244AR-PH04	Person falls from elevated surface	Roof weakness (more than 2 stories high)
244AR-PH05	Person falls from elevated surface	Crane maintenance activities
244AR-PH06	Person falls from elevated surface	Walking over weak filter vault roof
244AR-PH07	Person falls from elevated surface	Ladder climbing
244AR-PH08	Person comes in contact with rotating equipment	Maintenance work on rotating equipment
244AR-PH09	Person comes in contact with rotating equipment	Process operations activities
244AR-PH10	Person injured by failure of equipment during over speed event	Equipment malfunction
244AR-PH11	Personnel injury from contact with energized circuits or faulted equipment	Insulation failure
244AR-PH12	Personnel injury from contact with energized circuits or faulted equipment	Maintenance activities
244AR-PH13	Personnel injury from contact with energized circuits or faulted equipment	Mechanical damage to insulation
244AR-PH14	Personnel injury due to electrical fire	Insulation failure
244AR-PH15	Personnel injury due to electrical fire	Overload conditions, breaker failure, sparking in flammable atmosphere
244AR-PH16	Personnel exposure to insulation or construction materials containing asbestos	Disturbance from: fire, maintenance, wind, aging, water intrusion

Table D-6. Hazardous Conditions With Potential Occupational Safety Consequences. (7 Sheets)

ID	Hazardous Condition	Cause
244AR-PH17	Personnel exposed to toxic or corrosive materials	Maintenance and operations activities combined with leakage such as pipe failure, pump failure or valve packing leaks
244AR-PH18	Personnel injured by high pressure gas bottles becoming projectiles	Malfunction of bottle regulator
244AR-PH19	Personnel injured by high pressure gas bottles becoming projectiles	Improper storage and transport
BND-01	Industrial hazards (lifting, bending, tool accidents; creates tripping hazard)	Failure to follow safe work practices, equipment failures
BND-01-I	Injury of worker from (lifting, bending, tool accidents; creates tripping hazard) due to bonding activities	Failure to follow safe work practices, equipment failures
BND-02-I	Injury of worker from ignition of combustibles due to preparation for bonding	Drilling holes for bonding attachments causes sparks which is a hazard
CCF-14	Personnel illness or asphyxiation due to air supply faults	SCBA air supply of poor quality
CCF-15	Degraded operations, increased down time, possible personnel injury due to supply of inferior parts	Faulty parts or equipment supplied (e.g. o-rings, seals, electronics, HEPAs, pressure regulators, etc)
CDP-09	Driver error during drive-by causes injury to personnel	Driver error
CRN-14-I	Injury of worker from boom failure due to human error	Human error: improper load assembly, rigging, crane overloaded
CRN-15-I	Injury of worker from boom failure due to mechanical failure	Mechanical failure: corrosion, faulty materials
CRN-16-I	Injury of worker from boom failure due to high wind or seismic	High wind or seismic event
CRN-17-I	Injury of worker from electricity due to crane hitting powerlines/supplies	Human error: improper load assembly, rigging, crane positioning
CRN-24	Carbon monoxide from crane accumulates in pits or temporary confinement (greenhouse, etc)	Oxygen deficient atmosphere and failure to provide adequate ventilation, Failure to sniff or improper sniffing
CRN-24-I	Injury of worker from carbon monoxide accumulation in pits or temporary confinement (greenhouse, etc) due to crane motor exhaust	Failure to provide adequate ventilation,!Failure to sniff or improper sniffing
CRN-25	Loss of lateral load control, swinging load into personnel or equipment	Human error: improper load assembly, rigging, positioning error
CRN-25-IA	Injury of worker from swinging load into personnel due to loss of lateral load control	Human error: improper load assembly, rigging, positioning error

Table D-6. Hazardous Conditions With Potential Occupational Safety Consequences. (7 Sheets)

ID	Hazardous Condition	Cause
CRN-26	Loss of lateral load control, swinging load into personnel or equipment	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil
CRN-26-IA	Injury of worker from swinging load into personnel due to loss of lateral load control	Mechanical failure: corrosion, faulty materials, hydraulics, outriggers in soft soil
CRN-27	Loss of lateral load control, swinging load into personnel or equipment	High wind or seismic event
CVR-10	Person(s) asphyxiated	Oxygen deficient atmosphere and failure to sniff or improper sniffing
CVR-10-I	Injury of worker from asphyxiation due to pit atmosphere	Failure to sniff or improper sniffing
CVR-11	Person(s) asphyxiated	Oxygen deficient atmosphere and fresh air supply faults
CVR-11-I	Injury of worker from asphyxiation due to fresh air supply faults	Fresh air supply faults
CVR-14-I	Injury of worker from biological hazards (spiders, snakes, etc.) due to open nozzles or risers in pit	Open nozzles or risers in pit with biological hazards (spiders, snakes, etc.) inside
DCN-05	Personnel injury by contact with tools	Human error
DCN-05-I	Injury of worker from contact with tools due to human error during decontamination activities	Human error
DCN-07	Personnel exposed to asphyxiant	Oxygen deficient atmosphere and PPE failure or absence in confined space
DCN-07-I	Injury of worker from exposure to asphyxiant due to PPE failure	PPE failure or absence in confined space
EE-12	Washout of soils surrounding a transfer pipe	Water main to evaporator or steam plant breaks
EE-13	Steam jet impinges on equipment supporting multiple tanks	Steam line break
EE-14	Worker injury due to electrocution	Excavation into power source
EE-15	Washout of soils resulting in sink hole due to excavation error	Excavation into water line
GRN-01	Industrial hazards (lifting, bending, trips and falls, tool operations)	Human errors
GRN-01-I	Injury of worker from (lifting, bending, tool accidents; creates tripping hazard) due to temporary confinement activities	Human errors

Table D-6. Hazardous Conditions With Potential Occupational Safety Consequences. (7 Sheets)

ID	Hazardous Condition	Cause
GRN-02	Industrial hazards (lifting, bending, trips and falls, tool operations)	Mechanical failure of equipment, tools
GRN-02-I	Injury of worker from (lifting, bending, trips and falls, tool operations) due to mechanical failures	Mechanical failure of equipment, tools
GRN-03-I	Injury of worker from asphyxiants in greenhouse due to collection of asphyxiants before removal	Human error
I-242A-2-CMP-A	Release (potential for leak) to tank annulus (secondary confinement) caused by damage to feed tank due to overfilling of tank	Valve failure or inadvertently opened valve
I-242A-7-PRS-A	Personnel hazard from ruptured compressed air line	Failure of compressor unloading switch due mechanical failure or incorrect setting during maintenance
I-242S-5-PRS-A	Personnel hazard due to rupture of compressed air line	Human error - failure of compressor unloading switch due to incorrect setting during maintenance
LDUA 2-50	Worker injury due to equipment damage	Human error, software bug
LDUA 2-54	Worker injury due to industrial accidents	Industrial accidents
LDUA 3-19	Worker injury due to general industrial hazards	General industrial hazards (e.g. during end effector change out)
LDUA 3-20	Worker injury due to electric shock	Electric shock hazards during hook-up and maintenance
LDUA 4-11	Worker injury due to blow out of housing panel	Supply pressure on with the VPM housing gate closed
LDUA 4-43	Worker injury due to industrial hazards	Industrial hazards during maintenance
LDUA 5-17	Worker injury due to inadvertent motion of valve	Operator error, improperly positioned valves
LDUA 5-21	Worker injury due to shock load damaging equipment	Shock load causes damage
LDUA 5-32	Worker injury due to vehicle engine fire	Vehicle engine fire
LDUA 6-28	Worker injury due to communication failure	Communication failure between control locations and TRIC during maintenance
LDUA 6-29	Worker injury due to lifting	Lifting injuries in moving heavy cable
LDUA 6-30	Worker injury due to electric shock	Electrical malfunction
LDUA 6-5	Worker injury due to fire	Fire

Table D-6. Hazardous Conditions With Potential Occupational Safety Consequences. (7 Sheets)

ID	Hazardous Condition	Cause
LDUA 6-7	Worker injury due to electric shock	Impact, severing of cable by heavy equipment
LDUA 7-12	Worker injury due to accident when parking trailer	Collision with obstacles during parking of trailer
LDUA 7-13	Worker injury due to electric shock	Improper grounding - bonding
LDUA 7-14	Worker injury due to electric shock	Electrical shock hazards during hook-up
LDUA 7-16	Worker injury due to electric shock	Dust in electronic distribution disconnects and junction box
LDUA 7-3	Worker injury due to slipping hazard	Slipping hazards
LDUA 7-4	Worker injury due to fire	Fire in trailer
LDUA 7-6	Worker injury due to trailer falling over	Wind
LDUA 7-7	Worker injury due to trailer falling over	Seismic event
RAD-02-I	Injury of worker from exposure to radioactive materials due to radiation monitoring failure	Failure of monitoring instrument
RAD-03-I	Injury of worker from exposure to radioactive materials due to radiation monitoring failure	Improper calibration of monitoring instrument
RCSTS-08-AIR02	Exposure to chemical vapors and liquids in diversion box due to the spill or leak of chemicals in confined space	Chemicals brought in for decontamination and maintenance
RCSTS-08-AIR04	Personnel exposure to chemical waste in diversion box from leak of waste solution	Leak of waste solution
RCSTS-08-OCC01	Worker injury due to welding gas bottle becoming a missile in diversion box	Damage from welding gas bottle during maintenance activity in diversion box
RCSTS-08-OCC02	Worker discomfort from cold temperatures in diversion box	Running an exhauster during cold weather
RCSTS-09-AIR03	Exposure to chemical vapors and liquids in vent station due to the spill or leak of chemicals	Chemicals brought in for decontamination and maintenance
RCSTS-09-AIR04	Personnel exposure to chemical waste in diversion box from leak of waste solution	Leak of waste solution
RCSTS-09-OCC01	Worker injury due to welding gas bottle becoming a missile in vent station	Damage from welding gas bottle during maintenance activity in vent station

Table D-6. Hazardous Conditions With Potential Occupational Safety Consequences. (7 Sheets)

ID	Hazardous Condition	Cause
RCSTS-09-OCC02	Worker discomfort from cold temperatures in vent station	Running an exhauster during cold weather
RCSTSFS-LEVEL01	Personnel exposure to caustic solution in the sump pit from the water flush tank due to over filling of tank	Operator error - overfill of caustic material
RCSTSFS-LEVEL04	Personnel exposure to caustic solution in the sump pit from the water flush tank due to human error	Human error - drain valve left open
RCSTS-4FS-FLOW02	Personnel exposure to caustic material in the caustic storage area from caustic drum due to handling error	Materials handling accident
RSR-02	Asbestos hazard from gasket materials during access to riser	Failure to follow asbestos procedures
RSR-03	Asbestos hazard from gasket materials during access to riser	Failure of mask or fresh air (if appropriate)
RSR-08-I	Injury of worker from falling into facility due to large access opening and human error	Human error
SFF-01-I	Injury of worker from exposure to toxic materials due to sniff sampling failure	Improper sniffing technique or instrument failure
VEH-05	Vehicle impact with electrical power pole	Loss of control of vehicle or lack of attention to driving
VEH-05-I	Injury of worker from impact with electrical power pole due to vehicle accident	Loss of control of vehicle or lack of attention to driving
VEH-06	Personnel are pinched or crushed between vehicle and solid structure	Vehicle moves exerting pressure on personnel between vehicle and solid structure
VEH-06-I	Injury of worker from being pinched or crushed between vehicle and solid structure due to inattention to situation	Vehicle exerts pressure on personnel located between the vehicle and solid structure
VSU-05	Tripping hazard	Exposure above ground level
VSU-06	Falling hazard	VSU without a lid and not capped
W030-X35	Personnel injury due to fire	Fire in switch gear room caused by electrical short or overloading
W030-X36	Personnel injury due to electrical shock	High energy (electrical conductors) in switch gear room
W030-X37	Personnel injury and equipment damage due to diesel fire	Spill of diesel fuel and subsequent ignition
W151-53		Personnel injury due to high pressure leak

Table D-6. Hazardous Conditions With Potential Occupational Safety Consequences. (7 Sheets)

ID	Hazardous Condition	Cause
W320-ABCD-VENT01	Release of toxic gas to the atmosphere from Tank 241-AY-102 due to failure of ventilation system	Loss of ventilation causes gradual rise in waste temperature resulting in toxic gas release from tank and to workers
W320-B-TERM01	Release of toxic ammonia gas from tank to atmosphere due to burp which exposes facility personnel to toxic gases	Inadequate prediction of waste behavior
W320-D-VENT10	Personnel exposure to toxic gas from Tank 241-AY-102 due to inadequate ventilation from W030	Inadequate ventilation from W030 resulting in high waste temperature, increased toxic gas release and facility worker inhalation of toxic gases
W320-E-TERM02	Release of toxic hydrogen cyanide gas from Tank 241-AY-102 due to burp	Inadequate prediction of waste behavior

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Volume IV:
Appendixes E through K

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Richland, Washington

Hanford Management and Integration Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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Lockheed Martin Hanford Corporation

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APPENDIX E
CONTROL ALLOCATION TABLES

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LIST OF TERMS

DID	Defense-in-Depth
FSAR	Final Safety Analysis Report
ID	identification
NA	not assigned
SSC	structure, system, and component
SST	single-shell tank
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System

LEGEND FOR CONTROL ALLOCATION FIELDS

The hazards analysis database contains control allocation information in the following fields:

Rep Acc— Representative Accident - An alpha/numeric code used to specify the analyzed accident by which the specified Hazardous Condition is represented. The code is used in the Database in two forms, alpha/numeric with and without an X. The X identifies that the hazardous condition is represented by the analyzed accident. Hazardous conditions that were chosen as the analyzed accident have no X designator.

ID—This field contains a unique alpha/numeric identification code for each Hazardous Condition identified during the TWRS hazard evaluations activities. In general, these codes, derived from the name of the evaluation and the node numbering used in the evaluation, can be used to identify the analysis they came from.

Hazardous Condition—A description of the Hazardous Condition associated with the unique ID code. In general, Hazardous Conditions are related to uncontrolled releases of hazardous or radioactive material, however there are occurrences of Hazardous Conditions listed that are not specific to release events that can be identified by the BIN code.

Cause—A description of the factors that could cause the identified Hazardous Condition.

Prev SSCs—Safety related Structures, Systems, and Components (SSCs)/Preventive - Preventive Controls identified by the TWRS FSAR. These Safety SSCs are identified to prevent the occurrence of Hazardous Conditions.

Prev TSRs—Technical Safety Requirements (TSRs)/Preventive - Preventive Administrative Controls identified by the TWRS FSAR. These controls include actions to be taken or operability limits to prevent the occurrence of the Hazardous Condition.

Mit SSCs—Safety related Structures, Systems, and Components (SSCs)/Mitigative - Mitigative Controls identified by the TWRS FSAR. These Safety SSCs are identified to reduce the severity of the consequence of the Hazardous Condition.

Mit TSRs—Technical Safety Requirements (TSRs)/Mitigative - Mitigative Administrative Controls identified by the TWRS FSAR. These controls include actions to be taken or operability limits that reduce the severity of the consequence of the Hazardous Condition.

Control MEMO—Memo field contains a memo explaining the selection of the controls for the Hazardous Condition.

Failed Con Safety Cons—Failed Controls Safety Consequence - The resultant safety effect of a release or exposure associated with a specific Hazardous Condition assuming controls are present but fail to work correctly.

Failed Con Freq—Failed Control Frequency - The frequency of occurrence of the combined controls failure.

DID Preventive—Defense-in-Depth/Preventive - Identified Defense-in-Depth Controls to prevent the occurrence of Hazardous Conditions.

DID Mitigative—Defense-in-Depth/Mitigative - Identified Defense-in-Depth Controls to reduce the severity of the consequences of the Hazardous Conditions.

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APPENDIX E
CONTROL ALLOCATION TABLES

Appendix E describes how to generate tables showing how the various controls, including safety related Structures, Systems, and Components (SSCs), Technical Safety Requirements (TSRs) and additional Defense-in-Depth (DID) controls, apply to all the hazardous conditions identified by the hazard evaluations. The allocation of controls to each hazardous condition assures comprehensive control identification and is part of the control identification process. This information shows how risk is being managed for the spectrum of hazardous conditions identified at Tank Waste Remediation System (TWRS) facilities.

The tables are produced using a relational database tool, which is used to manage the hazard analysis database.

Potential control allocation tables of interest include:

- "Safety SSCs and TSRs for Potential S3 and S2 Consequences," which would list the S3 and S2 representative accidents by identification number, hazardous condition, cause, preventive and mitigative SSCs and TSRs, safety consequences, and frequencies. Qualitative safety consequences and frequencies were estimated by assuming that the controls failed. Any comments regarding the selection of controls are provided in the "Control MEMO" column.

- "Safety SSCs and TSRs for Potential S1 Consequences with F3 Frequency," which would list the S1 representative accidents with a no controls frequency F3 by identification number, hazardous condition, cause, preventive and mitigative SSCs and TSRs, safety consequences, and frequencies. Qualitative safety consequences and frequencies were estimated by assuming that the controls failed. Any comments regarding the selection of controls are provided in the "Control MEMO" column.

- "Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences," which would list the E3 and E2 representative accidents by identification number, hazardous condition, cause, preventive and mitigative SSCs and TSRs, safety consequences, and frequencies. Qualitative safety consequences and frequencies were estimated by assuming that the controls failed. Any comments regarding the selection of controls are provided in the "Control MEMO" column.

- "Defense In Depth Controls for Potential S3 and S2 Consequences," which would list the S3 and S2 representative accidents by identification number, hazardous condition, and cause along with their associated preventive and mitigative Defense-in-Depth controls.

- "Defense In Depth Controls for Potential S1 Consequences with F3 Frequency," which would list the S1 representative accidents with a no controls frequency F3 by identification number, hazardous condition, and cause along with their associated preventive and mitigative Defense-in-Depth controls.

- "Defense In Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences," which would list the E3 and E2 representative accidents by identification number, hazardous condition, and cause along with their associated preventive and mitigative Defense-in-Depth controls.

The control data in the hazards analysis database represent the end point of the control allocation of SSC, TSR, and DID controls used to support the control decision process used in the FSAR. The allocation of controls to the individual hazardous conditions was done to determine if additional controls were needed. However, because the allocation of controls to the hazardous conditions was only done to identify additional controls to those identified in the accident analysis, all controls do not appear in the hazard analysis database. The complete set of controls are listed in Chapter 3.0, Table 3.3.2.3.2-1. In addition, the control data in the hazards analysis database show a qualitative assessment of the residual risk (frequency and consequences) associated with each hazardous condition with the controls in place. Any refinements from the accident analysis results to the initial hazard analysis assessment of frequency and consequences are included in the residual risk assessment. If controls were not required for a hazardous condition "NA" is placed in the resulting frequency and consequences columns. Only SSC and TSR controls are considered in the residual risk assessment.

The identification of controls as preventive or mitigative was done during the allocation process to assist in assessing the impact of the controls on the frequency and/or consequences of the hazardous condition and to support the control decision process, which is based on criteria that prefers prevention to mitigation. However, the distinction between prevention and mitigation is not always clear. Indeed, some controls perform both types of safety functions.

If a control primarily affected the cause(s) of the hazardous condition, it was considered preventive and if it reduced the consequences, mitigative. Some controls could be considered as either preventive or mitigative, but are only listed in one category or the other in the tables. For example, in the case of a seismic event, the single-shell tank (SST) structure is a safety SSC that prevents gross structural failure resulting in dome collapse and mitigates potential consequences. From a hazard analysis perspective, the primary function of the SST structure is to prevent a dome collapse from occurring and preclude the hazardous condition as postulated (e.g., a dome collapse). However, the tank may still fail and leak, thus the control also mitigates potential consequences. In the tables in this appendix, the SST structure is allocated as a preventive control.

Note: The control allocation tables previously presented in this appendix have been deleted. Nuclear Safety and Licensing should be contacted directly for specific information on controls allocation for hazardous conditions or for any queries of the hazardous analysis database.

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LIST OF TERMS

CF	Concentration Factor
CWM	conservative waste model
DCRT	double-contained receiver tank
DF	decontamination factor
DST	double-shell tank
ERPG	Emergency Response Planning Guideline
PFP	Plutonium Finishing Plant
PUREX	Plutonium Uranium Extraction (Facility)
REDOX	reduction-oxidation
RMC	remote mechanical "C"
SOF	sum-of-fractions
SST	single-shell tank
TBP	tributyl phosphate

APPENDIX F
CRITICALITY

F1.0 SUMMARY AND CONCLUSIONS

The technical basis for the nuclear criticality safety of waste stored underground at the Hanford Site is summarized in WHC-SD-WM-TI-725, *Tank Farm Nuclear Criticality Review*. Under current operating conditions, a nuclear criticality accident is incredible in any of the Hanford Site double-shell tanks (DSTs), single-shell tanks (SSTs), or double-contained receiver tanks (DCRTs) at the Hanford Site. Likewise, the potential for criticality in the remainder of the TWRS facilities within the scope of this safety analysis report is also considered incredible. Refer to Sections 6.3.1.4 through 6.3.1.13 for detailed discussion.

The technical basis for safe subcritical storage of wastes in DSTs, SSTs, and DCRTs, considered the neutronics of the waste tank system, chemical and physical phenomena, and fluid dynamics factors related to initial deposition of wastes in the tanks, aging of the wastes, and behavior of the wastes in storage. Further, a detailed discussion of potential tank neutronics is discussed in WHC-SD-SQA-CSA-507, *CSER 96-010: Criticality Parameters for Tank Waste Evaluation*. The phenomena and mechanistics are described in WHC-SD-WM-TI-757, *Fluid Dynamics, Particulate Segregation, Chemical Processes, and Natural Ore Analog Discussions that Relate to the Potential for Criticality in Hanford Tanks*.

The approach used in WHC-SD-WM-TI-725 evaluates nuclear criticality safety of the Hanford Site tank farms using a deterministic approach. The technical basis focuses on the phenomena of the waste from transfer into the tank farms through aging of the waste during storage. The technical basis report concludes that (1) fissile material in the waste tanks is distributed at subcritical concentrations, (2) the neutron absorber(s)-to-plutonium mass ratios are typically well above the minimum values needed to ensure subcritical conditions, and (3) no physical or chemical phenomena or mechanisms can be identified that could separate, concentrate, and relocate sufficient quantities of fissile material to achieve criticality.

Collectively, the DSTs and SSTs contain an estimated 500 to 1,000 kg (1,100 to 2,200 lb) of plutonium. Analyses of tank waste samples established that the plutonium content of the waste is primarily associated with the sludge. The maximum measured plutonium concentration in the sludge was about 0.7 g/L, which is a factor of about 4 below the minimum concentration limit of 2.6 g Pu/L conservatively established for tank waste (sludge) conditions. In most DSTs and SSTs, the sludge plutonium concentration is less than one percent of 2.6 g Pu/L. This situation reflects the deliberate controls exercised throughout operation of fuel reprocessing and purification facilities to maintain the plutonium concentration in waste streams to very low levels.

Abundant analytical data shows that plutonium in DST and SST sludges is intimately combined with large amounts of iron, manganese, chromium, and other metals that are effective neutron absorbers. These metals precipitated along with the plutonium when the initially acidic

wastes were made alkaline before being transferred to the waste tanks. The neutron absorber-to-plutonium mass ratios are typically well above the minimum values needed to ensure subcritical conditions.

The conservatism included in the criticality safety analysis of the Hanford Site tank wastes is graphically shown in Figure F1-1. The figure shows the relationship among current tank conditions, historical operating limits, and subcritical limits as a function of mass and plutonium concentration. The optimized conservative waste model subcritical limit represents conservatively modeled waste conditions. The average waste composition represents subcritical limits for an average waste composition of 19 elements from 28 actual tank samples. All of these cases were calculated using a conservative geometry (i.e., spherical). Figure F1-1 shows that even with a high degree of conservatism under neutronically conservative conditions, the tank contents are definitely subcritical.

Where sorption is the dominant chemical mechanism, bonding of plutonium to strong neutron-absorbing metals such as iron and manganese ensures that tank criticality cannot occur. Where pure hydrous plutonium oxide formed as a crystalline precipitate when acidic wastes were made alkaline, the plutonium oxide particles would be agglomerated or mixed with neutron absorbers. In either case, large (tens of micrometers in size) plutonium particles along with minimal amounts of neutron absorbers must be created and concentrated hydraulically for nuclear criticality to occur. All literature data and calculations for modeling hydraulic operations, such as salt well pumping, air lift circulators, and transfer pumps, indicate that creation and separation of such plutonium-bearing particles are not plausible.

To complete the safety analysis, a mechanistic analysis of waste tank operations was performed. Though a criticality accident in the tanks was found to be incredible, the consequences of a postulated hypothetical criticality accident were analyzed (Section F6.3). The postulated accident involved an inadvertent transfer of plutonium from the Plutonium Finishing Plant (a plutonium separation and purification plant) and included a series of implausible control violations of management practices, operational limits, procedures, and equipment controls. These violations would have to occur in combination with the concentration of the plutonium into a compact spherical geometry in a waste tank rather than the more likely and less reactive deposit in a planar vein deposit (i.e., slab-like layer) that usually occurs when waste flows into a tank. Even with these implausible events and a postulated criticality accident, the consequences were within risk guidelines for an "extremely unlikely" event.

F2.0 WASTE TANK CRITICALITY PARAMETERS

The fissile material content of the waste is expressed in terms of its ^{239}Pu equivalence. Consequently, all isotopes of plutonium (i.e., ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Pu) are conservatively treated as ^{239}Pu.

The fissionable isotopes potentially present in waste are ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, and ^{241}Pu. Because ^{235}U is always combined with a quantity of ^{238}U sufficient to ensure that the uranium is subcritical, the ^{235}U can usually be ignored. When the ^{235}U is not ignored, it is often treated as if it were ^{239}Pu and added to the plutonium inventory. ^{233}U appears only in a few tanks, and when present it can be treated as if it were ^{239}Pu, and also added to the quantity of plutonium. At fissile concentrations above 50 g/L, ^{233}U can have a smaller critical mass than ^{239}Pu. However, in a large volume the minimum critical concentration for ^{233}U is larger than for ^{239}Pu. Over the range of fissile concentrations found in waste the replacement of ^{233}U with ^{239}Pu is conservative. That is to say, the ^{233}U and ^{235}U may be considered to be equivalent to ^{239}Pu. For these reasons the nuclear criticality safety of tank waste is usually discussed solely as a function of the plutonium present (WHC-SD-SQA-CSA-20368, *CSER 94-004: Criticality Safety of Double-Shell Waste Storage Tanks*).

Waste tank nuclear criticality is a function of the following four factors:

- Fissile material quantity and concentration
- Neutron absorbers
- Neutron moderation
- Geometry.

A comprehensive technical discussion of these criticality parameters is provided in WHC-SD-SQA-CSA-507. The following discussion of parameters that affect the analysis of stored waste is based on two important assumptions.

- All calculations are for systems at optimum moderation. This means that the hydrogen (water) content for all systems is assumed to be at a level that results in the lowest possible critical mass for the system being discussed. Addition or subtraction of water from an optimally moderated system results in a decrease in reactivity and an increased margin of safety (WHC-SD-WM-TI-725, Section 3.1).

- The nonfissile waste materials have a neutron absorption capacity equal to that of the conservative waste model.

The conservative waste model, defined in WHC-SD-SQA-CSA-20356, *CSER 92-009: An Analytical Model for Evaluating Subcritical Limits for Waste in Hanford Site Storage Tanks*, and WHC-SD-SQA-CSA-507, is a model of the neutron absorption properties of the waste. This model represents bounding waste conditions for criticality. The waste constituents were chosen to minimize the presence of neutron absorbers, maximize the concentration of neutron scatterers, and provide optimum moderation. This results in conservatively calculating a lower concentration of fissile material to achieve criticality than would occur under actual tank conditions. The conservatism of the waste model is based on the following characteristics.

- Elements with a greater ability to absorb neutrons are assumed at lower than expected concentrations.

- Elements with a greater ability to scatter neutrons or a greater scattering to absorption ratio are included whereas elements with a lesser ability or ratio are omitted.

- The concentration of oxygen is set at the largest concentration found in the samples because oxygen has a low ability to absorb neutrons and a high ability to scatter neutrons.

- Water is treated as an independent variable. The amount of water used in the model represents the optimal hydrogen-to-plutonium ratio (i.e., optimal moderation). Therefore, hydrogen is not included in the list of elements but is included in the water content provided in the model.

- The density of solids used in the model is lower than the density in real waste solids. A lower density decreases the ability of the solids to absorb neutrons.

F2.1 FISSILE MATERIAL CONCENTRATION

Calculations using the conservative waste model for the Hanford Site tank waste showed that the plutonium concentration must be at least 2.6 g Pu/L before criticality is possible, even in an unlimited volume of waste (WHC-SD-SQA-CSA-20356). This value is based on a uniform mixture of plutonium, waste solids, and water. The waste solids composition is described in WHC-SD-SQA-CSA-20356. The conservative waste model results in a conservative plutonium concentration value to ensure subcriticality that is well below the value of 7.2 g/L, which is generally reported as the minimum critical concentration of plutonium in water.

Plutonium concentration has been used as the primary control on waste streams discharged to the storage tanks (WHC-SD-WM-TI-757). Documents and procedures from the mid 1960's indicate that discharge levels were controlled to a maximum of 0.013 g Pu/L in a waste mixture being routed to a waste tank and 1 g Pu/L in waste tank solids (WHC-SD-WM-SARR-003, *High-Level Waste Tank Subcriticality Safety Assessment*). Flowsheets and transfer documents produced before 1960 indicate that this level of control has always existed (WHC-SD-WM-TI-725). A statistical analysis of the extensive number of waste tank characterization samples to date (more than 500) confirms the effectiveness of the concentration controls (WHC-SD-WM-SARR-003 and WHC-SD-WM-TI-757).

It is also important to understand the concentration factor that would be required to increase the present concentration of plutonium in waste to a level at which subcriticality could no longer be ensured.

Figure F2-1 shows the relationship between plutonium concentration factors and minimum critical sphere diameters. Using Figure F2-1 one can see that if a tank has an inventory of 100 kg (220 lb) plutonium that is uniformly distributed throughout the contents of a half-full tank (i.e., a nominal concentration of 0.05 g Pu/L), the concentration would have to be increased by a

factor of 52 to reach the 2.6 g Pu/L referenced previously. Such a tank configuration contains insufficient plutonium to achieve criticality (Figure F1-1). Increasing the concentration by a factor of 80 (to 4 g Pu/L) would be necessary before criticality could be achieved with the material configured in a sphere approximately 3.7 m (12 ft) in diameter. Increasing the concentration by a factor of 100 (to 5 g Pu/L) would be necessary with the material configured in a 2.1-m- (7-ft)-dia sphere. Figure F2-1 also shows the concentration factor necessary for the plutonium-water system and for a system similar to the conservative waste model containing plutonium and waste tank liquids with dissolved sodium salts. It is seen that the minimum critical concentration is 7.2 g Pu/L for plutonium in water and 8.5 g Pu/L for plutonium in sodium salt solutions.

If this example is applied to Tank 241-C-106 (total estimated plutonium inventory of 100 kg (220 lb) at a concentration of 0.132 g Pu/L and a sludge depth of approximately 1.8 m [6.0 ft]), the concentration would need to be increased by a factor of approximately 45 to form a critical sphere that would fit within the thickness of the existing sludge layer. This perspective indicates that even under the most conservative conditions, significant increases in fissile concentration would be required to approach a critical system. The resulting critical sphere would need to be as large as, or larger than, the thickness of the solids layer. (Spheres are modeled in this case for conservatism.) More realistic slab-like layers would require considerably higher plutonium quantities before subcriticality could no longer be ensured.

F2.2 OTHER NUCLEAR CRITICALITY FACTORS

The waste model for the Hanford Site tank waste provides the bounding case on which controls are based such that the waste is ensured to remain subcritical. However, many other factors provide an additional margin of conservatism. The variability in tank-to-tank composition, the difficulty in obtaining representative tank samples and the lack of historical operational controls make it impractical to justify a quantitative credit for these factors. They do, however, contribute qualitatively to the overall safety basis. The following assessment increases the level of confidence in the continued subcritical operation based on factors other than fissile material concentration.

F2.2.1 Neutron Absorbers

Neutron absorbers reduce the reactivity of any fissile assembly. A unique minimum absorber-to-plutonium mass ratio (X/Pu) for all absorbers, ensures the system will remain subcritical, independent of any other influences. This mass ratio is calculated for a homogeneous mixture of plutonium, absorber, and water. Because waste was sent to the tank farms as a relatively homogenized mixture, the absorber-to-plutonium ratio is a good indicator of subcriticality. Minimum subcritical absorber-to-plutonium ratios have been calculated for several important elements in the waste form (WHC-SD-SQA-CSA-20356). The results are reported in Table F2-1 for sludge and Table F2-2 for salt cake or liquid.

The minimum subcritical absorber to plutonium ratios are calculated with the plutonium equivalence values as discussed in Section F2.0. Since the plutonium equivalence includes the conservative consideration for ^{233}U and ^{235}U, the subcritical mass ratios reported in Tables F2.1 and F2.2 will bound the subcritical ratios for these uranium isotopes.

The relative contribution of a component to the subcriticality of a system can be found by dividing its actual mass ratio by the corresponding mass ratio to ensure subcriticality. This ratio of mass ratios is referred to as the absorber fraction. An absorber fraction greater than 1.0 means that the uniform mixture will be subcritical. Waste comprises many different components, each with its own minimum absorber-to-plutonium subcritical ratio. The combined effect of these absorbers can be estimated by summing individual absorber fractions according to the formula:

$$\text{If} \quad \sum_{j=1}^{N} \frac{\left(\frac{X_j}{Pu}\right)_{actual}}{\left(\frac{X_j}{Pu}\right)_{subcritical}} \geq 1$$

then $k_\infty \leq 1$.

where:

$\sum_{j=1}^{N}$	=	j is the identifier for each of the total number, N, of specific absorbers in the waste. The equation is to be calculated for all components (j), number 1 through N.
$\left(\frac{X_j}{Pu}\right)_{actual}$	=	Actual absorber mass or concentration divided by plutonium mass or concentration.
$\left(\frac{X_j}{Pu}\right)_{subcritical}$	=	Minimum subcritical mass ratio for the specific absorber.
k_∞	=	k infinity

When the sum-of-fractions is greater than 1.0, the total neutron absorption is sufficient to ensure subcriticality in an infinite system of homogeneous waste. The greater the sum-of-fractions, the greater the margin of safety.

The minimum subcritical absorber-to-plutonium (X/Pu) mass ratios were determined for systems of absorber, plutonium and water. The minimum subcritical mass ratios are not dependent upon waste composition and are not derived from the conservative waste model. The

subcritical limit concentrations were calculated based upon a k_{eff} (or k_∞) of 0.95 with a 95 percent confidence level. For the computer codes used, the confidence level requirement was satisfied by reducing k_{eff} by 0.015. Therefore, a configuration with a k_{eff} of 0.935 was considered to be a subcritical limit. Calculations were made using the GOLF code (WHC-SD-NR-SWD-024, *Software Certification Package for the GOLF Code*) with cross sections generated by the WIMS-E code (AEEW-R1329, *A General Introduction to the Use of the WIMS-E Modular Program*).

If the above equation is satisfied for waste components, i.e., the summation of ratios of the actual absorber to plutonium to the subcritical ratio is greater than or equal to 1, the k_{eff} will be less than 1 or actually 0.935. Because no comparisons to experimental benchmarks were made, most of the minimum subcritical mass ratios are based upon a calculated k_∞ of 0.90 with optimal water moderation. The exceptions are uranium, iron and manganese, for which independent determination of their mass ratios are reported in WER-HLE-921353, *Minimum Safe Ratios of Fe and Mn to Pu-239 in an Infinite System (U)*.

An independent evaluation of the subcritical mass ratios is reported in Appendix A of WHC-SD-SQA-CSA-507. Validation studies for the MONK6B package (WHC-SD-SQA-CSWD-20015, *MONK6A Pu Validation*; WHC-SD-SQA-CSWD-20019, *MONK6B Pu Validation*) supports a bias of 0.015 leading to a subcritical optimally moderated calculated k_∞. Eight validation runs were performed using MCNP[1] (LA-12625-MS, *A General Monte Carlo N-Particle Transport Code)* to support the calculational results presented. The k_{eff} is a function of the system geometry and the products of the nuclide concentrations and microscopic cross sections (which have the dimension of area), which makes the k_{eff} of a system invariant for a given geometry and relative concentrations as long as the product of the total concentration and characteristic length is invariant. For an infinite system, the k_∞ is a function of relative concentrations only. This fact was used to simplify the calculations by avoiding the need to provide a reasonable total concentration (material density): the ^{239}Pu concentration was arbitrarily set at 0.01 nuclei per barn-cm and the other concentrations were adjusted to provide the stated ratios.

Each MONK6B calculation of k_∞ (AEEW R2248, *MONK 6 - A Monte Carlo Code for Criticality Calculations*) used the composition specified as input to the WIMS-E/GOLF system, together with the radius found by GOLF for $k_{eff} = 0.935$. The Monte Carlo codes calculated lower values for k_{eff} than the WIMS-E/GOLF system. The difference is due to slightly different assumptions about the values of physical constants. However, since the WIMS-E/GOLF results are more conservative than the Monte Carlo results, the difference is inconsequential.

Because some issues noted in WHC-SD-WM-SARR-003 were specific to individual processing plant waste streams, neutron absorber ratios, and chemical and physical phenomena were analyzed for specific waste streams. Results are presented in Tables F2-3 through F2-8.

[1] A Monte Carlo computer code developed by Los Alamos National Laboratory.

Figure F2-2 shows that all waste streams contain at least one neutron absorber in excess of the minimum subcritical ratio.

Two of the most effective absorber materials (boron and cadmium) were excluded from the analysis. Boron and cadmium are known to be present in sometimes substantial quantities in waste solids. They are such strong absorbers that their contribution would totally dominate the conservative waste model, and the discussion would immediately center on defending the uniformity of their distribution. Therefore, boron and cadmium were purposely excluded to better defend the conservatism of the waste model.

F2.2.2 Neutron Moderation

The minimum critical mass is calculated assuming optimum moderation and infinite reflection. A certain amount of hydrogen (e.g., water) achieves optimal moderation. In an over-moderated system, additional water does little to further thermalize the neutron spectrum, but the additional water introduces additional neutron absorption, thereby reducing the reactivity of the system. If the calculations are performed for optimum moderation, any other amount of hydrogen would result in a less reactive system. Moderation is not related to an absolute quantity of plutonium and water, but to the ratio of hydrogen atoms to plutonium atoms (i.e., hydrogen to plutonium ratio). As the hydrogen to plutonium ratio increases, absorption and the lowering of the plutonium concentration makes a critical condition harder to obtain. Analyses documented in WHC-SD-SQA-CSA-20356 conclude that when the hydrogen to plutonium atom ratio exceeds 3,600 a criticality is not possible. In addition, the conservative waste model and the supernate model use optimum water concentration, which is a function of plutonium concentration. For the conservative waste model, WHC-SD-SQA-CSA-20356 provides the information shown in Table F2-9.

Water is the principal source of hydrogen and thus the principal moderator in the Hanford Site tank wastes. Generally, the waste form is over-moderated (at 2.6 g Pu/L in the modeled waste, optimum moderation is achieved at about 5 wt% water). Sludge and supernatant liquid are most often over-moderated, while salt cake may be near optimal moderation. Dry sludge, present in some SSTs, may also be near the optimal moderation.

The plutonium content of salt cake and supernatant liquid is low. Over-moderation in sludge results in an enhanced absorber effect (i.e., absorption cross sections are higher at the low neutron energy that results from an abundance of water moderation), thereby increasing the subcritical margin of safety.

F2.2.3 Areal Concentration Limit

ARH-2622, *Criticality Prevention Parameters of Plutonium in Solids,* calculates that the minimum critical areal density for plutonium in pure water is 2,580 g/m^2 (240 g/ft^2). The assumption of water as a neutron reflector is a conservative position in the case of areal density

because the reactivity is driven by leakage rather than by neutron absorption. The actual distribution of plutonium in the waste does not matter. As long as the plutonium content does not exceed 2,580 g Pu/m^2 (240 g Pu/ft^2) on the average, the waste will be subcritical independent of the actual distribution and moderator content.

LA-10860-MS, *Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U*, shows the critical slab thickness as a function of concentration. Information from this document is compared with the thickness needed to yield 2,580 g/m^2 (240 g/ft^2) over a 0.09 m^2 (1 ft^2) area (Table F2-10).

Actual tank waste contains neutron absorbers that result in a higher minimum critical plutonium areal density. As the plutonium concentration drops below 7.2 g Pu/L, the minimum critical areal density increases rapidly. Below 2.6 g Pu/L, the minimum critical areal density becomes infinite.

F2.2.4 Geometry

Geometry plays a strong role in determining critical conditions because of its impact on neutron leakage. If the tanks can be shown to be subcritical for infinite conditions, any tank of finite size will be more subcritical.

The effects of geometry are typically discussed in terms of a sphere. This is because a sphere is the most reactive geometry and thus constitutes the bounding case. The most probable configuration however is some approximation of a slab. No credible mechanism has been identified that would move fissile material radially within the slab to form a sphere with a diameter equal to the depth of the solids. As a result, the quantity of plutonium needed to go critical is quite large because of the higher neutron leakage from a slab compared to a sphere.

Figure F2-3 shows the relationship between plutonium concentration and minimum mass for a critical slab in a 22.9-m- (75-ft)-dia tank. All subcritical concentration values shown in Figure F2-3 are based on a k_∞ of 0.935 for conservatism. (This conservatism explains the difference between the experimentally derived minimum subcritical concentration of 7.2 g Pu/L for pure water [WHC-SQA-CSA-20356] approximately 6.6 g Pu/L value shown in Figure F2-3.) It can be seen that a slab containing approximately 1,000 kg (2,200 lb) of plutonium would be subcritical for any concentration. Either 5000 kg (11,000 lb) of plutonium would be required at a concentration of 3 g Pu/L, or 1,500 kg (3,300 lb) of plutonium would be required at a concentration of 6 g Pu/L to attain criticality.

F2.2.5 Minimum Critical Mass

The minimum critical mass of plutonium is 520 g (1.1 lb). Criticality is not possible with less than 520 g (1.1 lb) of plutonium regardless of other parameters. Consequently, tanks containing less than 520 g (1.1 lb) of plutonium have no limiting critical concentration (i.e., they

are inherently subcritical). Because the absolute quantitative plutonium inventory for individual tanks cannot be readily determined with a high degree of quantitative accuracy, inventory limits have not been solely relied upon to ensure the criticality safety of tanks.

F2.3 PERSPECTIVE ON PLUTONIUM CONCENTRATION WITHIN TANK WASTE FORMS

Given the minimum volumetric subcritical concentration of 2.6 g Pu/L, some perspective can be gained on the safe plutonium concentration in various regions of the tanks. For the liquid (supernate) regions, the concentration of plutonium is in the range of 0.0002 to 0.2 g Pu/L. The solubility of plutonium is only about 0.2 g Pu/L for solutions not containing materials that form complexes with plutonium at pH greater than 12. The 0.2 g Pu/L solubility value corresponds to a high carbonate solution at a pH equal to 9. This higher solubility limit is less than 10 percent of the established maximum plutonium concentration limit. Several hundred analyses of liquid samples were reviewed and none contained more than 0.2 g Pu/L.

The plutonium in the salt cake interstitial liquid also has a solubility limit of 0.2 g Pu/L. The crystalline portion of the salt cake is nominally free of plutonium because its large ion radius keeps plutonium from entering the crystal structure. Although some sludge could be entrained in the salt cake, the sludge quantities are relatively small and do not present a criticality concern.

The bulk of the plutonium is in the sludge. Consequently, the sludge layer is the primary area of concern for criticality safety. Of the 216 solid samples that were verified to have met regulatory protocol requirements (WHC-SD-WM-ER-400, *Tank Waste Source Term Inventory Validation*) and had no readily apparent errors, all 216 samples had less than 10 percent of the 2.6 g Pu/L maximum concentration limit. Furthermore, plutonium is broadly distributed throughout the sludge from the initial waste stream neutralization process with a substantial excess of other metal oxyhydroxides. Additional discussion of the waste tank chemistry and physics is included in Section F3.0.

Many reports provide the results of samples in addition to those discussed in WHC-SD-WM-ER-400. These samples were taken by various means that did not meet the requirements discussed in WHC-SD-WM-ER-400. The most recent of these reports, WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*, considers the sample data as presented in numerous sample reports and chooses the "worst case" (i.e., largest value) for radiological consequence analysis. Statistical data for $^{239/240}$Pu are reproduced in Table F2-11. All of the data specified came from samples. The data was transformed from that in WHC-SD-WM-SARR-037 by converting becquerels to curies and using 0.06 Ci/g as the specific activity of ^{239}Pu.

The term "solids" indicates the sludges at the bottom of the waste tank. The term "liquids" is the liquids (liquids, slurries) above the solids in the source term. Salt cake data is not specifically considered but is lumped under "liquids." As a comparison, WHC-SD-WM-SARR-003 provides the information shown in Table F2-12.

By using the plutonium concentration limits identified in Section F2.1, it is possible to assess the potential criticality concerns for the Hanford Site waste tanks. Waste added to the tanks as suspended solids tended to settle slowly over the underlying waste surface. Each waste layer appears to have a relatively uniform distribution. Moving down the vertical profile in a tank, significant changes in waste composition (reflecting the different waste processes as a function of time) can be expected.

Based on the areal concentration criterion of 2,580 g Pu/m^2 (240 g Pu/ft^2)applied over the full area of a 22.9-m- (75-ft-) dia tank, a total load of 1,060 kg (2,300 lb) per tank would be subcritical. This value is about twice the best estimate of all the plutonium sent to the waste tanks, and it approximately equals the maximum estimate of 1,000 kg (2,200 lb). Thus, all the plutonium within the Hanford Site tank farms could be stored in a single tank without exceeding subcritical conditions if lateral homogeneous conditions prevail.

Based on the maximum concentration limit of 2.6 g Pu/L, the total plutonium per meter of depth in a 22.9-m- (75-ft)-dia tank could be 1,070 kg (2,350 lb). Thus, a homogeneous slab approximately 1 m (3.3 ft) in depth in a single large tank could contain the entire worst-case estimated amount of plutonium sent to the tank farms and remain subcritical. To put this into perspective, the maximum plutonium inventory in any tank is estimated to be less than 100 kg (220 lb) (Tank 241-C-106). A 3,785,000-L (1,000,000-gal) tank containing a plutonium concentration of 2.6 g/L, would contain 9,840 kg (21,700 lb) of plutonium.

Assuming a tank inventory of 100 kg (220 lb) of plutonium (the approximate value of the highest estimated plutonium inventory for Tank 241-C-106) and a uniform plutonium distributed within the solids of a 3.8 x 10^6 L tank that is one-half full of solids, the plutonium concentration would be approximately 0.05 g/L. If the entire plutonium content of the tank were concentrated by a factor of 100 to a concentration of 5 g Pu/L and collected in a spherical geometry (the most reactive and conservative configuration), the resulting critical sphere would be approximately 2.1 m (7.0 ft) in diameter.

Because the fissile material remains relatively uniformly dispersed in the waste form, the waste will remain subcritical due to insufficient fissile material concentration. The factors discussed in this section qualitatively add to this conclusion. Consequently, the only way for an accidental criticality to become possible is for significant concentration during the waste aging process.

Section F3.0 provides an evaluation of the chemical and physical phenomena and mechanisms of potential concern for the separation and concentration of plutonium from neutron absorbers. The section concludes that the identified concentration mechanisms cannot result in the required concentration and redistribution of fissile material (factors of 40 or greater) necessary to result in a risk of an accidental criticality.

F2.4 USE OF PLUTONIUM CONCENTRATION VALUES

Throughout this appendix, concentration of plutonium as a result of waste storage, process plant operations, or tank farm activities will be compared to a minimum concentration needed to go critical. In almost all of the cases, the value of 2.6 g Pu/L will be used. It needs to be emphasized that the value of 2.6 g Pu/L is the minimum concentration of solid plutonium in an infinite volume of settled solids having optimal moderation necessary to go critical. In some cases a value of 7.2 g Pu/L (in water) or 8.5 g Pu/L (in tank waste solutions) is required. These are minimum concentrations needed to go critical when thoroughly mixed in an infinite volume of water or dissolved in an infinite volume of a solution of sodium salts. The presence of more moderator, a finite rather than infinite volume, dissolved plutonium not solid plutonium in settled solids and more neutron absorbers will result in a larger concentration needed for criticality. It also needs to be emphasized that the value of 2.6 g Pu/L is actually subcritical as k_∞ is still less than 1.0 (i.e., 0.935).

F3.0 CHEMICAL PROCESSING WASTE COMPOSITION

Estimates of the plutonium and neutron absorber concentrations in the waste tanks were obtained from two sources: (1) analyses of waste streams that went into the tanks from the various chemical processing facilities and (2) analyses of waste samples removed from the tanks. Both sources show that plutonium concentrations in the waste are much lower than the 2.6 g Pu/L limit and that the concentrations of neutron absorbers in the waste are generally higher than the minimum mass ratios for ensuring subcriticality.

During the 45 years of plutonium production and separation, plutonium-bearing wastes were distributed to many tanks, and no intentional plutonium concentration operations were performed. The potential for plutonium criticality problems was recognized at the onset. Specifications for liquid wastes to be routed to underground storage always limited the plutonium concentration to a very low value. Furthermore, in nearly all cases, a large mass of neutron absorbers (e.g., iron) was sent to storage tanks along with the small mass of plutonium. These neutron absorbers were typically added as part of the chemical processes used to recover plutonium from the irradiated reactor fuel.

Plutonium-containing wastes routed to the underground storage tanks were generated from five chemical processes (plants) operated at the Hanford Site from 1944 to 1988:

- Bismuth phosphate process (B and T Plants)
- Reduction-oxidation (REDOX) process (S Plant)
- Metal recovery process (U Plant)
- Plutonium uranium extraction (PUREX) process (PUREX Facility)
- Plutonium separation and purification process (Plutonium Finishing Plant [PFP]).

Each of these processes discharged large quantities of wastes to the tank farms in the form and composition specified in chemical process flowsheets (WHC-SD-WM-TI-725) for the individual processes. To avoid excessive corrosion of the mild steel tanks, all process wastes were made alkaline before transferring them to the underground tanks. Various metal hydroxides and hydrated oxides were formed when sodium hydroxide was added to the acidic waste solutions. Pumps and steam jets were used to transfer the neutralized wastes to tanks or between tanks. To ensure compatibility with jetting or pumping equipment, all process-generated waste solutions and slurries were intentionally dilute.

Because the bismuth phosphate process did not recover the uranium, large quantities of uranium from the B and T Plants were routed to the underground tanks. During 1954-1957, this uranium was reclaimed by hydraulic sluicing. The resulting slurry was transported to the U Plant where the waste was acidified with nitric acid. The uranium was recovered and purified by a tributyl phosphate (TBP) solvent extraction process. Small amounts of plutonium in the acid feed to the tributyl phosphate extraction process were not recovered. The acidic waste from the U Plant tributyl phosphate extraction process was made alkaline and transferred back to the tank farms.

Two important aqueous waste streams were generated by the REDOX process: cladding waste and high-level waste.

The cladding waste was generated by chemically dissolving aluminum cladding in a $NaOH$-$NaNO_3$ solution. This waste typically contained about 450 g (1.00 lb) of uranium per ton of fuel processed, and the uranium/plutonium mass ratio was typically about 560. The neutralized high-level waste contained 6.8 kg (15 lb) of iron per ton of fuel processed at an iron/plutonium mass ratio of about 350. The iron/plutonium weight ratio for this high-level waste was higher than the minimum value of 160 required (Section F2.0) to maintain subcriticality conditions. Although the uranium/plutonium ratio for the cladding waste was below the minimum value (770) to ensure subcriticality conditions, the uranium supplemented the absorption capability of the iron. The concentration of plutonium in this waste was also kept well below the maximum 2.6 g Pu/L limit (Section F2.0).

During its operation, the Hanford Site PUREX Facility reprocessed aluminum- and zircalloy-clad uranium metal fuel. In addition to generating two types of high-level wastes, several low-level waste streams were generated (e.g., cladding wastes, laboratory wastes, and solvent wash wastes). All these waste streams were made alkaline and transferred to the tank farms.

After addition of sodium hydroxide, the high-level waste (neutralized from acidic waste) from processing of aluminum-clad fuel contained 3.7 kg (8 lb) of iron per ton of fuel processed, equivalent to an iron/plutonium weight ratio of 28,500. The low-level wastes generated during this processing contained 719 g (1.6 lb) of uranium per ton of fuel processed, equivalent to a uranium/plutonium weight ratio of 850.

The high-level waste resulting from processing of zircalloy-clad uranium metal fuel contained 5.8 kg (12.8 lb) of iron per ton of fuel processed, equivalent to an iron/plutonium mass ratio of 2,000. The corresponding low-level wastes contained 4.3 kg (9.5 lb) of uranium, equivalent to a uranium/plutonium weight ratio of 2,000. The plutonium concentration in the neutralized current acid waste generated in processing either aluminum- or zircalloy-clad fuels did not exceed 0.003 g Pu/L.

Beginning in 1981, acidic wastes generated in the PFP operations were made alkaline and transferred to the 244-TX double-contained receiver tank and then to Tank 241-SY-102. During limited cleanout operations in 1981, iron was added to the acidic PFP waste to meet the 1 wt% total solids requirements specified by tank farm criticality controls. The wastes generated in the PFP solvent extraction operations also contained significant concentrations of aluminum. Typically, in neutralized solvent extraction waste, the aluminum/plutonium weight ratio was 723.

Tables F2-3 through F2-8 list the concentrations of plutonium, neutron absorbers, and the corresponding absorber-to-plutonium mass ratios in the waste streams from the various fuel reprocessing and separations plants. The values in these tables are based on flowsheet calculations and process records (WHC-SD-WM-TI-757).

Figure F2-2 illustrates the six principal waste types from the four processes at five facilities: the bismuth phosphate process at B & T Plants; the REDOX process at S Plant; and the PUREX process at the PUREX Facility. In the PUREX process, two types of cladding were processed (aluminum and zircalloy). From the four processes, each waste stream has an absorber to plutonium ratio (X:Pu) that ensures subcriticality for each absorber type. Each waste stream contained sufficient neutron absorbers to maintain a subcritical composition, regardless of any other conditions. In many cases, more than one neutron absorber type was present in sufficient quantities to provide this safety factor. Additionally, the collective neutron absorption ability of elements not sufficiently plentiful to guarantee subcriticality on their own contributed to the subcriticality margin (Section F2.2.1).

In summary, all of the waste streams sent to the Hanford Site underground tanks contained only very small amounts of plutonium. Furthermore, the concentrations of various neutron absorbers, particularly iron and uranium, in the waste streams were consistently high either because iron and uranium were an intrinsic part of each waste stream or because iron and uranium were deliberately added for criticality control. Detailed information concerning the volume and composition of the waste streams sent to the underground tanks is provided in WHC-MR-0132, *A History of the 200 Area Tank Farms*.

F4.0 BEHAVIOR OF PLUTONIUM IN THE WASTES

This section examines the chemical mechanisms that could occur in the sludge. The analysis focuses on the sludge, rather than the supernatant liquid, because plutonium concentrations of concern to criticality safety could arise only in the sludge. Plutonium is not very soluble in basic solutions.

RHO-RE-SA-75 P, *Solubility of $PuO_2 \cdot xH_2O$ in Alkaline Hanford High-Level Waste Solution*, shows that solutions containing sodium hydroxide, sodium aluminate, and sodium nitrate, at greater than 1 *M* NaOH, have a concentration of plutonium between 10^{-5} *M* and 2×10^{-6} *M* or 0.002 g Pu/L to 0.0005 g Pu/L. WHC-SD-WM-TI-757 shows that carbonate added to the solution increases the solubility of plutonium. At 1 *M* CO_3 and a low hydroxide concentration, the plutonium concentration is 0.2 g Pu/L. Increasing the hydroxide concentration decreases the amount of plutonium in the solution.

WHC-SD-WM-TI-757 also shows that the stability constant for complexed plutonium (plutonium attached to organic complexants) is less than for plutonium and carbonate. As a result, the peak concentration of plutonium in Hanford Site liquids cannot be more than 0.2 g Pu/L.

Sodium carbonate solubility depends on the hydration water associated with the salt. The stable phase depends on the ionic strength of the solution. With increasing ionic strength, the solubility controlling sodium carbonate phase changes with the number of attached waters of hydration. The ambient temperature solubilities of these phases range from 0.57 *M* to 2.66 *M*. Therefore, it is unlikely that aqueous carbonate concentrations at ambient temperature will exceed 2.66 *M*. In fact, carbonate concentrations in the waste tanks do not exceed about 1 *M* concentration. A rough estimate indicates that the carbonate concentrations have to exceed about 5.5 *M* before plutonium concentrations reach 0.01 *M* assuming the solubility at the lower pH range is linear to this concentration. Therefore, it is extremely unlikely that aqueous plutonium concentrations will ever reach the 2.6 g/L limit. The low solubility of plutonium in the liquid precludes a criticality concern in that medium. As a result, only the sludge needs to be considered for criticality safety.

Three potential chemical mechanisms need to be considered in determining the manner in which plutonium enters the sludge: (1) sorption onto precipitated metal oxide sludge particles, (2) precipitation of pure $PuO_2 \cdot xH_2O$ amorphous solids, and (3) solid-solid solution with metal oxyhydroxides. Plutonium-containing solid particles formed initially can be attracted to other more abundant particles to form agglomerates by the flocculation process. Once precipitated with the inorganic waste solids, the plutonium is believed to undergo an aging process that results in a slightly crystalline product. This results from a collapse of metal hydroxide bridges in favor of a metal oxide bridges as water is eliminated.

F4.1 ADSORPTION

Dissolved plutonium has been shown to adsorb onto a wide variety of metal oxide and hydroxide surfaces, including surfaces of the oxides that are known to exist in tank sludges. This section discusses the available evidence on adsorption as a mechanism for bonding plutonium to neutron absorbers such as iron, aluminum, uranium, and manganese oxyhydroxides found in the sludge. Where this mechanism prevails in the waste, concentration of plutonium during tank farm operations is not possible without simultaneous concentration of neutron absorbers.

Most of the high-level radioactive waste solutions generated from chemical operations at the Hanford Site were acidic solutions containing metals dissolved in nitric acid. Small concentrations of dissolved plutonium (typically $<10^{-5}$ *M* Pu, [WHC-SD-WM-SARR-003]) were not recovered in processing and were present in these waste solutions. Before sending the waste to underground storage tanks, the acid was neutralized with excess sodium hydroxide to prevent corrosion of the carbon steel tanks. Metals that were insoluble in basic solutions (including plutonium) were precipitated as oxyhydroxides during neutralization. These oxyhydroxides are the major components of the sludge in the tanks.

The concentrations of plutonium were very small compared with the concentrations of other metals dissolved in the waste solutions from the various processing operations (WHC-SD-WM-SARR-003). For example, typical mole ratios of iron/plutonium and aluminum/plutonium in the Hanford Site waste tanks are shown in Table F4-1. In addition to iron and aluminum, other dissolved metals such as uranium, zirconium, manganese, bismuth, chromium, nickel, and tin were present in the acid waste and were precipitated as oxyhydroxides.

In a nitric acid solution containing Pu(IV) as the only dissolved hydrolyzable metal ion, neutralization with sodium hydroxide, as required for waste solutions sent to the tanks, would produce plutonium polymer along with plutonium hydroxide. However, because of the low solubility and higher initial concentrations in the waste solution of iron and aluminum hydroxides, these iron and aluminum compounds will precipitate first as the waste is neutralized, and the plutonium will be coprecipitated with them. A comparison of the solubilities of amorphous $PuO_2 \cdot xH_2O$ (Rai and Ryan 1982, "Crystallinity and Solubility of Pu(IV) Oxide and Hydrous Oxide in Aged Aqueous Suspensions"; and Rai and Ryan 1984, "Solubility Constraint: An Important Consideration in Safety Assessment of Nuclear Waste Disposal"), amorphous $Fe(OH)_3$ (Lindsay 1979, *Chemical Equilibria in Soils*), and crystalline $Al(OH)_3$ (gibbsite) (Lindsay 1979) are given for a range of pH values in Table F4-2. This data indicates that iron will precipitate before any plutonium can precipitate as plutonium oxyhydroxide during the waste neutralization process.

Amorphous iron is much less soluble than amorphous plutonium hydroxide. Because the wastes contain thousands of times more iron and aluminum than plutonium, a pure plutonium phase (of plutonium hydroxide or polymer) is not likely to form. Rather, the plutonium is expected to be coprecipitated by sorption on the iron and aluminum hydroxides that precipitate first in much larger quantities.

The rate of iron hydroxide precipitation during waste neutralization is rapid compared with the rate of plutonium hydroxide precipitation (or plutonium hydroxide polymer formation). As long as the initial molar ratio of $[OH^-]/[Fe^{3+}]$ is greater than three, amorphous $Fe(OH)_3$ will precipitate immediately (Yariv and Cross 1979, *Geochemistry of Colloid Systems*). During neutralization of the acidic wastes, this ratio greatly exceeded three. Toth et al. (1981), "Polymerization of Pu(IV) in Aqueous Nitric Acid Solution," shows that the rate of plutonium hydroxide polymer formation is slow at the plutonium concentrations known to exist in the acidic wastes. The rate of polymer formation decreases with decreasing plutonium concentration. For example, only about 30 percent of the plutonium in a 0.05 *M* plutonium solution was polymerized after one hour at an acid concentration of 0.092 *M*. Because the plutonium concentration in the waste is about 10,000 times less than 0.05 *M*, polymer formation is expected to be much slower. This rapid iron hydroxide precipitation rate and the slow plutonium polymer formation rate facilitate absorption of the plutonium onto the iron hydroxide precipitate before a plutonium polymer could be formed.

Typical concentrations of plutonium in the acid wastes range from 10^{-5} to 10^{-6} *M*. At these low plutonium concentrations, incipient polymerization of plutonium hydroxide requires a relatively high pH. Also, polymerization is not instantaneous, but requires an induction period before it is formed (Toth et al. 1981). Although polymer formation is unlikely, any polymer that was formed would have a strong affinity to adhere to other particles suspended in solution or on nearby surfaces (Dran et al. 1994, "Interaction of Pseudocolloids with Mineral Surfaces: The Fate of the Scavenged Cation").

There are several likely coprecipitation mechanisms that are important. First, sorption of plutonium hydroxide on the large surface areas of the solid metal oxyhydroxides is the most important mechanism. The oxyhydroxides of iron and aluminum, in particular, develop large, amorphous surfaces as they are formed that attract heavy metal ions and, by inference, lanthanide/actinide cations (Laitinen 1960, *Chemical Analysis*).

The sorption capacity (in terms of available sorption sites) for iron oxyhydroxide gel has been estimated to be about 500 μmoles/millimole iron (Kinniburgh and Jackson 1976, "Adsorption of Alkaline Earth, Transition and Heavy Metal Cations by Hydrous Oxide Gels of Iron and Aluminum"). This capacity greatly exceeds the molar ratios of plutonium or iron in the waste tank sludges, which range from about 0.016 to 10 μmole Pu/millimole iron.

The hydrolysis of metal ions has been studied extensively (Baes and Mesmer 1976, *Hydrolysis of Cations*). It has been shown that as these hydrolysis reactions occur, the ions tend to aggregate through hydroxyl bridging, forming dimers, trimers, or extensive polymeric networks that can reach colloid dimensions. These polymers can then condense with the loss of water to form oxygen-bridged polymeric species (Thiyagarajan et al. 1990, "Plutonium[IV] Polymers in Aqueous and Organic Media"). The polymers can contain more than one metal hydroxide (hydroxides of other metal ions present in the initial solution mixtures) bonded to the polymer. For example, if uranium is present during plutonium or thorium hydroxide polymerization, the uranium is bonded through hydroxyl bridges to the polymer (Toth et al. 1981; and Toth et al. 1984, "Raman Study of Uranyl Ion Attachment of Thorium [IV] Hydrous Polymer"). Hydroxyl

bridge bonding is similar to that proposed for surface complexation models of sorption of hydrolyzable metal ions on oxide surfaces (Schindler 1981, "Surface Complexes at Oxide-Water Interfaces"; Davis et al. 1978, "Surface Ionization and Complexation at the Oxide/Water Interface"). Surface complexation models have been successfully used to predict sorption of uranyl ions onto amorphous iron oxyhydroxide, goethite, and hematite solids (Hsi and Langmuir 1985, "Adsorption of Uranyl onto Ferric Oxyhydroxide: Application of the Surface Complexation Site-Binding Model"). Structures of uranyl complexes at the surface of clay minerals have been identified by Chisholm-Brause et al. 1994, "Speciation of Uranyl Sorbed at Multiple Binding Sites on Montmorillonite." These studies suggest that the trace levels of plutonium hydroxide formed during neutralization of acidic wastes will be bonded to other oxyhydroxides that are present in much greater abundance in the sludge waste. Formation of individual crystals of $PuO_2 \cdot xH_2O$ was unlikely during neutralization because plutonium concentrations were thousands of times lower than the coprecipitated metal ions.

These observations provide considerable evidence to support sorption as the primary plutonium precipitation mechanism for the subject waste forms. However, because the experimental observations were not conducted under the precise conditions existing in tank wastes, some extrapolation is required to determine that adsorption is the dominant mechanism.

F4.2 PRECIPITATION OF PLUTONIUM OXYHYDROXIDE

The concept of solubility/precipitation is well established and can be used in bounding fate and transport analyses to estimate the distribution of actinides between the solution and solid phases. Solubility constructs for pure or solid solution phases determine an upper bound on the concentrations that would be expected in a solution in equilibrium with solids.

For the plutonium in the Hanford Site tanks, the solubility/precipitation concept can be used to assess the chemical impacts of plutonium in the supernatant liquids. Though the supernate cannot go critical (WHC-SD-WM-TI-757), solubility behavior of plutonium could affect the redistributed or segregated solid phase plutonium during tank farm operations that disturb the sludge layer. Although plutonium oxyhydroxide is not known to have precipitated during neutralization of the processing wastes, small amounts of plutonium oxide were present in PFP wastes that were sent to Tanks 241-TX-118 and 241-SY-102.

Solubility calculations are based on identification of the "solubility-controlling" solid and the predominant aqueous species that form upon dissolution of the controlling solid. This approach uses the thermodynamic solubility product or constant, K_{sp}, and the stability constant, K_i, to describe the formation of the predominant aqueous species to calculate the total solution concentration in the system of interest.

Waste stream data (LA-UR-96-858, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model*) indicate that the wastes were probably oversaturated with respect to $PuO_2 \cdot xH_2O$ after neutralization with caustic. This could result in precipitation of plutonium hydroxide polymer, but because the waste streams contained copious amounts of other metal

hydrous oxides, these other metal hydrous oxides would be expected to adsorb the plutonium species from solution before the plutonium species could form discrete plutonium solids. WSRC-TR-95-0462, *Effects of Coprecipitation of Uranium and Plutonium in Alkaline Salt Solution,* describes experiments with plutonium, uranium, aluminum, and iron, and, in some instances, other transition metals at mass levels much higher than the plutonium. The plutonium and uranium coprecipitated with the aluminum and iron. If plutonium were precipitated as a separate phase that precipitated by coagulation with the other metal hydroxides, the solubility of ions would be controlled by each distinct relatively pure solid phase.

Hydrous Pu(IV) oxide is only slightly soluble in tank environments except at low pH and high carbonate concentration. Several references also note that the solubility of the freshly precipitated plutonium compound drops as time progresses, as evidenced by continual slow losses of plutonium left in the solutions in contact with the solids (see WHC-EP-0882, *Calcination/ Dissolution Chemistry Development Fiscal Year 1995*; and Kim and Kanellakopulos 1989, "Solubility Products of Plutonium(IV) Oxide and Hydroxide"). Rai et al. 1980, "Solubility of Plutonium Components and their Behavior in Soils," Rai and Ryan 1982, and Delegard 1987 "Solubility of $PuO_2 \cdot xH_2O$ in Alkaline Hanford High-Level Waste Solution," characterized the solids early in the testing cycle and as late as three years after testing began. In the early test, the solid was x-ray amorphous, suggesting that the solid lacked enough ordering in its structure to generate distinct x-ray patterns or that the size of discrete crystallites are too small to allow the x-ray analysis techniques to see the crystal ordering. However, in later tests, the hydrous plutonium solid exhibited some of the characteristic x-ray patterns of high temperature formed crystalline PuO_2. In solubility tests that monitored both the solution concentrations above freshly precipitated hydrous plutonium oxide and crystalline plutonium oxide, the final plutonium solution concentrations between the two types of solids started to converge to similar values over several years (Rai and Ryan [1982] and Kim and Kanellakopulos [1989]). Rai and Ryan (1982) also showed, through x-ray diffraction, that the fresh amorphous precipitate became somewhat crystalline, then became less crystalline with time. Thus, in an aqueous solution, the fresh precipitate and the high temperature crystalline solid will both transform to the somewhat crystalline material called "aged" hydrous Pu(IV) oxide. Since the tank waste has been stored for about 40 years at elevated temperatures (≈25 to 90 °C [≈77 to 194 °F]) that promote aging, it is possible that the aged hydrous Pu(IV) oxide could be a controlling factor in the Hanford Site tanks.

The plutonium oxyhydroxide particles in the waste could affect the criticality safety of the wastes if these particles were to concentrate. Because the density of plutonium oxide is higher than that of the other solids, some separation from the less dense neutron absorbers is theoretically possible. Section F5.1 addresses the degree of plutonium concentration that could be expected from mechanical perturbation of the sludge solids and subsequent settling.

F4.3 SOLID SOLUTION FORMATION

Another coprecipitation mechanism is solid solution formation, in which a plutonium ion replaces an ion of another metal present at higher concentrations in a crystalline lattice. Because the ionic radius of Pu(IV) differs so much from those of Fe(III) and Al(III), such solid solution formation may be discounted for those metals. However, the ionic radii of Pu(IV), Zr(IV), La(III) and Bi(III) are quite similar. Thus, it is possible that some solid solution formation occurred in neutralized zircalloy cladding wastes, bismuth phosphate wastes, and perhaps other wastes. Zirconium and bismuth are the only two low neutron absorbers that have ionic radii compatible with a plutonium solid solution formation mechanism. (Lanthanum is a good neutron absorber.) If plutonium formed solid solutions with low neutron absorbers such as zirconium or bismuth oxyhydroxides and could be separated from the more effective neutron absorbers, the criticality potential of the waste could be increased.

Solid solution formation is a subset of coprecipitation phenomena in which two or more ions form a single solid phase. The solubility of a solid solution phase regulates the solution concentrations of each constituent ion at levels that may be significantly different from the solution concentrations of pure solid phases of each of the ions (Walton 1967, "The Formation and Properties of Precipitates"). Typically, one of the conditions for solid solution formation is that the ionic radii of constituent ions should be approximately equal (within 15 percent to 20 percent, Walton 1967). Based on ionic radii data (Shannon 1976, *Revised Effective Ionic Radii and Systematic Studies of Interatomic Distances in Halides and Chalcogenides*), the ionic radius of Pu(IV) was compared with other ions in the Hanford Site waste stream to determine which may accommodate Pu(IV) and potentially form solid solution phases. The data shows (Table F4-3) that only bismuth, lanthanum, and zirconium are likely to form true solid solutions with Pu(IV). The Pu(IV) ion is too large to form solid solutions with either aluminum or iron in six-fold coordination. Therefore, the observed removal of Pu(IV) from suspended colloidal form by aluminum and Fe(III) hydroxide gels is more than likely a coagulation or surface adsorption phenomena rather than the formation of thermodynamically definable solid solution that involves the removal of Pu(IV) from dissolved aqueous phase and substitution into structural sites in gel phases.

Some experimental data confirms the potential for formation of Pu(IV) solid solutions in certain Hanford Site waste streams. For example, bench-scale tests on cladding removal wastes showed that Pu(IV) could coprecipitate with lanthanum as a solid solution (Hodgson et al. 1985, "Content and Removal of TRU Elements from Aqueous Zirconium Cladding Waste"). The ratio of initial plutonium concentration in solution to the plutonium solution concentration in equilibrium with the solid solution phase is defined as the decontamination factor (DF). The data shows that the DF ranged from 3 to 61 and was a function of the lanthanum concentration. The DF of plutonium showed an exponential relationship with lanthanum concentration represented by

$$DF = 47.4e^{(219.0\,X)} - 46.6e^{(98.9X)} + 4108.6X$$

where X represents the molar concentration of lanthanum. The data shows that the mole fraction of plutonium in lanthanum solid phase ranged from 2.9×10^{-3} to 3.18×10^{-2}, depending on the

amount of lanthanum added to induce the precipitation of solid solution phase. Calculations indicate that within the range of lanthanum concentrations used in these experiments, the resulting solid solutions would contain lanthanum/plutonium mole ratios of from 30 to 349. Hodgson et al. (1985) also indicates that when cladding removal waste was neutralized with sodium hydroxide, soluble transuranic elements precipitated with the zirconium hydroxide. The DF for Pu(IV) coprecipitating as solid solution with zirconium hydroxide were estimated to range from 10 to 100. The data suggests that some of the Hanford Site waste streams that contained lanthanum, zirconium, and bismuth might have precipitated solid solution phases with Pu(IV) when they were neutralized.

The following section shows that even though these solid solution phases may form in a fraction of the wastes (those with high zirconium or bismuth concentrations), the criticality potential of the wastes is small. Particles of the solid solution phases form agglomerates with other particles that contain effective neutron absorbers. This maintains high neutron absorber/plutonium ratios and prevents plutonium concentration. Also, Table F2-1 shows that the mass ratio of zirconium to plutonium to assure subcriticality is 4,000 to 1. Therefore, at low ratios of plutonium to zirconium, the particle is subcritical regardless of other factors.

F4.4 FLOCCULATION OF PLUTONIUM PARTICLES

Flocculation occurs when the attractive forces between particles (e.g., van der Waals attractions) overcome the electrostatic repulsive forces. If a plutonium-laden particle flocculates with other sludge particles, the unique density and settling velocity of the plutonium particle is masked by the properties of the flocculate. Where rapid flocculation of the particles causes plutonium-bearing solids to be effectively bonded with the other waste solids, the criticality concerns associated with segregation can be dismissed (WHC-SD-WM-TI-725, Appendix A).

Flocculation is one of many processes that form agglomerates; therefore, all flocculations are agglomerates but not all agglomerates are flocculations. There is very strong evidence that the waste particles will agglomerate. The most direct evidence of this is a comparison of transmission electron microscopy data with measured sedimentation velocities and particle size data generated using light scattering techniques. Transmission electron microscopy measurements show that the primary particles of the sludge are submicron while sedimentation and particle sizing information indicates much larger particles. The reason for this is that sedimentation and light scattering techniques measure the properties of agglomerates of the waste particles, not the individual particles.

Calculations were performed to predict whether flocculation is expected to occur under the expected conditions during waste retrieval (WHC-SD-WM-TI-725, Appendix A). The calculations estimated the net attractive or repulsive forces between particles of various sizes. The repulsive force is a function of the liquid salt concentration, salt type, particle separation distance, particle size, and particle surface charge. The attractive forces are a function of the particle size, separation distance, and the Hamaker constant, which is a complicated function of the dielectric and polarizable properties of the particle and the liquid. When the relevant data

were lacking (e.g., the Hamaker constant and effective surface charge for waste solids are not known), conservative assumptions were made.

For a solution containing ≥0.1 molar salt, the calculations predict weak flocculation for particles larger than about 1 micron in diameter. Similar weak flocculation is predicted for particles larger than about 2 microns when the salt concentration is reduced to 0.021 *M*. The calculations do not predict that the smaller particles (≤1 micron) will form sufficiently strong flocs, but this prediction is not consistent with the observed behavior of sludge solids during hot-cell settling tests. Tests in the hot-cell demonstrate that the submicron particles, along with the larger particles, actually do participate in the formation of flocs. Recent data from hot-cell settling tests for Tank 241-C-107 are cited to support this claim. The conservatism in the values assumed for the effective Hamaker constant and particle surface charge are apparently the source of the discrepancy between the predicted and observed flocculation behaviors for the submicron particles.

While agglomerates within the waste are likely to be broken up by the pumps or the fluid jets associated with retrieval operations, the agglomerates are expected to reform under conditions suitable for settling of solids. The kinetics of the agglomerate breakup/reformation process have not been extensively studied, but hot-cell settling tests imply that agglomerates will reform quickly once mechanical disruption (e.g., mixing) is stopped.

Selective agglomeration (where a single type of particle preferentially agglomerates with itself) would not occur under the pH and saline conditions existing within the tanks. Conceptually, there is a possibility that particles that are agglomerated could selectively agglomerate if a chemical reaction were to occur to bond chemically similar particles. Through repeated cycles of breakup and reagglomeration these particles could stick together in larger clumps. It is not expected that PuO_2 would show this type of behavior, although some submicron SiO_2 agglomerates have been observed by transmission electron microscopy. The available evidence suggests that the plutonium will be agglomerated with other materials and will not segregate from the waste.

Rapid formation of flocs will prevent segregation of the waste solids provided that the salt concentration is at least 0.1 *M* in the supernate, the pH exceeds 10, and the mixing intensity is low enough to permit flocculation. These conditions will be present in almost all of the tank supernates.

F4.5 SOLUBILITY

Waste stream data indicates that the acidic wastes were probably oversaturated with respect to $PuO_2 \cdot xH_2O$ after neutralization with caustic occurred (LA-UR-96-858). It is also known that hydrous plutonium oxide ($PuO_2 \cdot xH_2O$) forms very rapidly under the conditions present during neutralization (Delegard 1987; Rai et al. 1980; Rai and Ryan 1982; Kim and Kanellakopulos 1989; Yamaguchi et al. 1994, "Effect of Complexation on Solubility of Pu(IV) in Aqueous Carbonate System"; and WSRC-TR-95-0462). The waste stream contains

copious amounts of other metal hydrous oxides, which could act as adsorption substrates to adsorb the plutonium atoms out of solution before the plutonium atoms could form discrete plutonium solids. In experiments with plutonium, uranium, aluminum, iron, and, sometimes, other transition metals at mass levels much higher than the plutonium, plutonium and uranium were found to be "coprecipitating" with aluminum and iron (WSRC-TR-95-0462). Such phenomena are thought to be coagulation of $PuO_2 \cdot xH_2O$ colloids by aluminum and iron-hydroxides rather than the formation of true solid solution phases.

However, aqueous plutonium could exist under some conditions. The identification of the predominant aqueous solution species expected in the Hanford Site waste tanks is documented in Yamaguchi et al. (1994); LA-12886-MS, *Plutonium Carbonate Speciation Changes as Measured in Dilute Solutions with Photoacoustic Spectroscopy*; and WHC-EP-0882. WHC-SD-WM-TI-757 predicts the total plutonium solution concentration in Hanford Site tanks as follows:

- Tanks with pH >12: $\approx 10^{-7}$ *M* at carbonate concentration of ≥ 0.1 *M*.
- Tanks with pH >12: $\approx 10^{-5}$ *M* at carbonate concentration of ≥ 1.0 *M* as long as pH >12.
- Tanks with pH ≤ 10: Values would increase by approximately 300 (to about 0.2 g Pu/L) for tanks with high carbonate but little free hydroxide. This is well below the minimum concentration for criticality of 7.2 g Pu/L in water and 8.5 g Pu/L in tank waste solutions.

F4.6 AGING EFFECTS

Crystallization of the fresh, amorphous iron and aluminum oxyhydroxide precipitates occurs as these precipitates age in the tanks. Precipitation of insoluble metal oxyhydroxides from synthetic acidic PUREX waste solutions containing plutonium by adding a sodium hydroxide solution is discussed in WSRC-TR-95-0462. After two months, the precipitated solids (mainly iron, aluminum, uranium, and nickel oxyhydroxides) were analyzed by x-ray diffraction. Most of the solids were amorphous, but crystalline goethite (α-FeOOH), gibbsite ($Al(OH)_3$), bayerite ($Al_2O_3 \cdot 3H_2O$), and sodium diuranite ($Na_2U_2O_7$) were also found. However, this crystallization did not affect the concentration of plutonium dissolved in the supernate over 59 days. The plutonium concentrations were more than 100 times lower than the solubility of freshly precipitated $PuO_2 \cdot xH_2O$ when iron or uranium were present in the original solutions. This strongly suggests that the plutonium was effectively coprecipitated by sorption on the iron and aluminum oxyhydroxides.

The effects of iron oxyhydroxide crystallinity on sorption of metal ions were studied by Tochiyama et al. (1994), "Sorption of Neptunium(V) on Various Iron Oxides and Hydrous Ion Oxides." Np(V) sorption on α-FeOOH prepared by adding a $Fe(NO_3)_3$ solution to 1 *M* NaOH was measured. The crystallinity was increased by heating the α-FeOOH to 130 °C (266 °F) and

300 °C (572 °F). At 300 °C (572 °F), the diffraction pattern was similar to hematite (α-Fe_2O_3). Sorption distribution coefficients were lowered from about 10^4 cm^3/g iron to 10^3 cm^3/g iron at a pH of 7 by the 300 °C (572 °F) heat treatment and were essentially unchanged by the 130 °C (266 °F) treatment. The lower neptunium sorption may also be caused by a lower surface area after heating, but the surface area was not measured. The sorption capacity of the oxyhydroxides for plutonium sorption probably decreases somewhat with aging, but the initial capacity is so large that the effect of crystallization is likely to be small.

The initial chemical bonding of the plutonium that was sorbed onto the surfaces of hydrated metal oxide sludge particles changed with aging of the waste. It is possible that the plutonium was incorporated into the evolving oxide structure (not necessarily in the crystalline structure) of the solids, which would increase the bonding strength between plutonium and the major oxyhydroxides present in the sludge. Metal ion sorption retards the crystallization of hydrous oxide gels because of this type of bonding (Kinniburgh and Jackson 1981, "Cation Adsorption by Hydrous Metal Oxides and Clay"). Incorporation of calcium, strontium, barium, nickel, copper, zinc, and cadmium into the hydrated alumina gel structure has been reported (Kinniburgh et al. 1976). This was confirmed by isotopic exchange studies, where the exchangeable percent of zinc adsorbed on aluminum gel steadily decreased with time. After 400 hours of aging, only 10 percent of the sorbed zinc was isotopically exchangeable. Thus, the zinc was steadily incorporated into the bulk structure of the aging gel. This bond would ensure high concentrations of neutron absorbers in intimate contact with plutonium in the sludge. It is unlikely that solid solution formation could account for these observations because the metal ions studied have different oxidation states and larger ionic radii than aluminum. For example, the ionic radii of Ba(II), Sr(II), and Zn(II) are 160 percent, 120 percent, and 45 percent larger than aluminum, respectively.

The solubility of discrete plutonium hydrous oxides decreases with age by two orders of magnitude from the solubility found in the laboratory for freshly precipitated material.

If discrete plutonium oxide particles are present in the sludge, it is important to evaluate the particle segregation potential of the various sludge components during operations involving hydrodynamic mechanisms (e.g., sluicing, operation of mixer pumps). Plutonium-rich particles could be partially segregated from the other sludge components (i.e., enrich the concentration of plutonium-bearing particles or deplete the neutron absorber concentrations in some portion of the tanks). Knowledge of the particle size and density of the plutonium-rich particles would be required to quantitatively evaluate this potential. No data is available on the particle size of plutonium or particle size of neutron absorbers in the tank sludges. Therefore, at this time only expert opinions can be offered.

As described in Schwetmann and Cornell (1991), *Iron Oxides in the Laboratory*; Stumm and Morgan (1981), *Aquatic Chemistry*; Hsu (1977), "Aluminum Hydroxides and Oxyhydroxides;" and Cornell and Schwetmann (1979), "Influence of Organic Anions on the Crystallization of Ferrihydrite," many common oxides (e.g., aluminum, iron, copper, and zinc) appear to form very small crystallites that are considered amorphous at first but that grow and become "crystalline" with time. Schwetmann and Hsu conclude that the crystallites were

essentially crystalline from the start and the individual particles were too small to yield measurable x-ray diffraction patterns. Because small particles exhibit very large surface energy (Stumm and Morgan 1981), they are thermodynamically less stable than larger particles of the same mineral. Thus, there is a driving force for the small particles to agglomerate into more stable larger particles. Once the particles reach a size above approximately 0.003 micron, they start looking "crystalline" to x-ray diffraction analyzers. In nature and in the laboratory, crystalline ferric oxides and aluminum oxides often are found as discrete particles with 0.1 to 10 micron sizes.

Schwetmann and Cornell (1991) shows that pure ferric oxides follow the stated trends and transform into several larger crystalline forms within days to a few weeks, depending on chemical and thermal conditions. Cornell and Schwetmann (1979) and Hsu (1977) and others concede that this recrystallization to form larger particles can be retarded/inhibited by other dissolved species in the system. Some of the most efficient inhibitors of recrystallization are simple organic acids such as citrate, and (to a much lesser extent) oxalate and fulvic acids from the decay of plant matter. Interestingly, these simple acids become much less effective at pH values of 11 or higher, which is the pH range most common in Hanford Site tanks. The impact of these other ligands (anions) in the tank solutions is not easily quantified, but there are some indications that the high pH, elevated temperatures, and long time periods (30 to 50 yr) available to react, may favor the eventual recrystallization of crystalline and partly crystalline products.

There is evidence in the Hanford Site, Savannah River, and Russian literature germane to defense tanks that crystalline aluminum and iron hydroxide, oxide, and oxyhydroxide compounds are present (Hobbs 1995, *Effects of Coprecipitation on the Concentrations of Uranium and Plutonium in Alkaline Salt Solution,* and Zakharova and Ermolaev 1995, *Transformation of Solid Phases During Storage of Radioactive Sludge in Tanks*). No literature studies have been identified that discuss the particle size or nature of plutonium solids within Hanford Site or other nuclear defense sludges. However, it is logical to expect that plutonium would act in a similar fashion to other metals such as iron and aluminum, for which some literature has been reviewed (as discussed above).

Estimates of particle size distribution of freshly precipitated and aged $PuO_2 \cdot xH_2O$ can be made using available data. Because freshly precipitated $PuO_2 \cdot xH_2O$ is x-ray amorphous, the bulk of this material may comprise particles smaller than 0.004μm. Andelman and Rozell (1970), *Plutonium in the Water Environment, I. Characteristics of Aqueous Plutonium*, shows that the bulk of freshly precipitated $PuO_2 \cdot xH_2O$ exists as colloids that are not settled through centrifuging. Studies of long-term aging of $PuO_2 \cdot xH_2O$ by Rai et al. (1980) and Delegard (1987) show decreases in solubility, which indicates that there was particle growth with concomitant increase in crystallinity from long-range structural ordering. Further, x-ray diffraction data obtained on aged (over 3 yr) $PuO_2 \cdot xH_2O$ precipitates showed that the precipitate had partially crystallized, resulting in particle growth and decreased solubility.

Solubility data obtained by Rai et al. (1980), Rai and Ryan (1982), and Kim and Kanellakopulos (1989) indicates that the solubilities of freshly precipitated and aged $PuO_2 \cdot xH_2O$ differ by about 2 orders of magnitude. Using these numbers, it is calculated that the finest

particles in aged $PuO_2 \cdot xH_2O$ material have average diameters of about 0.7 micron. This value has been used as the lower bound on particle size that controls the solubility.

An upper bound for particle size can be estimated based on the particle-size distribution data in Andelman and Rozell (1970), which shows that the largest particle size in the plutonium-hydroxide colloidal mass is approximately an order of magnitude larger than the smallest particle size. From this data it can be concluded that aged Pu(IV) oxyhydroxide has about 60 percent of the particles by mass less than 2 micron in size. About 40 percent of the mass of aged particles may range from about 2 to 8 micron in size. As shown in Andelman and Rozell (1970), it is important to bear in mind that ionic strength, presence of ligands, and other particulates will affect the particle size distribution of $PuO_2 \cdot xH_2O$.

The crystal growth process has been recognized for at least a century. In early literature this process is referred to as "Ostwald Ripening" and is succinctly defined as the process wherein small crystals, more soluble than large ones, dissolve and reprecipitate onto larger particles.

In summary, it can be inferred that the initial particle sizes of precipitates in the Hanford Site tank sludge should be the same as those assessed from literature data. It is possible that all the metals present in the acid waste stream that form insoluble hydroxide-like phases, and most likely those that form insoluble phosphate, sulfate, or carbonate compounds, all follow a similar history. At first, very small particles with a size range of less than one nanometer (<0.001 micron) to 0.004 micron form but only with fixed chemical structures. As time evolves, these very small crystallites grow larger, driven thermodynamically to reduce surface energy. They eventually reach a threshold size that is identified as "crystalline," using traditional techniques such as powder x-ray diffraction. Their size at this point is larger than 0.003 micron, depending on the criteria for calling the x-ray diffraction peaks as sharp enough to qualify as crystalline. Crystalline compounds of these metal oxides/hydroxides formed in the laboratory or isolated from natural soils/sediments are often in the 0.1 to 10 micron size range, although the details of particle size measurements or considerations of particles aggregation have not been explored in detail.

F4.7 CONCLUSION

This section reviewed the potential for plutonium bearing particles to selectively concentrate and settle to locations within a tank in a manner of concern to criticality safety. Plutonium in the settled solids and sludges is present in one of the following forms:

- Adsorbed onto iron or aluminum oxyhydroxides
- As a plutonium oxyhydroxide precipitate
- As an ion within a crystal lattice (solid solution)
- In a floc with other oxyhydroxides.

The chemical mechanisms for concentrating the plutonium in a waste tank to a concentration and quality sufficient for criticality would require dissolution of plutonium from the solid phase to the aqueous liquid phase and then the selective deposition into a compact volume of concentrated solids. For the first step, sorbed plutonium must be desorbed into the aqueous phase of the waste mixture. Plutonium sorption onto oxyhydroxides can be reversed (WHC-SD-W320-CSA-001, *Criticality Safety Assessment of Tank 241-C-106 Remediation*) only if the solution composition in contact with the plutonium is dramatically altered. Such an alteration would require (1) the addition of organic or inorganic plutonium complexants, (2) a change in the REDOX potential of the solution by adding oxidants, or (3) acidification of the solution.

The supernate solutions in the tanks contain high concentrations of dissolved nitrite that act as a reducing agent and keep the dissolved plutonium mainly as Pu(IV). Because Pu(IV) is sorbed more strongly than Pu(V) or Pu(VI), the nitrite helps fix the plutonium onto the oxyhydroxide surfaces. To change the REDOX production of the supernate solutions would require the addition of huge quantities of oxidizing or reducing agents to the tanks (enough to destroy the nitrite). Because all additions to the tanks are controlled, this is not a reasonable possibility.

Acidification of wastes in the tanks would cause partial dissolution of the oxyhydroxides on which the plutonium is sorbed and would also cause dissolution of some of the plutonium. Large volumes of gases would be generated by acid reactions with nitrite to produce NO_x gases, with carbonate to produce CO_2, and potentially with the carbon steel tanks to produce hydrogen gas. Accidental, undetected acidification of the wastes is highly unlikely. The available onsite inventories of acids are insufficient to acidify a waste tank.

Precipitated plutonium oxyhydroxide is typically not a pure species, but is usually associated with a flocculent. The flocculent contains other solids and neutron absorbers both of which result in the need for a greater concentration of plutonium to go critical than would otherwise be the case. If the precipitated plutonium hydroxide were to form as a pure phase, a criticality would still not be possible because the quantity needed for a thin slab (the reasonably worst case geometry for this material) is excessive.

Plutonium in solid solution crystals cannot go critical because of the high concentration of solids and absorbers. The only way a criticality is possible is with concentration and redistribution of the waste into a more reactive configuration. Chapter F5.0 discusses redistribution.

F5.0 PLUTONIUM CONCENTRATION MECHANISMS

The most credible mechanism for concentrating plutonium in the wastes is separation of plutonium-rich particles from other sludge particles during mechanical perturbations of the sludge layer. Such perturbations may result from heat-driven convection or tank farm operations that move the sludge. Separation of particles by differential settling of different densities, sizes, or shapes must be considered.

It is a conceivable means for plutonium to be concentrated by dissolution of plutonium in one region of the tank and by precipitation of the dissolved plutonium in a different region. These chemical concentration mechanisms are considered less significant than physical mechanisms because of the relatively uniform supernate and interstitial liquid composition expected in the tanks.

Many of the models considered in the following subsections were developed for specific activities. The models are conservative enough, however, that the results can be generally applied.

F5.1 SEPARATION OF PLUTONIUM-CONTAINING PARTICLES FROM SLUDGE

F5.1.1 Thermal Effects

Heat convection in a generic tank containing sludge has been simulated numerically. The simulations were performed to find the maximum flow velocities caused by heat convection cells formed in waste sludge. The sludge was modeled as a wet clay having 50 percent porosity 1.4 g/cm^3 density and 12.5 cp viscosity. The heat production was taken as 2.66 W/m^3 (0.257 Btu/h ft^3). This model corresponds with a heat load of about 2.9 kW (10,000 Btu/h) in a sludge layer 2.4-m (7.9-ft) thick. Heat loss from the walls and bottom of the tank were considered. Another case was run with a heat load of 43.2 W/m^3 (4.18 Btu/h ft^3).

The results show a convection cell forming near the walls of the tank where cooling occurs. The maximum velocity for the 2.66 W/m^3 (0.257 Btu/h ft^3) case is about 3 x 10^{-12} m/s (9.8 x 10^{-12} ft/s), and the velocity for the 43.2 W/m^3 (4.18 Btu/h ft^3) case is 2 x 10^{-8} m/s. The flow necessary to transport particulate is 0.2 to 2.5 m/s (0.66 to 8.2 ft/s) (WHC-SD-WM-TI-757). Therefore, thermal effects will not result in the migration of plutonium through erosion of a surface by moving liquid. Sufficient concentration and redistribution to result in a criticality could not occur from such thermal effects.

F5.1.2 Flow of Solids and Liquids into Tank

Solids can be transferred along with liquids during a tank transfer. Modeling has been performed using TEMPEST (WHC-SD-WM-TI-757) to simulate the sluicing retrieval of Tank 241-C-106 solids into Tank 241-AY-102. The results of this model are discussed here as an example of a transfer that includes solids. The solids are assumed to enter the tank as a 30 wt% slurry at 22 L/s (300 gal/min) through a distribution header configured as a cruciform in the horizontal plane with a 2.54-cm (1-in.) nozzle on each of the four legs. Solids were modeled using a particle density of 2.4 g/cm^3 and 9 size groups (representing a measured particle size distribution for Tank 241-C-106 solids) ranging in diameter from 5-10 micron (Group 1) to 50-55 micron (Group 9). Plutonium particles were assigned to size groups based on the settling velocity of those particles. Two cases were assumed for plutonium particles. A conservatively large, fast-settling plutonium particle was assumed to be 11.5 micron with a density of 11.5 g/cm^3, which placed it in Group 5. A more likely particle was assumed to be 2 micron with a density of 6 g/cm^3, which places it in Group 1.

Simulation results indicated that the slurry forms a density current that rapidly flows downward and spreads out over the existing settled sludge layer. The degree of enrichment of the settled solids in the Group 5 particles was limited to about 1.5 while the Group 1 particles were not enriched in the settled sludge layer. In contrast, concentration by a factor of 20 would be required to approach the minimum concentrations to allow criticality in an infinite volume of this sludge. Near the end of the transfer operation, the Group 1 solids would be enriched in the last solids to settle. However, these small solids would almost certainly settle into thin, uniformly distributed layers which would preclude criticality based on the 2,580 g/m^2 (240 g/ft^2) areal minimum requirement for criticality to occur.

The degree of segregation observed during a transfer of solids will vary with the physical parameters defining the transfer. However, the modeling performed specific to Tank 241-C-106 solids transfer to Tank 241-AY-102 indicates that the degree of segregation in this type of operation is not large. In addition, there are a number of reasons to not expect segregation sufficient to achieve criticality in this scenario. These reasons include (1) a review of mining literature, which indicates it would be difficult to separate the plutonium from tank sludge by gravity separation techniques, and (2) an expectation that small particulates should be flocculates so that the plutonium particles do not have different settling characteristics than other sludge. The expectation of flocculation is reinforced by observations from transmission electron microscopy. These observations of a number of tank sludge samples indicate that the primary particle size is submicron and that the particles are agglomerate based on light scattering measurements. Segregation that may occur between faster-settling and slower-settling agglomerates will not change the relative plutonium concentrations in the sludge. Finally, where plutonium is bound to neutron absorbers through sorption or solid solution mechanisms, this would provide an additional barrier to segregation preventing a criticality resulting from waste transfers.

Plutonium concentrations in waste transferred from other facilities to the tank farms are controlled. Plutonium is typically in solution at these other facilities and during the process of tank neutralization plutonium precipitates from the solution. Because it is difficult to accurately obtain a value for plutonium concentration in the precipitate, controls are placed on the plutonium concentration prior to precipitation. The control value has been set at 0.04 g Pu/L in the batch being transferred.

The control value was selected on the basis of actual plutonium concentrations in the tank waste and the minimum concentrations that would post threats of criticality accidents. The highest measured plutonium concentration in the waste tanks was 0.7 g Pu/L, which is assumed to be the result of tank farm operations (waste transfer, evaporation) that produced waste near the 0.013 g Pu/L production limit, or a concentration factor of 54. The maximum concentration limit for this waste, using the conservative waste model, is 2.6 g Pu/L, assuming an infinite volume. A more realistic value assuming a finite volume is 5 g Pu/L. A 5 g Pu/L solution would need a sphere 100 cm in radius containing about 20 kg (44 lb) to go critical (Figure F1-1). A slab with a concentration of 5 g Pu/L would need 1,800 kg (4,000 lb) to go critical (Figure F2-3). Actual waste transferred is expected to form a slab-like geometry rather than a spherical geometry. WHC-CM-4-29, *Nuclear Criticality Safety Manual*, requires a safety margin of 2.22 (or 45 percent of the total) for waste transfers, therefore, the maximum allowable concentration for waste transfers is 2.25 g Pu/L. Using the actual tank concentration factor of 54, the allowable transfer concentration is 0.04 g Pu/L. This value is considered to be conservative.

The highest plutonium concentration measured in the tank solids was 0.7 g/L. WHC-SD-WM-TI-757 shows that the average plutonium concentration in the worst case waste was 0.0028 g Pu/L. Using this assumption, the plutonium concentration increased by a factor of 250. If it is assumed that waste at 0.04 g Pu/L is concentrated to the same extent, the resulting long-term concentration will be 10 g Pu/L. If this waste settles into a sphere having optimum neutron absorbers over those of the conservative waste model, 1 kg (2.2 lb) of plutonium is needed to go critical. This would require 25,000 L (6,600 gal) of waste at 0.04 g Pu/L to be transferred and concentrated. It is extremely unlikely that 25,000 L (6,600 gal) of waste would be transferred at the limiting concentration, concentrated, and then relocated into a sphere with a diameter of 0.5 m (1.6 ft). Even if this were to occur, a criticality accident would still not be possible due to the presence of neutron absorbers.

Because transferred waste is well mixed, there is no reason to believe it will settle into a small sphere. The waste will most likely settle into a thin slab. A slab of plutonium at 10 g Pu/L must be at least 30-cm- (12-in.)-thick to go critical. If it is assumed that the slab occupies an area with a radius of 11.4 m (37.5 ft), the total quantity of plutonium needed to go critical is 1,200 kg (2,640 lb). This would require a transfer of 30×10^6 L (8.0×10^6 gal) of solution at the concentration limit.

F5.1.3 Salt Well Pumping

Salt well pumping essentially involves extraction of liquid waste with a subcritical concentration of plutonium from an SST and dispersing that waste into similar liquid waste in a DST that also contains a subcritical amount of plutonium. Salt well pumping is accomplished with perforated steel pipes inserted vertically at various points in an SST from the top of the waste to the bottom of the tank. Liquid waste that enters the pipe is continuously pumped to a DST until the pumping rate falls below a previously determined flow rate. Initially, some disturbed sludge and salt cake solids are transferred to a DST along with the liquid phase. However, the amount of solid waste transferred in this manner quickly decreases as the bulk solids surrounding the salt well pipe begin to act as a filter and prevent additional finely divided solids from migrating into the well.

SST solids pumped from salt wells are introduced into the receiver DST in a controlled manner in order to avoid any potential for accumulation of plutonium-bearing solids in one location. From a nuclear criticality perspective, salt well pumping is a localized and benign activity that does not cause significant separation or physical concentration of solid materials. In particular, plutonium oxide, plutonium-bearing oxides and oxyhydroxides of metals that are not effective neutron absorbers cannot be effectively concentrated.

WHC-SD-WM-TI-757 presents the results of a study of the effects of salt well pumping on plutonium distribution. The study contained the following assumptions:

30% - porosity
12 cm^2 - permeability (a very low value)
1.4 g/cm^3 - density
12.5 cp - viscosity
2 gal/min - pumping rate.

The maximum velocity was 0.002 m/s (0.01 ft/s) at the edge of the salt well. The velocity drops off very rapidly with distance away from the pump. Because the critical velocity needed to resuspend plutonium is 0.2 m/s - 2.5 m/s (0.66 ft/s - 8.2 ft/s) (based on resuspension of particles from stream beds), there would be no redistribution of plutonium. If the waste were salt cake, the porosity and permeability would be larger and lead to higher velocities. However, the plutonium concentration in salt cakes is quite low and redistribution is of little concern.

F5.1.4 Solids Settling

A one-dimensional solids settling analysis was performed (WHC-SD-WM-TI-757) to determine the degree of segregation that may occur from settling DST solids under stagnant conditions. Light scattering techniques were used to establish particle size distributions of solids from Tanks 241-C-106 and 241-SY-102. Solids from Tank 241-C-106 ranged in size from 5.5 to 90 micron, while solids from Tank 241-SY-102 ranged from 7.5 to 137 micron. Waste characterization data was used to establish the elemental composition. Iron was assumed to be in

the form of hematite with a density of 5.26 g/cm^3, aluminum was assumed to exist as gibbsite with a density of 2.4 g/cm^3, and other sludge constituents were assigned a conservatively low density of 2.0 g/cm^3. The same sludge composition was assumed for the entire particle size distribution. Plutonium was assumed to exist as discrete particles of PuO_2 and was either assumed to be uniformly distributed across the size distribution, or assigned a single size of either approximately 5 to 10 micron or 20 micron. These sizes were selected as the upper limit on credible sizes for discrete PuO_2 particles. PuO_2 particle densities of both 11.5 g/cm^3 and 6 g/cm^3 (minimum density of freshly precipitated plutonium) were evaluated separately. The results are shown in Table F5-1.

The initial plutonium concentration for Tanks 241-C-106 and 241-SY-102 is about 0.14 g Pu/L. Therefore a concentration factor of about 20 would result in a concentration of 2.6 g Pu/L, the maximum concentration limit for ensuring subcriticality. There are three particle sizes for which the concentration factor of 20 could be met or exceeded. Table F5-1 shows that for cases where all the Pu particles are 52.5 micron, 90 micron, or 6 micron, a concentration factor of 20 can be exceeded. However, even under these conditions, a criticality is not possible for the following reasons:

- Solids settle in layers that are not pure plutonium. The presence of other elements increases the neutron absorption and means that more plutonium bearing solids would be needed to reach criticality. Such an abundance of plutonium in a single layer is not plausible.

- Concentrations in spheres of at least 5 g Pu/L are needed, and even greater concentrations are needed for slabs to reach criticality. These concentrations are not plausible.

- The potential for creating substantial amounts of uniform diameter pure plutonium particles is very remote.

- Observations using transmission electron microscopy indicate that in a number of tank sludges, the primary particle size is submicron and that the measurements obtained using light scattering techniques are most likely agglomerates. Segregation that may occur between faster-settling and slower-settling agglomerates will not change the relative concentrations of plutonium in the sludge.

- Where the plutonium is bound to neutron absorbers through sorption or solid solution mechanisms, this binding would provide an additional barrier to segregation.

As a result of all of the above, a criticality cannot occur from solids settling.

F5.1.5 Mixer Pump Operations

Mixer pump modeling studies have been conducted by Pacific Northwest National Laboratory personnel using the TEMPEST (PNL-8857) computer code. Modeling studies have been performed for the use of a single rotating jet and for the use of two mixer pumps at the center of a DST. No results have been obtained in either case that achieve sufficient separation and concentration of fissile material from neutron absorbers to result in a criticality concern (WHC-SD-WM-TI-757). Note, however, that the TEMPEST code does not model all the physical concentration mechanisms evaluated in the mineral processing industry. Evaluation of these types of mechanisms for the Hanford Site waste tanks has been addressed by evaluating the operational principles of gravity separation. Again, no results were obtained which indicated a sufficient segregation or selective relocation of fissile material to result in a criticality concern (WHC-SD-WM-TI-757).

A mixer pump is installed and operated in Tank 241-SY-101 to prevent the accumulation and sudden release of potentially explosive gases. Before startup of the mixer pump in Tank 241-SY-101, Los Alamos National Laboratory personnel performed a special safety assessment of the proposed operations including the potential for an accidental nuclear criticality (LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, Appendix I). Because there is only about 1 kg (2.2 lb) of plutonium in the sludge in Tank 241-SY-101 and the plutonium is combined with a large amount of iron and other metals, the Los Alamos National Laboratory analysis concluded that the proposed mixer pump installation and operation would not lead to a nuclear criticality accident. Furthermore, preliminary investigation of underground storage tank hydraulics by Pacific Northwest National Laboratory scientists indicates that the operation of a single mixer pump will not lead to deposition of solids in a compact geometry (WHC-SD-WM-TI-757). Under these conditions, solids will likely be deposited in an annular ring around the mixer pump.

F5.1.6 Air Lift Circulator Operations

Air lift circulators are not currently operating in any SST. However, air lift circulators are installed in several DSTs (e.g., 241-AZ-101, 241-AZ-102, 241-AW-102) and are available for use when needed. Air lift circulators are simply vertical steel pipes that are open at both ends. Air is pumped through the pipes to keep sludge solids dispersed in the liquid phase, thereby evening out the heat generation in the tanks. Historically, air lift circulators have been operated in those tanks where the ^{90}Sr content of the sludge phase is significantly high and large amounts of heat energy are generated by radioactive decay of ^{90}Sr. Operation of air lift circulators in such tanks prevents "bumping" and hot spots, both of which are objectionable phenomena for safe tank management.

WHC-SD-WM-TI-757 presents the results of a study that showed that the operation of air lift circulators could resuspend much of the solids beneath the circulator and also presents the

results of a different study that showed that only the very small solid particles would become suspended. The results of this suspension are similar to those discussed in Section F5.1.4. A criticality is not possible because of air lift circulator operation.

F5.2 DISSOLUTION/PRECIPITATION

F5.2.1 Water Addition

Water is added to waste for a variety of reasons (e.g., sluicing and heat removal). Water addition to tank liquids reduces the hydroxide concentration and the carbonate concentration and adds volume. These additions are not expected to significantly change the solubility of plutonium compounds and therefore will not result in dissolution or precipitation of plutonium.

In order to get more plutonium in solution, the plutonium must be suspended in the supernate as a colloid or as a particulate. Plutonium in the sludges is not available to the liquid unless the action of water addition stirred up the sludge. Even if more plutonium is added, the plutonium concentration will remain below 2.6 g Pu/L (the maximum concentration limit for ensuring subcriticality in an infinite system with solids) because the peak solubility in these liquids is 0.2 g Pu/L (under high carbonate concentration).

Water addition to the solids increases neutron moderation in the system. This increases the quantity of plutonium needed to go critical because the system is overmoderated. Because the concentrations are initially subcritical, a criticality is even less possible under these conditions.

Water addition to salt cake makes some of the salt cake soluble and adds to the volume. The water addition overmoderates the system because of the low plutonium concentration. If carbonate is present in the salt cake, some of the plutonium could go into solution. On the basis of these considerations, a criticality will not occur as the result of water addition.

F5.2.2 Caustic Addition

Sodium hydroxide is added to tanks that have a low concentration of free hydroxide. The addition of caustic to the supernate increases the hydroxide concentration and lowers the solubility of plutonium in the supernate. The plutonium forms a colloid in the supernate as it is forced out of solution. For tanks that have no carbonate, the solubility increases somewhat, but the solubility is extremely low (10^{-5} to 10^{-6} *M*). If the plutonium remains suspended in the solution as a colloid, the only change in the liquid is more oxygen and hydrogen. If the plutonium precipitates as a particulate and settles, a thin layer of plutonium will form on the surface of the solids layer. The geometry is such that a criticality is not credible. The areal concentration has to be at least 2,580 g/m^2 (240 g/ft^2) before a criticality would be possible. Because the fallout would

be uniform over the entire area of the tank, 1,060 kg (2,300 lb) of plutonium would be needed for a criticality in the larger Hanford Site tanks. Individual waste tanks do not contain anywhere near this much plutonium.

F5.2.3 Temperature Gradients

It is conceivable that temperature differences in the sludge could provide a driving force to transport plutonium along a temperature gradient. However, for most tanks the temperature differences in the sludge layer are small, with only a few degrees difference from the top of the sludge to the bottom. For a few high temperature tanks (e.g., 241-C-106 and 241-SX-108) maximum temperature differences in the sludge layer are 16 °C and 29 °C (29 °F and 52 °F), respectively (based on thermocouple measurements). Because the plutonium can be present as adsorbed plutonium on metal oxyhydroxide surfaces or as separate oxide phases, preferential concentration of plutonium along a thermal gradient would require a very large temperature effect for plutonium sorption/desorption or dissolution/precipitation.

Measurements of plutonium distribution coefficients for sorption on geological material over a 60 °C (140 °F) range showed an almost insignificant effect of temperature on solubility. Further, the small amount of data available on plutonium solubility does not show significant differences for plutonium oxide and known solution species over the temperature range of 25 to 100 °C (77 to 212 °F). Because plutonium would have to be concentrated by orders of magnitude to approach criticality, a thermal driving mechanism is very unlikely. Furthermore, because the sludge layers are relatively evenly distributed and the temperature gradient is primarily vertical, the plutonium concentration, if it could occur at all, would result in a relatively thin, flat layer on the top or bottom of the sludge depending on whether the plutonium is more or less soluble at high or low temperature. This configuration is critically safe for the maximum credible concentrations of plutonium found in the tanks (Section F2.2.3). Large deposits of concentrated plutonium would require very large quantities of plutonium that are beyond what has been found to exist in the waste tanks. Therefore, a criticality is not possible.

F5.2.4 Radiolysis

The effects of radiolysis on plutonium chemistry with respect to the criticality safety are discussed in WHC-SD-WM-TI-757. Alpha emissions from the decay of ^{239}Pu produce free radicals which are powerful REDOX agents. These free radicals may induce plutonium REDOX reactions resulting in the formation of various valence species. Such self-catalyzed plutonium reactions are categorized as radiolytic effects. Radiolysis has been analyzed for its ability to provide a REDOX-driven solubility transport and reconcentration mechanism.

There are only a limited number of experiments in which radiolysis effects have been studied under near neutral or slightly alkaline conditions. There is only limited radiolysis experimental data relevant for very highly alkaline and ionic strength solutions that are typical of Hanford Site high-level waste supernatant liquids; therefore, the effects cannot be easily quantified

for the conditions in the waste tanks. However, radiolysis can provide a REDOX-driven solubility transport and reconcentration mechanism. Based on actual waste sample data (0.7 g Pu/L) (Section F1.0) and experimental data, the Pu concentration will remain below 2.6 g Pu/L.

F5.3 SUMMARY

The criticality technical basis (WHC-SD-WM-TI-725) shows that under current plutonium inventories and operating conditions, the waste contents are subcritical and a nuclear criticality accident is incredible.

F5.4 KEY ASSUMPTIONS OR CONCLUSIONS

The key assumptions or conclusions are as follows:

- About 500 to 1,000 kg (1,100 to 2,200 lb) of plutonium are currently estimated to be in the tank farms. Future waste additions will not significantly increase this total.

- The plutonium is reasonably distributed in all of the tanks. That is, there are likely no large sphere-like volumes containing plutonium concentrations significantly different than that in the radially adjacent waste.

- Nonaged (i.e., fresh) plutonium containing liquids with high carbonate (>1*M*) concentrations do not exist in the tanks and will not be added to the tanks.

- The existing waste is, and the future waste additions will be, alkaline. As a result most of the plutonium is in solid form along with the important neutron absorbers and the attractors of plutonium (i.e., chemicals that result in attachment of plutonium due to adsorption, solid solution, flocculation, and attraction of metals by hydroxides).

- Tank farm activities include only mechanical movement and separation of plutonium occurs. No activity involving deliberate chemical separation will occur.

F6.0 CRITICALITY ACCIDENT ANALYSIS

The technical basis for criticality discussed in Sections F2.0 through F5.0 concludes the following:

- Fissile material in the waste tanks is distributed in subcritical concentrations.
- Neutron absorber-to-plutonium mass ratios are typically well above those needed to ensure subcritical conditions.
- No physical or chemical phenomena or mechanisms that could separate or concentrate fissile material at sufficient quantities or concentrations to approach criticality can be identified.

Although the technical basis shows that a criticality accident in the tanks is not credible, a postulated criticality accident was analyzed to complete a comprehensive safety analysis. The postulated accident was assumed to occur from an inadvertent transfer of plutonium from a plutonium separation and purification plant such as PFP.

The events necessary to cause a criticality accident in the tanks would include an implausible series of process failures in combination with violation of (1) management practices; (2) operational limits, controls, and procedures; and (3) equipment controls. These failures and violations would have to be accompanied by the plutonium in the tank forming a compact, nearly spherical shape rather than the more likely slab-like layer that occurs when waste flows into a tank. Even if a criticality accident occurred, the consequences would still be within the risk guidelines.

F6.1 CRITICALITY IN SMALL TANKS

Nuclear criticality safety has been analyzed for SSTs, DSTs, DCRTs, catch tanks, 200 Series tanks, and waste transfer lines. The results of the analyses are summarized below.

F6.1.1 Double-Contained Receiver Tanks

The three types of DCRTs are (1) long horizontal tanks 3.7 m (12 ft) in diameter (244-BX, 244-TX, and 244-U), (2) large vertical tanks 4.6 m (15 ft) in diameter (244-S, 244-CR and TK-003), and (3) small vertical tanks 1.4 m (4.6 ft) in diameter (244-A). With the exception of 244-TX, all DCRTs function as lag storage tanks for salt well pumping and receive primarily supernate with a very small amount of solids. Supernate contains an insufficient concentration of plutonium (less than 0.2 g Pu/L) to pose a criticality threat; thus, the plutonium concentration is insufficient for a criticality accident. If some plutonium were transported as a colloid, the

concentrations would still be well below the minimum concentrations of 7.2 g Pu/L for water or 8.5 g Pu/L for supernate to achieve criticality.

Plutonium forms into colloids when sodium hydroxide is added to tanks that have a low concentration of free hydroxide because the resulting alkalinity lowers the solubility of plutonium in the supernate and forces it out of solution. If the plutonium remains in solution as a colloid, the only change in the remaining liquid is more oxygen and hydrogen. If the plutonium precipitates as a particulate and settles, a thin layer of plutonium forms on the surface of the solids layer. A criticality is not possible with the plutonium in this type of layer because the areal concentration has to be at least 2,580 g Pu/m^2 (240 g Pu/ft^2) before a criticality is possible. For example, the 244-A DCRT has a surface area of least 1.5 m^2 (16 ft^2). At the minimum critical areal density for this tank, the minimum plutonium for criticality is 3.84 kg (8.5 lb). Spread uniformly, the 244-A tank inventory would be subcritical regardless of the plutonium concentration. A 100 g/L tank inventory that forms a slab 6.4-cm (2.5-in.) thick (Table F2-10) would require 9 kg (20 lb) of plutonium to reach the critical limit.

Plutonium solids from PFP are transferred to DCRT 244-TX and could reach DCRT 244-S as the result of a mistransfer. DCRT 244-TX is 10.7 m (35 ft) long and 3.6 m (12 ft) in diameter. DCRT 244-S is 4.6 m (15 ft) in diameter and 4.6 m (15 ft) tall. Before 1981, neutralized waste from PFP was transferred to DCRT 244-TX without added iron. Since 1981, iron has been added to the waste at a concentration of 0.7 percent by volume to ensure a sufficient plutonium-to-iron neutron absorber ratio to prevent criticality.

Assuming that in DCRT 244-TX the plutonium solids settle with optimal concentration of water so as to form a layer having a concentration equal to 10 g Pu/L, a sphere 0.6-m (2-ft) in diameter would be needed to go critical. This size sphere could not form until the liquid plutonium waste stream covers the entire bottom of the DCRT. For criticality to occur, the 10 g Pu/L assumed concentration must be spread over an area of 11 m^2 (120 ft^2) over the bottom of the DCRT and 0.6-m (2-ft) thick. This yields a quantity of plutonium that equates to about 1/10 of the entire plutonium inventory transferred to all tanks, an unrealistically high value to be contained in a single tank. Even for the waste transfers before iron was added to the PFP waste, some iron was added to that waste by tank corrosion and aluminum was added during PFP processing. The presence of iron and aluminum means that much more plutonium would be needed to go critical.

F6.1.2 Catch Tanks and Diversion Boxes

Catch tanks are underground tanks used to collect waste drained from valve pits and diversion boxes. The catch tanks are the same size as the DCRTs except for catch tank 241-AZ-154, which is 1.5 m (5 ft) in diameter. Catch tanks are emptied into diversion boxes or tank trucks through pump out lines.

Catch tanks primarily receive liquids but some cases could contain up to 30 percent solids. Assuming that the solids were left in the tank to evaporate, at least 30 kg (66 lb) of plutonium would be required to go critical based on the DCRT analysis. In the catch tanks, however, when the solution evaporates the neutron absorbers of nitrate, sodium, nitrite, phosphorous, and sulfate would still be present and would remain with the plutonium. As a result, a criticality in catch tanks is not credible for the same reasons as described for the DCRT analysis.

F6.1.3 Transfer Lines

A 7.6-cm (3-in.) transfer line would require a 7,000 g Pu/L solution to go critical, and a 15-cm (6-in.) line would require 100 to 1,000 g Pu/L to go critical (LA-10860-MS). Plutonium solutions of this concentration do not exist. Therefore, a criticality event is not credible in the transfer lines.

F6.1.4 Criticality in Soil

An evaluation of the criticality safety implications of supernate leaking into the ground is documented in WHC-SD-SQA-CSA-20356. If liquid from a waste storage tank leaked into the soil, criticality would not be credible. A conservative model of soil can be postulated based on silicon dioxide, one of the least neutron absorbing (and hence one of the most conservative) materials occurring in nature. WHC-SD-SQA-CSA-20339, *CSER 91-011: Minimum Critical Safety Limits for Nuclear Waste*, and Altschuler and Doto 1991, *Minimum Critical Safety Limits for Nuclear Waste*, report that the minimum critical concentration (in an infinite medium) of plutonium in sand is 0.82 g Pu/L of sand. WHC-SD-SQA-CSA-507 notes that this value is reduced to 0.70 g Pu/L in an infinite medium based upon a k_∞ of 0.95 at a 95 percent confidence level for added conservatism. This minimum critical concentration occurs when the sand contains no water. The addition of water increases neutron absorption and, at the same time, minimum critical concentration. This calculated concentration for criticality is based on an infinite volume. Finite volumes and the presence of water, solids, and other absorbers in waste require higher concentrations of plutonium for a criticality to occur.

A waste leak to the soil would be comprised primarily of supernate, although some small fraction of solids may be included. When supernate drains into the ground, the soil filters and traps the plutonium along with any suspended solids in a relatively small volume near the source of the leak. The depth to which the plutonium penetrates the soil depends on the form of the plutonium-bearing waste. Particles are filtered out within a short distance, whereas dissolved plutonium migrates a greater distance (along with the liquid).

Liquid intrusions into tanks from snow melt or rainwater may dissolve some soluble neutron absorbers, however, the criticality safety posture of waste in the tanks has been evaluated in the presence of insoluble absorbers which are also insoluble in rainwater or snowmelt. The liquid intrusions into leaking waste tanks can provide a motive force for washing plutonium bearing solids into the soil column. However, because the intrusive water does not contain fissile

material, any washed solids will have the same composition as solids discussed above. The chemistry of solids washed from a tank by rainwater will be comparable to the chemistry of solids washed from the tank by supernate generated in a chemical separations facility.

For criticality to occur, both the plutonium concentration and the quantity of plutonium would have to be quite large. Criticality is not possible if the plutonium concentration is less than 0.7 g Pu/L. In systems of plutonium, water, and silicon dioxide, the minimum critical plutonium mass (i.e., plutonium concentration times the volume) is achieved when the water content is high and the volume is small. Addition of silicon dioxide lowers the average neutron absorption and reduces the degree of moderation over that of water. This permits criticality at a lower plutonium concentration but requires a much larger volume, hence a greater plutonium mass.

Data for critical concentration and critical mass in soils is provided in ARH-2622. The following critical parameters assume 3 wt% ^{240}Pu, 40 vol% voids, and full water reflection.

Sphere:

- 8.5 g Pu/L requires a sphere 94 cm (37 in.) in diameter
- 10 g Pu/L requires a sphere 76 cm (30 in.) in diameter
- 30 g Pu/L requires a sphere 51 cm (20 in.) in diameter
- For <7.2 g Pu/L, no data is provided but the curve is quite steep in this region. The critical diameter increases significantly for small changes in concentration.

Infinitely Long Cylinder:

- 7.2 g Pu/L requires a cylinder 64 cm (25 in.) in diameter
- 10 g Pu/L requires a cylinder 51 cm (20 in.) in diameter
- 30 g Pu/L requires a cylinder 25 cm (10 in.) in diameter
- For <7.2 g Pu/L, no data is provided but the curve is quite steep in this region. The critical diameter increases significantly for small changes in concentration.

Infinite Slab:

- 7.2 g Pu/L requires a slab 41 cm (16 in.) thick
- 10 g Pu/L requires a slab 28 cm (11 in.) thick
- 30 g Pu/L requires a slab 18 cm (7.0 in.) thick

- For <7.2 g Pu/L, no data is provided but the curve is quite steep in this region. The critical thickness increases significantly for small changes in concentration.

This data matches fairly well with WHC-SD-SQA-CSA-20339 and Altschuler and Doto 1991, which report 0.82 g Pu/L as the minimum critical concentration in an infinite system.

Beginning with a system composed largely of SiO_2, the plutonium critical mass decreases monotonically with the addition of water, which fills the interstitial space. After the interstitial space is filled, the addition of more water requires the water to replace SiO_2. The smallest critical mass occurs when no SiO_2 is present. The soil traps a large fraction of the leaked plutonium in a relatively small volume near the source of the leak. This volume comprises mostly solids, thereby limiting the water fraction and increasing the neutron absorption.

Although the subcritical plutonium concentration limit is 0.82 g Pu/L (for an infinite system of SiO_2), the thickness of the slab required for criticality is large for concentrations approaching this value. The total plutonium required for criticality is not possible because the plutonium concentration in sludges is at most 0.7 g Pu/L. If solids are carried over, those solids are trapped by soil. A criticality would not occur because the solids contain a sufficient ratio of neutron absorbers (it is important to note that the better neutron absorbers such as uranium or manganese are conservatively not included in the model). In addition, the thin layer would require a larger plutonium concentration for criticality. Therefore, a criticality in the soil is not credible. Even if it is postulated that the absorbers could be removed, leaving only the plutonium (i.e., a very selective and efficient "ion exchange" column), a criticality event still could not occur because of an insufficient quantity of plutonium and the inability of the soil to concentrate the available plutonium. In conclusion, criticality in the soil column around a leaking tank is not credible.

F6.2 TRANSFERS INTO THE TANK FARMS

In order for a criticality accident to occur in the tank farms from an inadvertent waste transfer, a series of implausible events would be required, including repeated process failures and violation of controls and procedures. In addition to the series of events, thousands of grams of plutonium suspended in hundreds of liters of a highly acidic solution would have to be inadvertently transferred directly into the tank farms before a criticality would be possible.

In a survey of Hanford Site waste generators, it was determined that only PFP has a sufficient quantity of plutonium to cause concern. T Plant is another potential source of plutonium (as noted in Section F6.2.1); however, there is insufficient quantity and concentration of plutonium there for a criticality concern. Of the other operational facilities, B Plant contains only minute amounts of plutonium. The remainder of the Hanford Site processing (PUREX, REDOX, bismuth-phosphate, and uranium recovery) plants are nonoperational, undergoing terminal clean-out or decontamination and decommissioning, and do not have sufficient plutonium quantities.

Plutonium requires an acidic solution to stay in solution. While B Plant, PFP, and the PUREX Facility previously used large quantities of concentrated nitric acid, the nitric acid has been removed from these plants. B Plant uses small quantities (<379 L [<100 gal] batch sizes) within the plant. It is therefore not possible, through any credible series of errors, for a sufficient quantity or concentration of nitric acid to be transported to the tank farms from any of these plants.

F6.2.1 T Plant Transfers

T Plant handles only very small quantities of plutonium. The transfer quantity of waste is from 110 to 140,000 L/yr (30 to 38,000 gal/yr) with an average plutonium concentration of 10^{-4} to 10^{-7} g Pu/L. The T Plant criticality prevention specifications have a limit of 2 g Pu/L for sludge. Waste from T Plant goes into a sump pit (211-T) and is then pumped to cell 6-L where it flows to tank TK 5-1 by way of tank 5-7, 5-6, or 5a. The liquids are sampled before being pumped from the tank to a railcar. The criticality specification for the railcar is 0.04 g Pu/L. Once the liquids are removed, the sludge is sampled and compared with the limit of 2 g Pu/L. As a result, transfer of waste from T Plant cannot cause a criticality to occur in the tank farms because waste from that plant has an insufficient quantity and concentration of plutonium.

F6.2.2 Plutonium Finishing Plant Transfers

PFP has, or will have, four waste streams: analytical laboratory waste, vertical calciner waste, waste from the remote mechanical "C" (RMC) filtrate ion exchange line, and waste from the persulfate process line. The analytical lab waste and the vertical calciner waste are existing waste streams. The other two waste streams are proposed future waste streams that were included for completeness:

- **Analytical laboratory waste**—The analytical laboratory waste (in batch quantities of typically 30 to 100 mL) is collected in batches of up to 4 L (1 gal) in volume. Liquid wastes having high plutonium concentrations are stored in containers that are sent back to the originating process. The remaining low concentration liquid wastes are manually transported to a drain that empties into a holding tank for laboratory waste. The low plutonium concentration wastes are discharged to the waste container (a 4-L [1-gal] bottle). The collected waste is sampled prior to disposal. The color of the waste solution in a transparent 4-L (1-gal) bottle containing hundreds of grams of plutonium is also a sensitive visual indicator of the plutonium concentration. High plutonium concentrations are green to dark in color depending on concentration. Prior to transfer of the waste to tank D-8, sample results are reviewed and approved by Process Engineering (i.e., the PFP Cognizant Engineer), the Environmental Compliance officer, and the Operations manager. The analytical labs, as well as all areas within PFP, must comply with strict material balance controls administered by the nuclear material control group.

- **Vertical calciner waste**—The vertical calciner waste is gathered into 15 to 30 L (4 to 8 gal) batches. The waste stream comes from the offgas system not the process system. There is negligible plutonium in this waste stream even after a process upset.

- **Waste from the RMC filtrate ion exchange line**—The ion exchange process filtrate from the RMC line contains the wash solution. The typical wash solution will contain minimal concentrations of plutonium because the column is eluted twice before washing (once to remove americium and once to remove plutonium). Only if an undetected process upset occurs during elution could plutonium be eluted with the waste stream. The waste from the ion exchange process goes to a separate waste holding tank. The RMC line waste stream is controlled by the nuclear materials control group. Loss of plutonium in the wash step rather than in the elution step would be identified by operations and the nuclear materials control group. The RMC line waste is sampled before discharge to tank D-8. The sample results are currently reviewed prior to the approval of waste transfer by Process Engineering and the Operations Manager. However, once the ion exchange process moves out of the testing mode and into a production mode, waste transfers will be approved by the shift manager. Although iron is added to the waste, this analysis assumes it only provides a minimal contribution to the iron to plutonium neutron absorber ratio, since after a postulated upset condition there would be much more plutonium in this stream than in normal PFP waste.

- **Persulfate process waste**—The persulfate process waste comes from the caustic wash step. The process feed is ash, which contains plutonium (average is 7 percent by weight). The stream is filtered to remove any ash carried over during the wash. The waste is stored in a separate waste holdup tank.

Each waste stream has its own storage vessel. The plutonium quantity and volume are recorded daily for each vessel. This running total is used to verify operational safety requirement compliance and for material balance purposes. Waste streams are sampled before the transfer of the waste to the PFP waste receiver tank (D-8) is approved.

Only the waste streams from the analytical labs and the RMC ion exchange process could conceivably accumulate sufficient quantities of plutonium to be of concern. However, it would be extremely difficult to accumulate thousands of grams of plutonium in the analytical laboratory waste. The samples arrive in small volumes, typically from 10 to 100 mL. Each hood and glovebox, as well as each waste tank, has a daily running plutonium inventory with a plutonium inventory limit, typically 10 to 100 g, based on Technical Safety Requirements.

To accumulate several hundred liters of solution with thousands of grams of plutonium solution from the analytical lab would require releasing the inventory of hundreds of 4-L (1-gal) lab waste containers into the lab waste drain. The typical volume of laboratory samples is 100 mL

or less with plutonium concentrations less than 1 g Pu/L. The following is a list of repeated failures necessary for this accumulation to occur:

- Failure to identify the loss of inventory in material balance reports written by Nuclear Material Controls.

- Failure to recognize that the quantity of plutonium was close to or over the Technical Safety Requirement controls on inventory.

- Failure by lab personnel to notice that the color of the solution through the transparent waste containers (high plutonium concentration solutions have a green to dark color, while typical lab waste is colorless).

- Multiple operator errors on each of the numerous 4-L (1-gal) lab waste containers by entering an incorrect low plutonium concentration onto the sample sheet rather than the correct high concentration value. The Process Engineer, the Operations Manager, or the Environmental Control Officer would also have to fail to notice the high plutonium quantity in the waste.

- Multiple operator errors by incorrectly recording each of the many daily running lab waste inventory totals for each of the many 4-L (1-gal) bottles released to the PFP waste receiver tank.

- Multiple administrative failures in not sending the high plutonium concentration samples back for reprocessing. In addition, the process group would have to fail to notice that the samples had not been returned to them as anticipated.

In order to accumulate kilogram quantities of plutonium in a small volume (tens to hundreds of liters) in the D-8 receiver tank from the RMC filtrate ion exchange system, repeated process upsets would be required where plutonium is not eluted from the column prior to wash. Only after such a series of errors could hundreds to thousands of grams of plutonium be discharged to the RMC line drain. The following is a list of repeated failures necessary for this accumulation to occur:

- Operators would not notice the process upsets.

- Nuclear Materials Control would not notice the loss of material.

- Equipment failures, operator errors, or management errors would have to occur on each of the samples of the RMC line waste that contained the material from the process upset, such that the discharge of a large quantity of plutonium was not recognized.

- No significant dilution from any other streams into the receiver tank occurs during the time of the multiple process upsets on the RMC line.

Typical transfers to the tank farms are in batches of about 8,000 L (2,100 gal) because considerable effort is required to complete a transfer. A waste manifest is the record of transfer, and contains the sampling results to satisfy the State of Washington and other regulators. Included in the record is the water content, concentration of hydroxide, nitrite, nitrate, percent solids, and the iron-to-plutonium ratio.

For a criticality to occur in a DST in the tank farm from a PFP transfer, there must be a failure to sample and record the transfer, and the size of the transfer must also be limited to tens to hundreds of liters. A larger transfer has the potential for criticality occurring in the PFP D-8 receiver tank or the DCRT 244-TX before the waste reaches the DST. For example, tank D-8 has a 3-m (10-ft) diameter. Using an areal density of 2,580 g/m^2 (240 g/ft^2), a transfer of more than 1,800 L (480 gal) of 10 g/L plutonium solution has the potential for a criticality in tank D-8. DCRT 244-TX has larger dimensions and would require a larger waste volume transfer.

These events are "beyond extremely unlikely" for the following reasons. First, multiple running failures would have to occur without being identified and without being interrupted by other operations. Second, proper operation will result in dilution of the waste and require even more failures to create a critical mass. Third, waste minimization at PFP is a high priority. There has not been a waste transfer to tank farms in two years. During those two years, PFP has generated only 11,000 L (2,900 gal) of waste, which includes slightly contaminated rain water from the heavy spring rains or overflow from a faucet and a transfer of caustic. As a result, few transfers are expected to tank farms.

F6.3 CONSEQUENCES

Although no credible scenario has been identified leading to a criticality in a waste tank, DCRT, catch tank, or 200 Series tank or in a mistransfer from PFP, the consequences of a postulated accidental criticality are addressed in this section.

The initial waste transfer for this analysis was chosen to be 500 L (132 gal) of a 10 g Pu/L solution that is transferred at 4.7 L/s. The concentration and quantity is based on an estimate of the quantity of plutonium that could conceivably be transferred from PFP providing that multiple failures occurred. Transfers of a higher plutonium concentration would be overly conservative. Lower plutonium concentrations would require too large a volume for criticality to occur. A concentration of 10 g Pu/L could be formed into a critical sphere with a reasonable diameter and size. The plutonium concentration of 10 g Pu/L was chosen for the following reasons:

- The plutonium is assumed to be well mixed during the transfer. Figure F2-1 and Section F2.1 show that for plutonium well mixed in water, the minimal critical concentration is 7.2 g Pu/L. The scenario required a concentration greater than 7.2 g Pu/L.

- There is strict inventory control at PFP. In discussions with plant personnel, they indicated that they would certainly notice a discrepancy in the range of hundreds of grams of plutonium. Since the plutonium in the waste tank was placed there by error, there would be a mass discrepancy within the plant.

- The critical diameter is about 51 cm (20 in.) (Figure F2-1). The waste tanks are 3 m (10 ft) in diameter. The waste tank would go critical if 36 kg (79 lb) were added at 10 g Pu/L. So the presence of 5 kg (11 lb) (500 L [132 gal] at 10 g Pu/L) is near the point that a criticality would occur at PFP.

F6.3.1 Scenario

It was assumed, notwithstanding the inordinate number of failures required, that a solution containing thousands of grams of plutonium accumulates in PFP waste receiver tank D-8 through a single or repeated and undetected sequential process upsets to a previously empty tank. If the tank is not originally empty or other waste is dumped into the tank between the process upsets, the waste would be diluted causing a decrease in the plutonium concentration. The contents of receiver tank D-8 are then transferred to tank D-5. Both of these tanks have a diameter of over 3 m (10 ft) and would require over 18 kg (40 lb) of plutonium to achieve an areal density of 2,580 g Pu/m^2 (240 g/ft^2), the minimum for a criticality. Because the transferred waste contains only 5 kg (11 lb) of plutonium, criticality would not occur in either tank D-8 or D-5 for this size transfer. The contents of tank D-5 are then routed to an empty 244-TX DCRT. The transferred waste would not go critical in DCRT 244-TX because this tank has an even larger surface area than tank D-5. When the PFP waste is transferred to the DST, the waste is postulated to form a compact spherical shape in the existing waste. The radius of this sphere was assumed to increase until a critical volume was reached. It is believed that this accident scenario contains enough failures to be considered incredible.

Based on previous criticality accidents at other facilities, a criticality accident would have an initial fission burst followed by a rapid shutdown. The shutdown would occur as a consequence of fission energy releases that would erupt the critical geometry by thermal expansion, density reduction from the formation of very small bubbles, and fissile dilution through mixing from convective currents with expulsion of part of the critical mass. Early in the burst, small bubbles would form. As the burst continued, the amount of dissolved gas might increase enough to support the formation and expansion of larger bubbles. As the burst terminated, a sudden internal pressure relief might occur resulting in rapid steam production and the release of the dissolved gases. The gases and steam, along with the fission gas and a fraction of the waste, might be carried into the headspace of the tank. The increase in the pressure in the headspace would be relieved by venting a fraction of the headspace through high-efficiency particulate air filters. The pressure of the steam might also cause the critical volume to expand and disperse. The tank is large compared with the critical volume and the expansion would result in dilution of the fissile bearing volume. The likelihood of turbulent and chaotic conditions along with the dilution would probably perturb the fissile bearing volume sufficiently that reassembly into a new critical mass would not occur. The continued addition of 10 g Pu/L waste will not result in

another criticality. The critical initial volume is dispersed and the plutonium concentration is well below 10 g Pu/L. The addition of 200 L into a turbulent mass will dilute some of the continued addition. Even if the waste were quiescent, 200 L of 10 g Pu/L is not sufficient to go critical. The postulated DST criticality was therefore modeled as a single burst.

F6.3.2 Calculations

Because the critical volume for a 10 g Pu/L solution has been calculated to be 300 L (80 gal) (WHC-SD-SQA-CSA-507) with a radius of 41.5 cm (1.4 ft), the transfer of 500 L (132 gal) is potentially enough to reach a critical condition. At the fill rate of 4.7 L/s (75 gal/min), it would take 63 seconds to transfer the 300 L (80 gal). The k_{eff} of the sphere during the fill is a function of the sphere radius and can be calculated from the following equation (Duderstadt 1976, *Nuclear Reactor Analysis*; Hetrick 1971, *Dynamics of Nuclear Reactors*):

$$k_{eff}(r) = k_{\infty} \frac{\exp^{-\tau B_g(r)^2}}{1 + L^2 B_g(r)^2}$$

where:

$k_{eff}(r)$	=	the value of k at radius r
k_{∞}	=	k infinity
B_g	=	buckling $= \pi/r$
r	=	radius of the sphere, cm (including reflector savings)
τ	=	Fermi age = 26 cm^2 (Duderstadt 1976)
L	=	diffusion length.

This equation can be used to find the reactivity insertion rate as the sphere goes critical. The reactivity insertion rate, typically expressed in \$/sec, is a measure of the rate at which the number of fissions in the critical volume is increasing. A \$ (dollar) is a basic unit of reactivity equal to the amount of reactivity required to be critical on prompt neutrons only and, therefore, is equal to the effective delayed neutron fraction. For small changes, the reactivity insertion rate is the increase in k_{eff} with the increase in the sphere radius divided by the time required for the radius to increase. The rate at which the radius increases is a function of the fill rate. From the following equation, the reactivity insertion rate for the 10 g Pu/L sphere at the critical radius of 41.5 cm (16.3 in.) is 0.57 \$/sec:

$$\text{reactivity insertion rate } \left(\frac{\$}{s}\right) = \frac{1}{\beta_{eff}} \frac{\dfrac{k_{eff}(r+\delta r) - k_{eff}(r)}{k_{eff}(r+\delta r)\, k_{eff}(r)}}{\dfrac{V(r+\delta r) - V(r)}{\text{fill rate}}}$$

where:

$k_{eff}(r)$ = the value of k at radius r
$V(r)$ = volume of sphere at radius r
β_{eff} = effective delayed neutron fraction
= 0.002 for ^{239}Pu.

It is possible to predict the neutronic response to a reactivity driving function by using point kinetics, as long as appropriate feedback models are employed. For small systems (with tight spatial coupling), this method has produced results that replicate both experimentally measured power and pressure curves reasonably well as shown in (Hetrick 1993, *Computer Models for Predicting the Effects of Criticality Accidents in Solutions*) for both dilute plutonium and uranium solutions. These calculations are compared to critical solution excursions measured at Silene. The Hetrick (1993) point kinetics model for fissile solutions includes both the Doppler feedback (fissionable material temperature) effect and the feedback associated with the change in volume of the system. The change in volume includes thermal expansion of the fluid as well as radiolytic gas bubble formation.

For pure plutonium and very highly enriched uranium systems, it is expected that the Doppler coefficient is either nearly zero or may in fact be positive. This is because neutron absorption resonances also include a dominant fission component, and the Doppler broadening of these resonances may increase neutron production faster than the increase in neutron loss (Hetrick 1971). For fast transients, the radiolytic gas bubble generation rate may dominate the thermal expansion effect, and so this will be a significant feedback effect for solution criticalities. The gas generation rate is calculated by using the "G" value for the solution, which is the quantity of gas produced per amount of energy deposited by fission in the solution. There is a threshold effect and so some amount of energy deposition is required before the solution becomes saturated and large bubbles begin to form.

One of the cases described in Hetrick (1993) can be used for estimating the postulated tank farm criticality energy release. The particular case of interest involves a transient for a one-region plutonium solution in a cylindrical geometry with a radius of 40 cm (16 in.). The fuel concentration was 10.5 g/L. Hetrick (1993) contains a calculation of a neutron temperature coefficient of reactivity and a volume expansion coefficient from multi-group cross-sections using transport theory. The power and reactivity for a step reactivity input of 4$ were reported. After some initial positive feedback from rising system temperature, the transient terminates rapidly with the formation of radiolytic gas. The maximum inertial pressure for the pulse is 0.58 MPa and the energy yield was 89 MJ.

The postulated DST waste criticality would have a similar volume and plutonium concentration as the Hetrick (1993) calculation. The postulated waste tank criticality would occur in a fluid with a "G" value reasonably close to that of water. The temperature and volume expansion coefficients would be comparable with the Hetrick (1993) calculation. Because the DST criticality reactivity insertion rate is under 1 $/s, compared to the 4$ step increase in

reactivity assumed in the Hetrick (1993) calculation, the energy yield and pressure for the DST criticality would be conservatively bounded by the calculated transient.

Based on the similarity of the postulated DST criticality with the calculations shown in Hetrick (1993), it is assumed that 89 MJ of energy (equivalent to 2.8×10^{18} fissions) would be released in the postulated DST criticality with inertial pressures of about 0.6 MPa. Most of the 89 MJ of fission energy goes into heating the liquid within the critical volume. The temperature of the fissile bearing volume would increase because of the power burst until the saturation temperature is reached and steam is generated. About 75 percent of 89 MJ is needed to raise the liquid temperature from a DST liquid temperature of 48 °C (118 °F) to boiling. This leaves 25 percent (or 22 MJ) available to create steam. A volume of 15.4 m^3 (540 ft^3) of steam is produced, raising the pressure in the headspace of a full DST by about 0.0015 MPa (6.0 in. of H_20).

F6.3.3 Source Term Analysis

The dose consequences result from the release of radioactive noble gases, iodine, and aerosolized plutonium and tank waste. The source term for the tank waste and plutonium identifies the amount of material released to the environment. The methodology and atmospheric constants used with this source term to calculate dose consequences are described in Chapter 3.0, Section 3.4.1, of this FSAR.

Of the fission products resulting from the postulated criticality, 100 percent of the noble gases and 25 percent of the iodine are assumed to be released to the headspace and then to the environment. The release of particulate fission products is negligible. For calculating the plutonium release, 8.9 L (2.3 gal) of the initial 300 L (80 gal) critical volume is converted to steam. A fraction of the plutonium is released to the headspace from the criticality. As the headspace overpressure is vented to the atmosphere, 15.4 m^3 (540 ft^3) of the headspace volume is released unfiltered to the environment. In addition to the fission products and the plutonium in the critical volume, a similar fractional volume of the original waste in the tank was assumed to be entrained and released. After the overpressure (associated with the 15.4 m^3 [540 ft^3]) has been vented, the remainder of the aerosol is released via the high-efficiency particulate air filters because of the action of the ventilation system.

The radiological dose consequences from the noble gases and iodine are calculated using the inventory prescribed in Regulatory Guide 3.35, *Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in Fuel Reprocessing Plant*. This fission inventory is based on a series of bursts totalling 10^{19} fissions (350 MJ). Because the dose consequences are a linear function of the number of fissions, the fission gas submersion and inhalation doses are ratioed by the respective number of total fissions (2.8×10^{18} and 1.0×10^{19}) to get consequences for the DST criticality. The results are given in Table 3.3.2.4.1-3.

The quantity of material released into the headspace as aerosol, was assumed to comprise 0.05 percent of the salt content of the solution that is evaporated (consistent with Regulatory Guide 3.35). The 22 MJ is enough energy to evaporate 8.9 L (2.3 gal) of liquid. Based on 8.9 L (2.3 gal) with the standard DST liquid content and 10 g Pu/L, 0.0045 L DST liquid waste and 45 mg of plutonium would be released to the tank headspace. This would increase the headspace concentrations to 4.3×10^{-6} L (1.1×10^{-6} gal) DST liquid/m^3 and 0.043 mg Pu/m^3.

The quantity of material released to the environment was thus the headspace concentrations multiplied by the volume of steam (15.4 m^3 [540 ft^3]) generated. This yields 6.6×10^{-5} L (1.7×10^{-5} gal) of DST liquid and 0.66 mg of plutonium released to the environment immediately after the criticality.

The radiological consequences for the tank waste and plutonium released by the postulated criticality accident are given in Table 3.3.2.4.1-3.

F6.3.4 Toxicological Consequences

The toxicological consequences sum-of-fractions methodology is described in Chapter 3.0, Section 3.4.1, of this document. Using the previously calculated value of 6.6×10^{-5} L (1.7×10^{-5} gal) of DST liquid released to the environment, the calculated onsite and offsite toxicological consequences are compared to the guidelines for an "extremely unlikely" event (10^{-6} to 10^{-4}/yr) in Table 3.3.2.4.1-3.

F6.3.5 Comparison with Guidelines

The unmitigated accident doses and toxicological exposures are compared with the offsite and onsite risk evaluation guidelines in Table 3.3.2.4.1-3. Although the accident is considered to have a frequency "beyond extremely unlikely" (less than 10^{-6}/yr), the accident consequences were compared to the guidelines for "extremely unlikely" events (frequency of 10^{-6} to 10^{-4}/yr). Both the onsite and offsite radiological doses would be acceptable relative to these guidelines because the toxicological sum-of-fractions are well below one.

F7.0 TECHNICAL SAFETY REQUIREMENTS AND SAFETY CLASSIFICATION

It has been shown that a plutonium criticality resulting from tank farm operations is not credible. The likelihood of transfers from plutonium generators resulting in a criticality is only credible through an extremely large number of sequential human errors, this criticality is considered "extremely unlikely." Because the consequences of the criticality presented are below

the risk guidelines for both radiological and toxicological releases, no Technical Safety Requirements are needed to mitigate the accident. Because both the offsite and onsite dose consequences are less than 4.0×10^{-2} Sv (4.0 rem) and 1.0×10^{-1} Sv (1.0×10^{1} rem), respectively, no Safety-Class or Safety-Significant features are required either.

Technical Safety Requirement controls are required, however, to protect the key assumptions identified in Section F5.4 though a criticality resulting from transfers from the generators is assumed to be "extremely unlikely." The following controls will ensure that the key assumptions are protected:

- All liquids transferred into the tank farms from outside the Tank Waste Remediation System (e.g., from PFP, 300 Area) shall have a pH of 8 or greater.
- The plutonium concentration of mixtures transferred to the tank farms shall not exceed 0.04 g Pu/L (averaged over the entire volume of the transferred waste).
- Liquid and solid wastes transferred into the tank farm shall have a sufficient concentration of insoluble chemicals with the sum of individual absorber fractions greater than 1 to ensure subcriticality.

For waste containing less than 0.001 g Pu/L, verification of the mass ratios of the neutron absorbers is not necessary and not required. By maintaining plutonium concentration in incoming waste streams below 0.001 g Pu/L, the plutonium will not precipitate unless the solutions were intentionally made strongly alkaline (e.g., 2 *M*), far beyond the maximum tank farm conditions. Even if this small concentration of plutonium were to precipitate, the total amount of precipitated plutonium would be small and would not result in a criticality concern.

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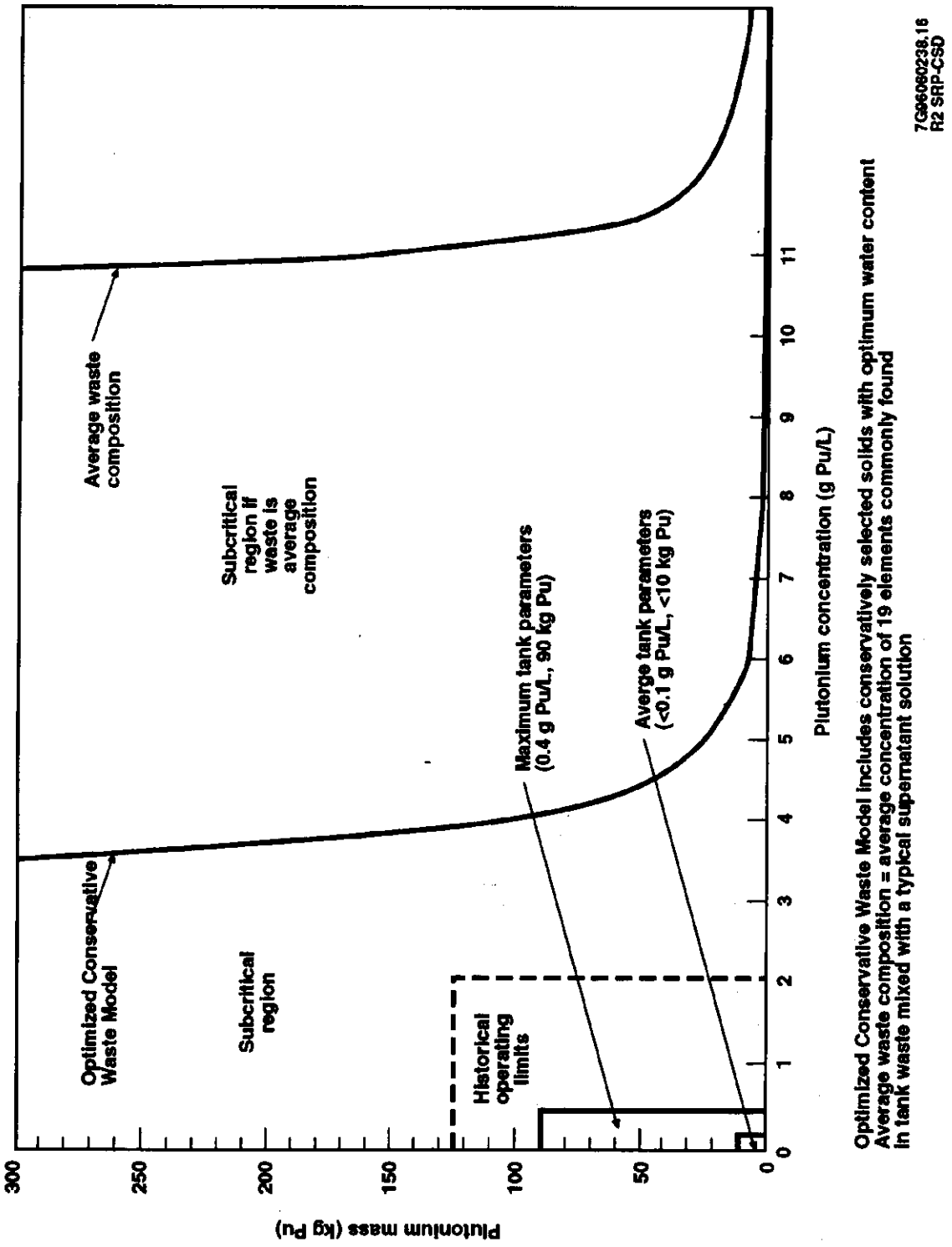
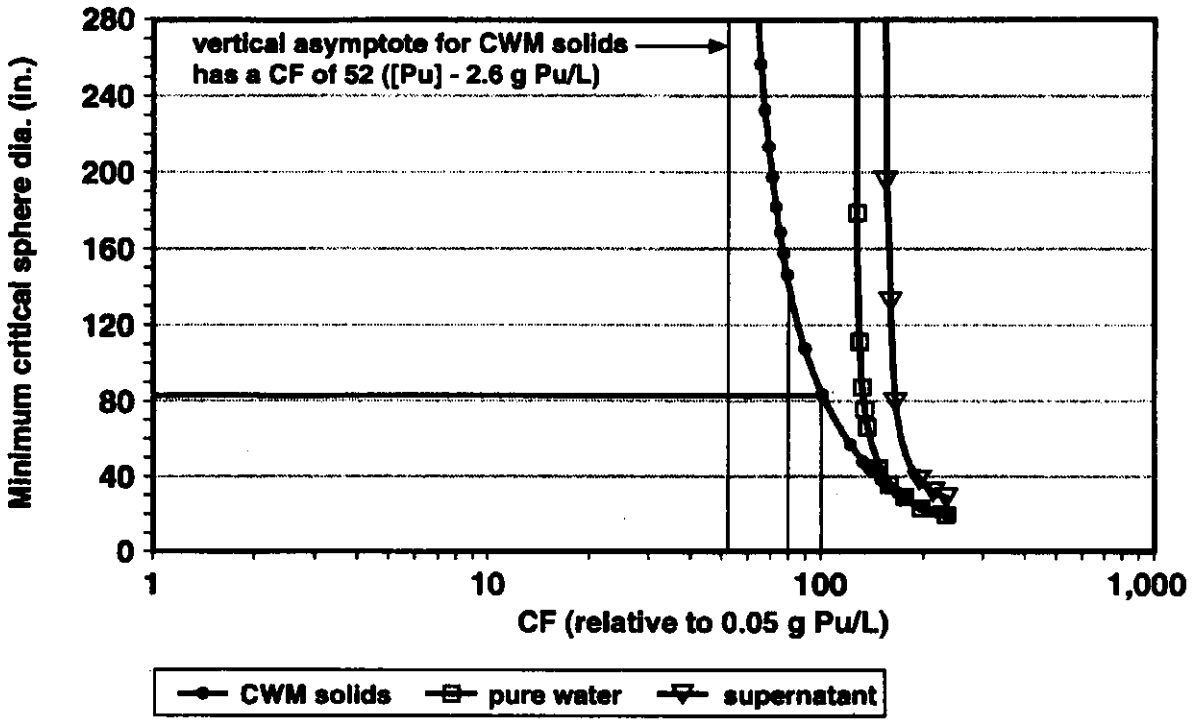
Figure F1-1. Perspective of Hanford Site Waste Tank Subcritical Limits--Plutonium Critical Mass vs Concentration (Spherical Geometry).



1 Figure F2-1. Plutonium Concentration Factor vs Minimum Critical Sphere Diameter.



CF = concentration factor relative to 0.05 g Pu/L. (To obtain the actual concentration [in g Pu/L], multiply the value on the axis by 0.05.)

CWM = conservative waste model.

To convert inches to millimeters, multiply by 25.40

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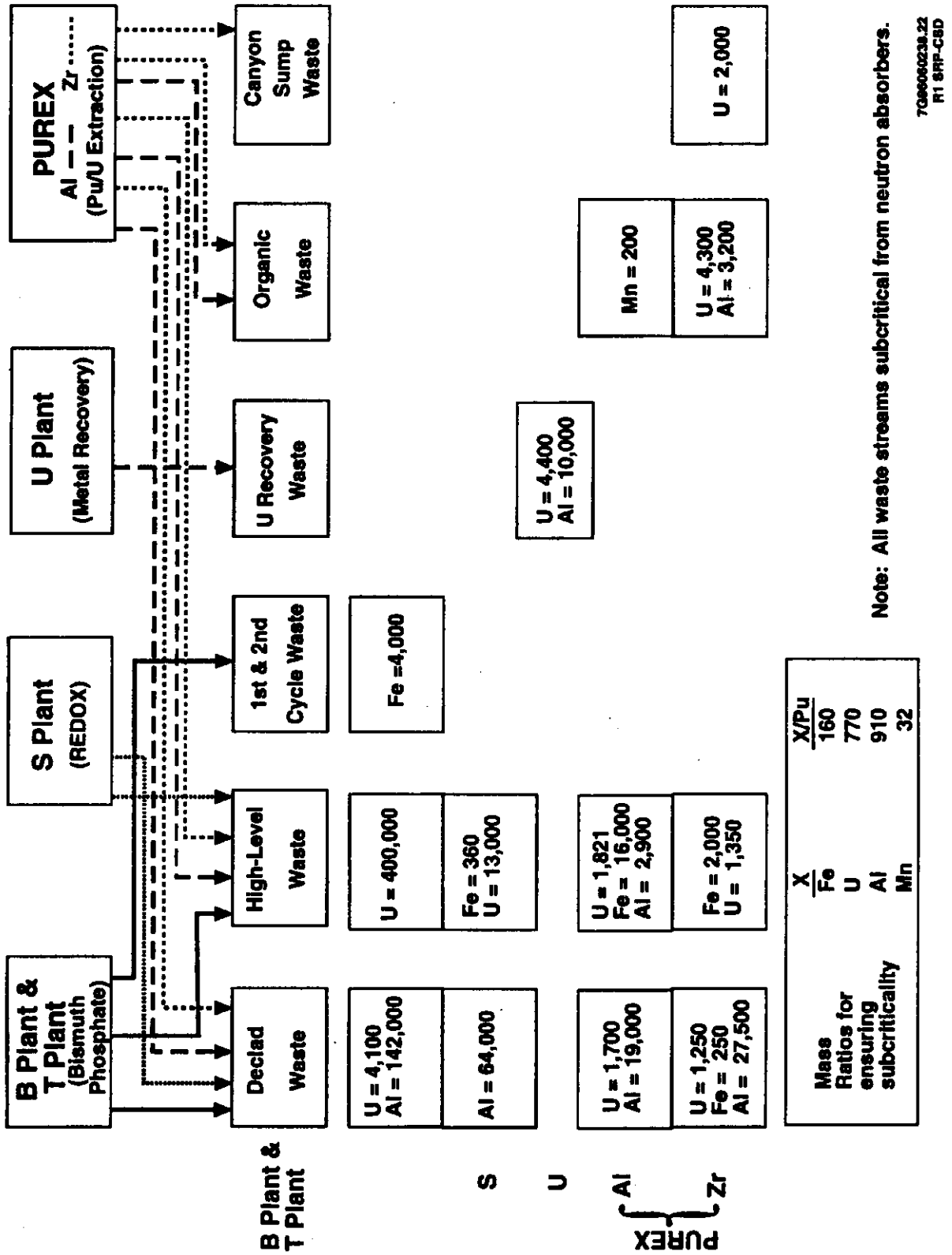
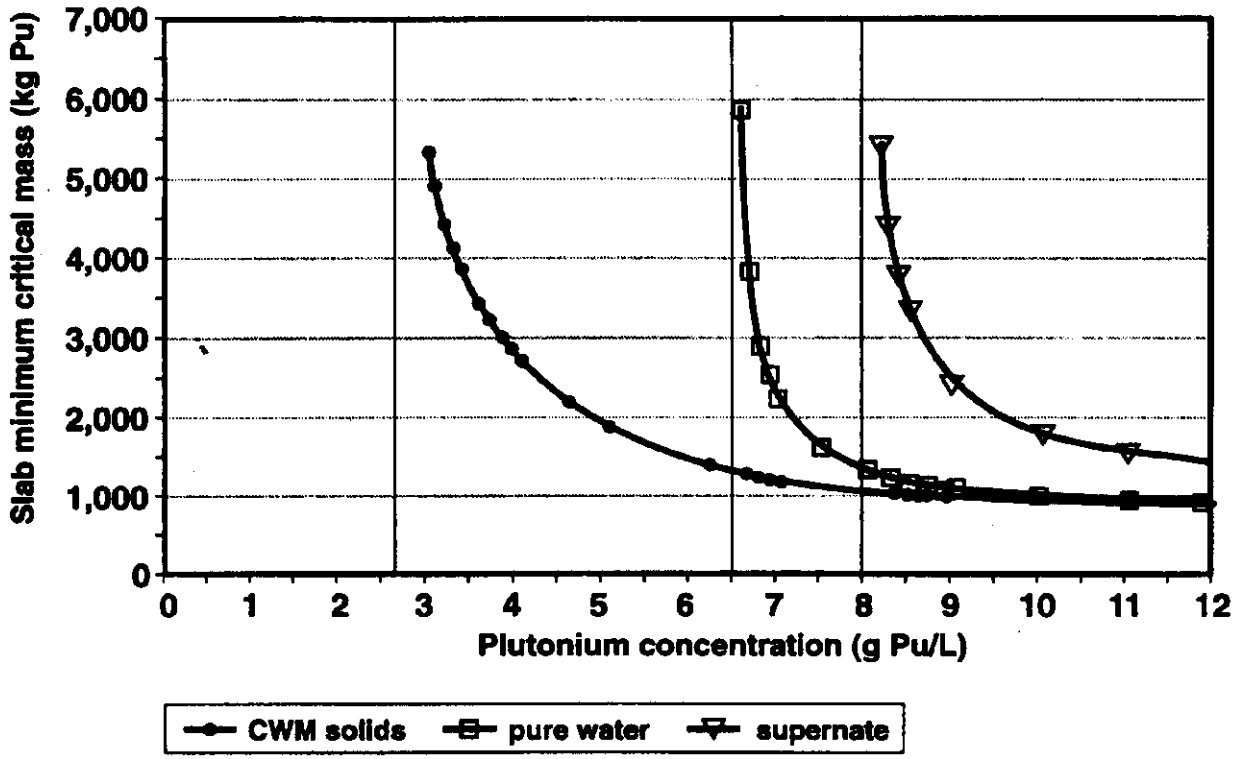
R5 SRP-CSD

Figure F2-2. Absorber to Plutonium Ratios for Processing Plant Waste.



1 Figure F2-3. Slab Minimum Critical Mass vs Plutonium Concentration in a 22.9-m- (75-ft-) dia Tank.



CWM = conservative waste model.

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Table F2-1. Insoluble Absorber-to-Plutonium Minimum Ratios to Ensure Subcriticality (Sludge).

Element	Minimum subcritical ratio (X/Pu mass ratio)
Chromium	135
Iron	160
Manganese	32
Nickel	105
Uranium (natural)	770
Zirconium	4,000

Table F2-2. Soluble Absorber-to-Plutonium Minimum Ratios to Ensure Subcriticality (Salt Cake or Liquid).

Element	Minimum subcritical ratio (X/Pu mass ratio)
Aluminum	910
Nitrate	270
Sodium	360

Table F2-3. Chemical Characteristics of Waste Streams from PUREX Processing of Aluminum Clad Fuel.

Characteristics	Declad waste	High-level waste	Organic wash waste
Volume (L/MTU)	1,292	1,573	Not provided
Total Volume, 10^6 L	73	88	Not provided
Pu, g/L	<0.0017	0.0014	0.0001
U g/L	2.9	2.55	0.036
Al, g/L	32	4.1	--
Fe, g/L	0.16	22	--
Mn, g/LO	--	--	0.02
CO_3, g/L	--	--	7.8
U:Pu	1,700	1,821	360
Al:Pu	19,000	2,900	--
Fe:Pu	94	16,000	--
Mn:Pu	--	--	200

PUREX = plutonium uranium extraction.

Table F2-4. Chemical Characteristics of Waste Streams from PUREX Processing of Zircalloy Clad Fuel.

Characteristics	Declad waste	High-level waste	Canyon sump waste	Organic wash waste
Volume (L/MTU)	5,764	1,032	1,979	2,716
Total volume, 10^6 L	28	5	9	13
Pu, g/L	0.0004	0.0028	0.00081	0.0001
U, g/L	0.5	0.67	1.59	0.426
Zr, g/L	11.0	3.8	--	--
Fe, g/L	0.1	5.6	--	--
Al, g/L	--	12.4	--	--
Mn, g/L	--	--	--	0.32
CO_3, g/L	--	--	--	7.2
U:Pu	1,250	240	2,000	4,300
Fe:Pu	250	2,000	--	0
Al:Pu	--	4,400	--	0
Mn:Pu	--	--	--	3,200
Zr:Pu	27,500	1,350	--	--

PUREX = plutonium uranium extraction.

Table F2-5. Characteristics of Waste Streams from REDOX Processing of Aluminum Clad Fuel.

Characteristic	Declad waste	High-level waste
Volume (L/MTU)	1,600	7,000
Total volume, 10^6 L	21	93
Pu g/L	0.0005	0.0025
U, g/L	0.28	0.5
Fe [as Fe $(OH)_3$], g/L	--	0.9
Al [as $NaAlO_2$], g/L	32	32
U:Pu	560	200
Fe:Pu	0	360
Al:Pu	64,000	13,000

REDOX = reduction-oxidation.

Table F2-6. Characteristics of Waste Streams from the Bismuth Phosphate Processing of Aluminum Clad Fuel.

Characteristics	Declad waste	High-level waste	First and second cycle waste
Volume (L/MTU)	1,425	14,400	19,500
Total volume, 10^6 L	4	46	62
Pu g/L	1.7 E-04	1.7 E-04	4.0 E-04
U, g/L	0.7	69.4	0
Al [as Na AlO_2], g/L	24	--	--
CO_3 [as Na_2CO_3], g/L	--	53	--
Fe [as $Fe_2(SO_4)_3$], g/L	--	--	1.6
U:Pu	4,100	400,000	0
Fe:Pu	0	0	4,000
Al:Pu	142,000	0	0

Table F2-7. Waste Stream Characteristics from the Uranium Recovery Process.

Characteristic	Waste
Volume (L/MTU)	14,400
Total volume, 10^6 L	46 (assuming the same MTU as Table F2-6)
Pu, g/L	0.00014
U, g/L	0.62
Fe, g/L	1.34
U:Pu	4400
Fe:Pu	10,000

Table F2-8. Chemical Characteristics of Waste Streams from PUREX Processing of Thoria Fuel.

Characteristics	Lab waste	Declad waste	High-level waste	Organic wash waste	Canyon sump waste
Volume (L/MTU)	9,142	3,703	2,273	9,813	3,054
Total Volume, 10^6 L	6	2	1	6	2
Th g/L	0.84	0.26	4.23	0.34	2
U^{233} g/L	0.0036	0.0026	0.005	0.0015	0.0062
Al g/L	--	17.7	9.2	--	--
Fe g/L	--	--	1.4	--	--
Mn g/L	--	--	--	0.65	--
Al:U	--	6,800	1,840	--	--
Fe:U	--	--	286	--	--
Mn:U	--	--	--	433	--
Th:U	233	100	846	226	322

PUREX = plutonium uranium extraction.

Table F2-9. Hydrogen to Plutonium Atom Ratios.

Pu concentration	Conservative waste model optimum H to Pu atom ratio	Optimal amount of water, g/L
2.6 g/L	100	10
4 g/L	500	75
10 g/L	1,500	565
30 g/L	500	565

Note that H to Pu atom ratio of 500 at 4 g Pu/L and 1,200 g/L solids from the conservative waste model yields a water content of 150 g or 12% by mass. When the water content exceeds that specified by the H to Pu atom ratio, more plutonium is need to go critical than that specified by the model.

Table F2-10. Critical Slab Thicknesses.

Concentration g/L	Slab thickness (cm) that yields 240 g/ft^2	Critical slab thickness (cm)	gPu/ft^2 in critical slab
10	26.0	30.0	279
100	2.5	6.4	595
1000	0.25	5.0	4,650
19,000	0.013	0.08	1,414

Table F2-11. Statistical Data for $^{239/240}$Pu.

Waste Type	$^{239/240}$Pu concentration, g/L			
	Mean	95%	99%	Worst case
Aging waste facility solids	0.05	0.12	0.18	0.2
Aging waste facility liquid	6.0 E-05	0.0002	0.0004	0.0005
Single-shell tank solids	0.014	0.07	0.14	0.2
Single-shell tank liquid	0.0008	0.003	0.014	0.016
Double-shell tank solids	0.03	0.09	0.4	0.7
Double-shell tank liquid	0.003	0.002	3.5 E-05	0.0035

Table F2-12. Comparison of Waste Types and Maximum Concentration.

Waste type	Maximum concentration
Supernatant (tank liquids)	0.02 gPu/L
Salt cake (evaporation of liquid waste)	0.002 gPu/L
Sludge	0.35 gPu/L

Table F4-1. Mole Ratios in Hanford Site Waste Tanks*.

Process	Iron/plutonium ratio	Aluminum/plutonium ratio
Bismuth phosphate	12,000	28,000
REDOX	1,400	132,000
PUREX (aluminum clad)	63,000	1,400,000
PUREX (Zirflex)	3,000	13,000
Plutonium Finishing Plant	100	7,400

*Does not include iron added to control criticality.
PUREX = plutonium uranium extraction.
REDOX = reduction-oxidation.

Table F4-2. Comparison of Plutonium, Iron, and Aluminum Hydroxide Solubilities.

Log of Solubilities (*M*)			
pH	$PuO_2 \cdot xH_2O$, Amorphous	$Fe(OH)_3$, Amorphous	$Al(OH)_3$, Crystalline
3	-3.6	-5.5	-1
4	-4.4	-7.1	-3
5	-5.3	-8.0	-6
6	-6.0	-9.2	-7
7	-6.8	-10.0	-7
8	-7.6	-10.3	-7
9	-8.4	-10.0	-6

Table F4-3. Differences (Percent) in Ionic Radii Between Pu(IV) and Potential Solid Solution Forming Ions in Hanford Waste Streams.

Ions	Coordination number*	
	VI	VIII
Bi(III)	-17	-18
La(III)	-17	-17
Zr(IV)	+19	+14
Al(III)	+61	--
Fe(III)	+33	--

*Ionic radii data from Shannon, R. D., 1976, *Revised Effective Ionic Radii and Systematic Studies of Interatomic Distances in Halides and Chalcogenides*, Acta Cryst. A32, pp. 751-767.

Table F5-1. Plutonium Concentration Increase Resulting From Settling.

Size distribution	Plutonium particle size	Concentration increase factor
Tanks 241-C-106 and 241-SY-102	Uniform over all sizes	2.7 - 7.5
Tanks 241-C-106 and 241-SY-102	All Pu is 52.5 microns diameter	10 - 20
Tanks 241-C-106 and 241-SY-102	All Pu is 90 microns diameter	55 - 90
Tanks 241-C-106 and 241-SY-102	All Pu is 20 microns diameter	4.1 - 14.4
Tanks 241-C-106 and 241-SY-102	All Pu is 6 microns diameter	3.4 - 32.1

APPENDIX G
SITEWIDE CONTROLLED MANUAL CROSS-REFERENCE TABLE

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APPENDIX G
SITEWIDE CONTROLLED MANUAL CROSS-REFERENCE TABLE

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LIST OF TERMS

CM	controlled manual
FDH	Fluor Daniel Hanford, Inc.
WHC	Westinghouse Hanford Company

APPENDIX G
SITEWIDE CONTROLLED MANUAL CROSS-REFERENCE TABLE

G1.0 PURPOSE

Most of the controlled manuals (e.g., WHC-CM-X-XX) referenced in this safety analysis report have been superseded by Fluor Daniel Hanford, Inc. (FDH) procedures (e.g., HNF-PRO-XXX). A cross-reference table is provided in Table G-1 to guide the reader in locating the equivalent current FDH procedure(s).

The cross-referenced list provided in Table G-1 has been tailored to be specific to this safety analysis report and should not be construed as a complete listing of all Hanford Site FDH procedures. Refer to the intranet web address provided below for a complete cross-referenced listing of Hanford Site procedures.

http://docs.rl.gov/phpp/procedures/crossget.asp

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Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

Controlled manual number	FDH procedure number	FDH procedure title
WHC-CM-1	NA	NA
WHC-CM-1-10	HNF-PRO-074	*Safety Responsibilities*
	HNF-PRO-075	*Safety Communications*
	HNF-PRO-076	*Safety Inspections*
	HNF-PRO-077	*Reporting, Investigating, Managing Events*
	HNF-PRO-078	*Subcontractor Safety and Health Management*
	HNF-PRO-079	*Job Hazard Analysis*
	HNF-PRO-080	*Worksite First Aid*
	HNF-PRO-081	*Hazardous Energy Control Program*
	HNF-PRO-083	*Personal Protection*
	HNF-PRO-084	*Safety Showers and Eyewashes*
	HNF-PRO-085	*Hand and Portable Hand Power Tools*
	HNF-PRO-086	*Machine Guarding*
	HNF-PRO-087	*Storing, Using, and Handling Compressed Gases*
	HNF-PRO-088	*Electrical Work Safety*
	HNF-PRO-089	*Electrical Installation Safety*
	HNF-PRO-090	*Excavating, Trenching and Shoring*
	HNF-PRO-091	*Walking/Working Surfaces*
	HNF-PRO-092	*Fall Protection*
	HNF-PRO-093	*Elevating Work Platforms*
	HNF-PRO-094	*Portable Ladders*
	HNF-PRO-095	*Scaffolding*
	HNF-PRO-096	*Material Handling and Storage*
	HNF-PRO-100	*Transportation Safety*
	HNF-PRO-101	*Signs, Tags, and Barriers*
	HNF-PRO-102	*Safety Color Coding*
	HNF-PRO-105	*Steam Distribution System Safety*

Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

	Controlled manual number	FDH procedure number	FDH procedure title
1	WHC-CM-1-11	HNF-PRO-110	*Confined Space*
2		HNF-PRO-111	*Occupational Medical Qualification and Monitoring*
3		HNF-PRO-115	*Hearing Conservation*
4		HNF-PRO-119	*Lead Program*
5		HNF-PRO-120	*Respiratory Protection Program*
6		HNF-PRO-121	*Heat Stress Control*
7		HNF-PRO-409	*Exposure Monitoring, Reporting, and Exposure Records Management*
8	WHC-CM-1-3	HNF-PRO-041	*Company Service Regulations*
9		HNF-PRO-042	*Fitness for Duty*
10		HNF-PRO-107	*Responding to RL Direction*
11		HNF-PRO-116	*Managing DOE Directives*
12		HNF-PRO-333	*Responding to Internal Audits*
13		HNF-PRO-589	*Processing Project Hanford Procedures*
14		HNF-PRO-590	*Invention Protection and Commercialization*
15		HNF-PRO-656	*Data and Information Management Standards*
16	WHC-CM-1-5	HNF-PRO-055	*Facilities Start-Up Readiness*
17		HNF-PRO-058	*Critique Procedure*
18		HNF-PRO-060	*Reporting Occurrences and Processing Operations Information*
19		HNF-PRO-062	*Identifying and Resolving Unreviewed Safety Questions*
20		HNF-PRO-063	*Alarm Management Policy*
21		HNF-PRO-066	*Electrical Utilities Lock and Tag Program*
22		HNF-PRO-067	*Managing Lessons Learned*

Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

	Controlled manual number	FDH procedure number	FDH procedure title
1		HNF-PRO-3468	*Shutdown and Stop-Work Direction*
2	WHC-CM-1-8	HNF-PRO-069	*Maintenance Management*
3		HNF-PRO-070	*Plant Forces Work Review (Davis-Bacon Act Compliance)*
4		HNF-PRO-072	*Plant Instrumentation and Equipment Functional Status Identification*
5	WHC-CM-2-1	HNF-PRO-123	*The Material Request/Purchase Requisition/Contract Requisition Process*
6		HNF-PRO-126	*Shipping and Returning Materials Using the Parts and Tools Return (PTR) Form*
7	WHC-CM-2-14	HNF-PRO-154	*Responsibilities and Procedures, for all Hazardous Material*
8		HNF-PRO-156	*Nonradioactive Hazardous Materials/Hazardous Waste (HM/HW) Shipments*
9		HNF-PRO-157	*Radioactive Material/Waste Shipments*
10		HNF-PRO-158	*Shipping and Receiving in the 1100 Area*
11		HNF-PRO-163	*Documentation and Record Keeping*
12		HNF-PRO-166	*Transportation Safety Training Requirements*
13	WHC-CM-3-5	HNF-PRO-210	*Records Management Program Standards*
14		HNF-PRO-211	*Public Information Repository and Administrative Records Files*
15		HNF-PRO-222	*Quality Assurance Records Standards*
16		HNF-PRO-224	*Document Control Program Standards*
17		HNF-PRO-229	*Technical Procedure Standard*
18		HNF-PRO-231	*Correspondence and Commitment Control*
19		HNF-PRO-232	*Project Files Management*
20		HNF-PRO-233	*Review and Approval of Documents*
21	WHC-CM-4-2	HNF-PRO-246	*Management Assessment*
22		HNF-PRO-261	*Quality Assurance Program Plans*

Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

	Controlled manual number	FDH procedure number	FDH procedure title
1		HNF-PRO-263	*Qualification and Certification of Inspection and Test Personnel*
2		HNF-PRO-265	*Standards/Requirements Identification Document Process*
3		HNF-PRO-268	*Control of Purchased Items and Services*
4		HNF-PRO-283	*Control of Inspections*
5		HNF-PRO-286	*Test Control*
6		HNF-PRO-297	*Inspection, Test, and Operating Status*
7		HNF-PRO-298	*Nonconforming Item Reporting and Control*
8		HNF-PRO-301	*Control of Suspect/Counterfeit Items*
9		HNF-PRO-309	*Computer Software Quality Assurance Requirements*
10	WHC-CM-4-27	HNF-PRO-315	*Completed Decision Making Packages*
11		HNF-PRO-316	*Radiation Protection Interpretive Authority*
12		HNF-PRO-319	*Radiation Protection Self-Assessments*
13		HNF-PRO-320	*Personal Nuclear Accident Dosimetry*
14		HNF-PRO-321	*Fixed Location Nuclear Accident Dosimetry*
15		HNF-PRO-322	*Tour Dosimetry*
16		HNF-PRO-323	*External Dosimetry Quality Assurance*
17		HNF-PRO-324	*Spectral Studies*
18		HNF-PRO-325	*Contaminated Wildlife or Vegetation*
19		HNF-PRO-326	*Contamination Area Controls*
20		HNF-PRO-327	*Fixed Contamination Areas*
21		HNF-PRO-328	*Personnel Monitoring*
22		HNF-PRO-329	*Radiological Training*
23		HNF-PRO-330	*Radiologically Controlled Vehicles*
24		HNF-PRO-331	*Work Place Air Monitoring*
25		HNF-PRO-332	*Radon*

Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

	Controlled manual number	FDH procedure number	FDH procedure title
1		HNF-PRO-378	*Radiation Protection First-Line Supervisor Qualifications*
2		HNF-PRO-379	*External Dosimetry Program*
3		HNF-PRO-380	*Internal Dosimetry Program*
4		HNF-PRO-381	*Supplemental Dosimetry*
5		HNF-PRO-382	*Area Dosimetry Program*
6		HNF-PRO-383	*External Dosimetry Emergency*
7		HNF-PRO-384	*Skin Contamination Dose Assessment*
8		HNF-PRO-385	*Declaring Personal Pregnancy*
9		HNF-PRO-386	*Radiological Control Technician Qualification and Training*
10		HNF-PRO-387	*Sealed Radioactive Source Control*
11	WHC-CM-4-29	HNF-PRO-334	*Criticality Safety: General Requirements*
12		HNF-PRO-537	*Criticality Safety Control of Fissionable Material*
13		HNF-PRO-538	*Criticality Safety Training*
14		HNF-PRO-539	*Criticality Safety Evaluations*
15		HNF-PRO-540	*Criticality Prevention Specifications*
16		HNF-PRO-541	*Criticality Safety Postings*
17		HNF-PRO-542	*Fissionable Material Labeling*
18		HNF-PRO-543	*Fissionable Material Storage*
19		HNF-PRO-544	*Criticality Plant Configuration Control*
20		HNF-PRO-545	*Fissionable Material Packaging and Transportation*
21		HNF-PRO-546	*Criticality Alarm System*
22		HNF-PRO-547	*Criticality Safety for Firefighting*
23		HNF-PRO-548	*Criticality Safety Inspections and Assessments*
24		HNF-PRO-549	*Criticality Safety Nonconformance Response*
25		HNF-PRO-550	*Criticality or Potential Criticality Accident*
26	WHC-CM-4-40	HNF-PRO-578	*Hazard Communication*

Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

	Controlled manual number	FDH procedure number	FDH procedure title
1		HNF-PRO-579	*Carcinogen Control*
2		HNF-PRO-580	*Process Safety Management*
3		HNF-PRO-582	*Using Nonionizing Radiation*
4		HNF-PRO-583	*Laser Safety*
5		HNF-PRO-584	*Bloodborne Pathogens*
6		HNF-PRO-587	*Laboratory Safety*
7		HNF-PRO-699	*Storing and Handling Chemicals*
8	WHC-CM-4-41	HNF-PRO-340	*Fire Protection Program Overview*
9		HNF-PRO-341	*Fire Protection Policy Statement*
10		HNF-PRO-342	*Responsibilities*
11		HNF-PRO-344	*Exemptions and Equivalencies*
12		HNF-PRO-345	*Fire Protection Corrective Actions*
13		HNF-PRO-346	*Fire Protection in Facility Operating Procedures*
14		HNF-PRO-347	*Employee Fire Protection Training*
15		HNF-PRO-348	*Fire Protection Records*
16		HNF-PRO-349	*Fire Protection Design Criteria*
17		HNF-PRO-350	*Fire Hazard Analysis Requirements*
18		HNF-PRO-351	*Fire Protection System Testing/Inspection and Maintenance*
19		HNF-PRO-352	*Fire Protection System Discrepancies*
20		HNF-PRO-353	*Fire Protection System Winterization*
21		HNF-PRO-354	*Fire Surveillance Requirements*
22		HNF-PRO-355	*Portable Heaters*
23		HNF-PRO-356	*Controlling Hotwork*
24		HNF-PRO-358	*Flammable/Combustible Liquids*
25		HNF-PRO-359	*Control of Combustibles*
26		HNF-PRO-360	*Construction/Occupancy or Demolition - Activities*
27		HNF-PRO-361	*Portable Fire Extinguishers*

Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

	Controlled manual number	FDH procedure number	FDH procedure title
1		HNF-PRO-362	*Non-emergency Use of Fire Hydrants*
2		HNF-PRO-363	*Building Emergency Egress*
3		HNF-PRO-365	*Fire Barriers*
4		HNF-PRO-368	*Laboratories*
5		HNF-PRO-370	*Hazardous Material Storage*
6		HNF-PRO-371	*Disposing of Waste Absorbent Material*
7		HNF-PRO-372	*Hanford Fire Department*
8		HNF-PRO-373	*Hanford Fire Department Coordination Requirements*
9		HNF-PRO-4564	*Hanford Fire Marshal Permits*
10	WHC-CM-4-43	HNF-PRO-424	*Emergency Preparedness Program*
11	WHC-CM-4-46	NA	*NA*
12	WHC-CM-5-34	NA	*NA*
13	WHC-CM-6-1	HNF-PRO-244	*Engineering Data Transmittal Requirements*
14		HNF-PRO-440	*Engineering Document Change Control Requirements*
15		HNF-PRO-1819	*PHMC Engineering Requirements*
16	WHC-CM-6-34	NA	*NA*
17		HNF-PRO-450	*Air Quality - Radioactive Emissions*
18	WHC-CM-7-5	HNF-PRO-451	*Regulated Substance, Management*
19		HNF-PRO-452	*NEPA, SEPA, Cultural and Natural Resources*
20		HNF-PRO-453	*Environmental Notification and Reporting*
21		HNF-PRO-455	*Solid Waste Management*
22		HNF-PRO-459	*Environmental Training*
23		HNF-PRO-462	*Pollution Prevention*
24		HNF-PRO-472	*Cold Weather Protection*
25	WHC-CM-8-7	HNF-PRO-473	*Performing Excavation Activities*
26		HNF-PRO-482	*Controlling Cross Connections*
27		HNF-PRO-488	*Repair of ASME-Coded Pressure Systems*

Table G-1. Project Hanford Procedure Cross Reference. (8 sheets)

Controlled manual number	FDH procedure number	FDH procedure title
	HNF-PRO-490	*Control of Measuring and Test Equipment, and Nondata Test Equipment*

Notes:

1. All controlled manuals were produced by Westinghouse Hanford Company, Richland, Washington
2. All FDH procedures were produced by Fluor Daniel Hanford Company, Inc., Richland, Washington

CM = controlled manual.
FDH = Fluor Daniel Hanford, Inc.
WHC = Westinghouse Hanford Company.
NA = indicates controlled manual has not been directly translated in a FDH procedure.

APPENDIX H
SUMMARY OF COMPUTER PROGRAMS USED IN THE ACCIDENT ANALYSES

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APPENDIX H
SUMMARY OF COMPUTER PROGRAMS USED IN THE ACCIDENT ANALYSES

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LIST OF TERMS

ANOVA	analysis of variance
FSAR	Final Safety Analysis Report
LANL	Los Alamos National Laboratory
PNNL	Pacific Northwest National Laboratory

APPENDIX H
SUMMARY OF COMPUTER PROGRAMS USED IN THE ACCIDENT ANALYSES

H1.0 SUMMARY OF COMPUTER PROGRAMS USED IN THE ACCIDENT ANALYSES

H1.1 GENII

Pacific Northwest National Laboratory (PNNL) developed updated versions of environmental pathway analyses models used at Hanford. The system of codes used to perform these analyses is referred to as Generation II or GENII. The system comprises seven linked computer codes and associated libraries. The codes calculate radiation doses for acute releases with options for annual dose, committed dose, and accumulated doses. The doses are calculated in the manner presented in ICRP 26, *Recommendations of the International Commission on Radiological Protection*. The pathways modeled include inhalation, submersion (both semi-infinite and finite cloud geometries), and ingestion pathways. Source term variations include the ability to model decay of radionuclides from the release to the start of the exposure scenarios.

The GENII package of codes was developed under a stringent quality assurance plan based on ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*. All steps of the code development have been documented and tested. The code has been extensively verified using hand calculations. A 10-volume set of test documentation is available from PNNL. An external peer review of the internal dosimetry portions of the code was conducted. The code is under configuration management; only authorized and approved changes can be made to the working versions. A list of users is maintained.

Quality assurance aspects of the code are discussed in detail in the GENII User's Manual (PNL-6584, *GENII - The Hanford Environmental Radiation Dosimetry Software System*).

H1.2 GOTH

GOTH is a finite volume computer code that solves the conservation equations for mass, momentum and energy for multicomponent, multiphase flow. The multiphases may include liquids, solids and gases. The conservation equations are coupled by mechanistic models for interfacial energy and momentum transfer that cover the entire flow regime map from single phase flow through multiphase flow. The code is capable of calculating the following behavior:

- Separation of particles from the supernatant as the result of combined effects of gravity, turbulence, inertia, and thermal and mass diffusion.

- Combined thermal effects of conduction in the nonconvective layer, conduction, thermal transport in the convective layer, heat transfer to solid structures being cooled with ventilation flow on their external surfaces, evaporative cooling at the pool surface, conductive and turbulent heat transfer in the tank atmosphere, and modeling of the tank ventilation system.

GOTH is a modified version of the GOTHIC code, which is a derivative of the COBRA family of codes. GOTHIC is currently being used by more than 35 United States and foreign utilities to perform nuclear reactor safety-related analyses. Configuration control is maintained for the code. Validation of the GOTH code for the tank farm final safety analysis report (FSAR) analyses is documented in Appendix A of WHC-SD-WM-CN-022, *Evaluation of Potential and Consequences of Steam Bump in High Heat Waste Tanks and Assessment and Validation of the GOTH Code*.

H1.3 GXQ

GXQ, Version 4.0 is a microcomputer-based program for calculating atmospheric dispersion using site-specific joint frequency data (WHC-SD-GN-SWD-30002, *GXQ Program User's Guide*). The code uses the Gaussian straight line model for both instantaneous and continuous releases. Several models are available to the user that modify parameters within the Gaussian plume model to account for phenomena such as plume depletion, building wake, plume meander, gravitational settling, and plume rise. Additional controls alter the handling of joint frequency data and output. The code will calculate χ/Q' in compliance with *Regulatory Guide 1.145* (NRC 1982).

GXQ has three modes of operation. These modes allow (1) calculation of a centerline χ/Q' based on site-specific meteorology, (2) an offset χ/Q' based on atmospheric stability class and wind speed, and (3) an x-y plot file based on atmospheric stability class and wind speed.

The GXQ code is controlled by the code custodian. The custodian is responsible for maintaining a validated version of the code and documentation and for reporting any changes in code status or errors identified to registered users. The code source listing, as well as verification case results, are provided in WHC-SD-GN-SWD-30003, *GXQ Program Verification and Validation*. A GXQ registered users' list is maintained by and available from the GXQ code custodian upon request.

H1.4 HSC CHEMISTRY

HSC Chemistry for Windows is a commercial software that can be used for retrieving chemical property information. This program was used for the organic nitrate calculations to obtain information such as enthalpy of formation, entropy of formation and specific heat for different compounds. The code is described in Roine (1994), "Outokumpu HSC Chemistry for Windows."

H1.5 HMS/TRAC

HMS/TRAC is a combination of two separate computer codes (HMS [Travis and Wilson 1992, *HMS: Theory and Computational Model*] and TRAC [Pasamehmetoglu et. al 1993, *TRAC-PF1/MOD2 Vol 1, Theory Manual*]). HMS/TRAC is a finite volume code that solves the transient 3-D compressible fluid Navier Stokes equations with multiple species combined with chemical kinetics. The code was developed at Los Alamos National Laboratory (LANL) to be a best-estimate tool for predicting the transport, mixing, and combustion of hydrogen gas in nuclear reactor containments. HMS was used to model the gas release into the tank vapor space. The TRAC code was then used to model the ventilation system. Principal use of the code was in the Tank 241-SY-101 mixer pump study (LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*), but the results have been used for other calculations.

LANL has completed an HMS assessment document for the Nuclear Regulatory Commission. LANL is also completing an assessment for TRAC. The combined computer code HMS/TRAC use for tank farm calculations has been assessed with the best available data. Experiments were performed in the Bureau of Mines Pittsburgh Research Center to benchmark the burn model in HMS. Further details and further references concerning the validation of the HMS/TRAC computer codes for tank farm work is described in Section 2.5 of Appendix D of LA-UR-92-3196.

H1.6 MICROSHIELD

MICROSHIELD is a computer code used to analyze shielding and estimate exposure from gamma radiation. It is an adaptation of the ISOSHLD mainframe code, with enhancements to facilitate user input. This code performs radiation dose calculation for a variety of source isotopes. Shielding materials are limited but accommodate most common materials. The code's point kernel methods of solution will calculate doses for 14 different simple geometries.

The code is sold commercially in configuration controlled versions. A user's manual (Negin and Worku 1992a, *MicroShield 4 Users' Manual (92-2)*) and a validation and verification document (Negin and Worku 1992b, *MicroShield 4 Verification and Validation (92-3)*) are available for the code.

H1.7 MICROSKYSHINE

The *MICROSKYSHINE* computer program is used to calculate the dose from overhead scattered radiation. A receptor who may not have direct line of sight path to a radioactive gamma source may still receive a dose from scatter from the air. This air scatter is referred to as skyshine. The code is used in the FSAR to calculate doses to a person standing near a large pool where the angles are such that there may be significant skyshine relative to direct dose. The code uses line beam response functions which were determined by empirical fits to Monte Carlo

calculations. A user's manual is available (Grove 1987, *MICROSKYSHINE*) for the code, and the validation of the code is discussed in two supporting documents (Faw and Shultz 1987, "The Microskyshine Method for Gamma-Ray Skyshine Analysis") and (Shultz and Faw 1987, "Improved Response Functions for the Microskyshine Method").

H1.8 ORNATE

ORNATE (Organic Nitrate) is a computer program written to model hypothetical organic nitrate reactions in Hanford waste tanks. The ORNATE model is used in a study performed on a tank-by-tank basis to find the volume reacted to achieve a given threshold, and the amount of each toxic or radioactive compound released. Key input parameters are the volume of the reactive waste, total organic carbon levels, and headspace volume. Key output parameters are the release fraction of each radioactive isotope and toxic chemical, and whether the pressures are sufficient to rupture the high- efficiency particulate air filters.

The ORNATE models were verified against hand calculations. The ORNATE models and validation are discussed in Appendix B of WHC-SD-WM-CN-058, *Compilation of Calculation Notes in Support of Organic Salt-Nitrate Reactions Safety Analysis*.

H1.9 POOLFIRE

POOLFIRE is a computer program written to analyze solvent pool fires within Hanford Site tanks. The program calculates tank internal pressures, quantity of organic burned, quantity of gas vented, and the temperature of tank surfaces. The program is written in the BASIC computer language. POOLFIRE solves the basic gas law and thermal conduction equations to analyze the results of the solvent fires. The code calculates oxygen quantities within the tank and models the extinguishment of the fire when there is insufficient oxygen to support combustion.

The code results were compared to an independent analysis to confirm that the code results were valid. An independent analysis of the code equation and models was also conducted. The code and the verification methods are discussed in Appendix A of WHC-SD-WM-CN-032, *Analysis of Consequences of Postulated Solvent Fires in Hanford Site Waste Tanks*. A listing of the code is also given in the reference.

H1.10 S-PLUS

S-Plus is a commercial statistical package that uses the tank waste data to compute the probability that a tank has threshold volume of reactive waste for an organic fire (Martin and Mirandi 1995, "S-PLUS: Tool for Engineers and Scientists"). S-Plus is an object-oriented programming language, designed specifically for the analysis of scientific and technical data.

The analysis of variance models used in the organic-nitrate safety issue are fitted to total organic carbon and H_2O using a function provided in S-Plus, called "varcomp." S-Plus is a general statistical data-analysis package produced by Mathsoft. The "varcomp" function uses a well-documented procedure for fitting analysis of variance (ANOVA) models to data.

To validate the "varcomp" routine, a comparison of its output with that from an alternative statistical package using the same restricted maximum likelihood algorithm was performed. An alternative statistical package (i.e., Statistical Analysis System [SAS Language and Procedures, 1991]) produced the same results as the S-Plus function when the code was tested using two data sets extracted from early total organic carbon/H_2O data. Agreement between the results was demonstrated to five decimal places.

H1.11 SPRAY

A microcomputer-based program called SPRAY has been prepared to facilitate solution of the spray equations discussed in WHC-SD-GN-SWD-20007, *A Model for Predicting Respirable Releases from Pressurized Leaks*. Both circular orifice and rectangular slits are modeled. The program has two basic modes of operation. The first mode calculates the release rate, both total and respirable, given a specified orifice diameter or slit width/length. The second mode includes a search for the optimal orifice diameter or slit width to maximize the respirable flow rate. The effect of wall friction is included by specifying an orifice or slit depth and absolute surface roughness. The code determines whether the flow is laminar or turbulent and calculates the friction factor accordingly.

One additional feature of the SPRAY program allows the user to force the friction factor calculation to be based on either the laminar or turbulent relations. This feature is provided to prevent the code from cycling between the two relationships when flow is in the critical region.

The code has been calibrated against five example calculations. These examples provide the basis of the SPRAY code verification. Appendix A of WHC-SD-GN-SWD-20007 contains the code calculated results for each example. Verification that the code calculates the same result, within round off, is evidence of proper operation. Results indicate that the code does implement the model as expected and can be depended upon to accurately compute the model equations.

The SPRAY code is controlled by the code custodian. The custodian is responsible for maintaining a validated version of the code and documentation and for reporting any changes in code status or errors identified to registered users.

A registered user can only obtain the code directly from the code custodian. The code custodian is required to ensure that all quality affecting errors or changes to the code are documented and communicated to the registered users. Code recompilations incorporating changes will be documented, verified, and assigned a unique version number. A SPRAY registered users list is maintained by and is available from the SPRAY code custodian upon request.

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APPENDIX I
TOXICOLOGICAL HAZARD EVALUATION

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APPENDIX I
TOXICOLOGICAL HAZARD EVALUATION

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LIST OF TERMS

ACGIH	American Conference of Governmental Industrial Hygienists
DST	double-shell tank
EDTA	ethylenediaminetetraacetic acid
HASP	health and safety plan
HCN	hydrogen cyanide
HCR	historical characterization report
HEDTA	hydroxyethylethylenediaminetriacetic acid
NIOSH	National Institute of Occupational Safety and Health
NPH	normal paraffinic hydrocarbon
SST	single-shell tank
STEL	short-term exposure limit
TBP	tributyl phosphate
TLV	threshold limit value
TOC	total organic carbon
TWA	time-weighted average

APPENDIX I
TOXICOLOGICAL HAZARD EVALUATION

I1.0 TOXICOLOGICAL HAZARD EVALUATION

Table I-1 is taken from WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*. The philosophy behind development of the table was as follows:

1. List all the elements, anions, cations, and compounds mentioned in:

   - WHC-SD-WM-TI-565, *Radionuclide and Chemical Inventories for Single-Shell Tanks*
   - WHC-SD-WM-TI-543, *Radionuclide and Chemical Inventories for Double-Shell Tanks*
   - WHC-SD-WM-HSP-002, *Tank Farm Health and Safety Plan*
   - Tank Farm historical characterization reports

2. Determine what compounds would be formed assuming an alkaline medium created by addition of NaOH.

3. Determine form and relative toxicity of compounds, and from that, determine if consequence assessment is necessary (or alternatively, if the "threshold quantity" approach or back-calculate-problem-quantity approach should be applied).

   In the column titled "Relative to Toxicological Analysis," not all compounds have values for TLV-TWA listed. For several compounds, these values were not readily available. In Appendix D of WHC-SD-WM-SARR-011, Rev. 2, it is noted that missing values were developed for the Hanford Environmental Health Foundation using methods approved by the American Industrial Hygiene Association Emergency Response Planning Guideline Committee, with minor modifications. The values used in the risk guidelines for tank waste chemicals are listed in Tables F-1, F-2, and F-3 of Attachment 5, Appendix D, WHC-SD-WM-SARR-011.

4. For chemicals worthy of consequence considerations, inventories from inventory documents will be used to determine unit release consequences.

   Note that the column titled "Relevant to Toxicological Analysis" is a summary of the one presented in WHC-SD-WM-SARR-011. WHC-SD-WM-SARR-011 gives the basis for the "no" designation.

I2.0 REFERENCES

ACGIH, 1996, *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

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WHC-SD-WM-TI-565, 1993, *Radionuclide and Chemical Inventories for the Single-Shell Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
H_2O	HCR	NA	Liquid	No.
NO_3^{-1}	HCR, HASP, DST, SST	$NaNO_3$ (sodium nitrate)	Liquid (in solution) Solid (crystallized salts)	Yes - not listed in ACGIH, NIOSH.
NO_2^{-1}	HCR, HASP, DST, SST	$NaNO_2$ (sodium nitrite)	Liquid (in solution) Solid (crystallized salts)	Yes - not listed in ACGIH, NIOSH.
PO_4^{-3}	HCR, DST, SST	Possibly Na_3PO_4 [Sodium phosphate (tribasic) = Na_3PO_4*12HOH] Possibly Na_2HPO_4	Liquid (in solution) Solid (crystallized salts)	Yes - not listed in ACGIH, NIOSH.
		$BiPO_4$	Solid	No.
		$AlPO_4$ (insoluble phosphate) [See Al^{+3}]	Solid	No.
		Polyphosphates (e.g., P_2O_7) may be possible	Solid	No.
		$Na_7F(PO_4)_2$ (sodium fluoride diphosphate)	Solid	No - [See F(-1)].
		Organophosphate esters [See TBP]	Liquid	Yes - [See TBP].
CO_3^{-2}	HCR, DST, SST	Na_2CO_3 (primary) [See Na_2CO_3]	Solid and in solution	Yes - not listed in ACGIH, NIOSH.
		$NaHCO_3$ (sodium bicarbonate)	Solid and in solution	No.
		Insoluble $CaCO_3$ possible if large amounts of Ca present (not frequent)	Solid	No.
F^{-1}	HCR, DST, SST	NaF (sodium fluoride) [See HF]	Liquid (in solution) Solid (crystallized salts)	Yes - TLV - TWA = 2 mg/m^3.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
F^{-1} (cont.)	HCR, DST, SST	F^{-1} - $BiPO_4$ process generated LaF_3 [See La]	Solid	No.
		Also, F^{-1} forms strong metal complexes with Fe, Al (e.g., Na_3AlF_6)	Liquid Solid	No.
		$Na_7F(PO_4)_2$ (sodium fluoride diphosphate)	Solid	No.
Cl^{-1}	HCR, DST, SST	NaCl (sodium chloride) - solution & crystallized salts	Liquid (in solution) Solid (crystallized salts)	No.
OH^{-1}	HCR, DST, SST	Free OH- ion	Liquid	Yes - Covered by NaOH for SSTs, use OH- as indicator for NaOH in DSTs. TLV - TWA = 2 mg/m^3.
		See "hydroxided" cations and metals	NA	NA.
Na	HCR, DST, SST	NaOH (sodium hydroxide)	Liquid (in solution) Solid (crystallized salts)	Yes - covered by NaOH.
Na^{+1}, definitely no Na metal in the tanks		Also possible mineralization (possibly $NaAlSiO_2$) Possibly SiO_4, which is a silicate	Solid	No.
		$NaNO_3$ [See NO_3] $NaNO_2$ [See NO_2] Na_2SO_4 [See SO_2, SO_3, SO_4, and $NaSO_4$] Na_3PO_4 [See PO_4]	NA	[See specific compound entries].
Al^{+3}	HCR, DST, SST	$Al(OH)_3$ at pH < 13 [See $Al(OH)_4^{-1}$]	Solid at pH ≤ 9.5) Liquid (in solution) at pH > 10.5 [becomes $NaAl(OH)_4$; listed separately]	No.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Al^{+3} (cont.)		$Al(PO_4)$ [See PO_4^{-3}]	Solid	No.
		$NaAl(OH)_4$ (sodium aluminate) at pH > 13. [See $Al(OH)_4^{-1}$]	Liquid or solid salt	Yes - not listed in ACGIH, NIOSH.
		$Al_2(CO_3)_3$ precipitate if lots of carbonate present	Solid	No.
	HCR, DST, SST	Also found as mineral form - cancrinite, zeolite, and sodium aluminosilicate are possibilities.	Solid	No.
		AlOOH Crystals seen with X-ray diffraction in U-110.	Solid	No.
$Fe^{+2/+3}$	HCR, DST, SST	$Fe(OH)_3$ (ferric hydroxide)	Solid	No.
		$Fe_2(CO_3)_3$ (ferric carbonate)	Solid	No.
		Fe may also mineralize	Solid	No.
Ca^{+2}	HCR, DST, SST	$CaCO_3$ (calcium carbonate) [See CO_3]	Solid	No.
		$CaOH - SiO_2 - H_2O$	Gel Solid	Yes - TLV - TWA = 5 mg/m³.
		$Ca(OH)_2$ (calcium hydroxide)	Solid	Yes - TLV - TWA = 5 mg/m³.
Bi^{+3}	HCR, DST, SST	$BiPO_4$ (Bi phosphate) Good possibility since it was used in process. All of Bi in tanks is probably present as this.	Solid	No.
		$Bi(OH)_3$	Solid	No.
		$Bi_2(CO_3)_3$	Solid	No.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
$Cr^{+3/+6}$; both possible based on SST analyses	HCR, DST, SST	Cr^{+6} and Cr^{+3} are the toxic concerns	Liquid (+6) Solid (+3)	Yes - Cr compounds are toxic. Cr^{+6} compounds are considered carcinogenic. (TLV-TWA = 0.05 mg/m^3 as Cr for Cr^{+6} compounds, and 0.5 mg/m^3 as Cr for Cr^{+3} compounds.)
		$Cr(NO_3)_3$ (Cr as Cr^{+3}): only if pH is relatively low (<7)	Solid (possibly a gel)	Yes - Cr compounds are toxic. Cr^{+6} compounds are considered carcinogenic. (TLV-TWA = 0.05 mg/m^3 as Cr for Cr^{+6} compounds, and 0.5 mg/m^3 as Cr for Cr^{+3} compounds. Actually NA because not present at high pHs.) [Covered by Cr^{+6} and Cr^{+3}].
		$Cr(OH)_3$ if Cr is +3 and pH is high	Solid	Yes - Cr compounds are toxic. Cr^{+6} compounds are considered carcinogenic. (TLV-TWA = 0.05 mg/m^3 as Cr for Cr^{+6} compounds, and 0.5 mg/m^3 as Cr for Cr^{+3} compounds 0.5 mg/m^3 as Cr.) [Covered by Cr^{+6} and Cr^{+3}].
		Na_2CrO_4 (sodium chromate)	Liquid	Yes - Cr compounds are toxic. Cr^{+6} compounds are considered carcinogenic. (TLV-TWA = 0.05 mg/m^3 as Cr for Cr^{+6} compounds, and 0.5 mg/m^3 as Cr for Cr^{+3} compounds 0.5 mg/m^3 as Cr.) [Covered by Cr^{+6} and Cr^{+3}].
Zr^{+4}	HCR, DST, SST	$Zr(OH)_4$	Solid	No.
		ZrO_2*nH_2O	Solid	No.
		Zr forms complex salts. May form zirconyl compounds - $ZrO(NO_3)_2$	Solid	No.
		ZrF_6^{-2} or $ZrOF_2$ [Zr cladding was dissolved in NH_4F] ZrF_6^{-2} exists only in acid and neutral solutions - not in waste tanks. $ZrOF_2$ probably does not exist in tanks.	Solid	No.
Si^{+4}	HCR, DST	SiO_2 (silica, quartz, minerals)	Solid	No.
		Na_4SiO_4	Liquid	Yes - not listed in ACGIH, NIOSH.
TOC	HCR, DST, SST	Possibly many organic chemicals	Gases, liquids, and solids	Yes - for some organophosphate esters [See TBP]; releases of organics and other vapor space constituents are evaluated in the gas release portion of this analysis.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
FeCN [$Fe(CN)_6^{-4}$]	HCR, SST	NA [$Na_2NiFe(CN)_6$, $Na_2Fe(CN)_6$]	Probably solid	No; Yes for soluble ferricyanides ($Na_2Fe(CN)_6$).
		NaCN	--	Yes - extremely toxic.
U UO_2^{+2}	HCR, DST, SST	Insoluble U compounds	Solid	Yes - listed in ACGIH and NIOSH for toxicological reasons. TLV-TWA = 0.2 mg/m³, TLV-STEL = 0.6 mg/m³.
NPH	HASP	Remains as NPH (a kerosene-type compound; duodecane is another name) 1. C10 - C15 aliphatic. 2. Hydrolysis, radiolysis and nitration will degrade NPH with time.	Liquid	Yes - not listed in ACGIH, NIOSH.
Ammonia (NH_3)	HASP, DST, SST	NH_3 (alkaline drives NH_3 off into headspace)	Primarily gas	Yes - TLV-TWA = 17 mg/m³.
		NH_4NO_3 (ammonium nitrate) possible if pH < 11 (much < 11 per DKO)	Liquid	Yes - not listed in ACGIH, NIOSH.
Acetone	HASP	Acetone	Liquid	Yes - TLV-TWA = 1,780 mg/m³.
Butanol (Butyl alcohol)	HASP	Butanol (Butyl alcohol) (1-butanol or n-butyl alcohol)	Liquid and vapors	Yes - irritant and toxic.
TBP	HASP	TBP	Liquid and vapor	Yes - TLV-TWA = 2.2 mg/m³. TBP vapor releases are evaluated in the gas release portion of this analysis. TBP liquid releases are evaluated in the gas release portion of this analysis.
		Dibutyl phosphate (TBP degradation product)	Liquid and vapor	Yes (for liquid releases), no (for vapor releases) - TLV-TWA = 8.6 mg/m³.
		Monobutyl phosphate (TBP degradation product)	Liquid and vapor	Yes - not listed in ACGIH, NIOSH.
		Possibly other TBP degradation products	Liquid and vapor	Yes; since there is no speciation available for other TBP degradation products, further evaluation of liquid releases cannot be made.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Formic acid (cannot exist in tanks)	HASP	HCOONa (sodium formate)	Solid and Liquid	Yes - TLV-TWA = 9.4 mg/m^3.
Hydrogen	HASP	H_2	Gas	No.
H_2S	HASP	Metal sulfides [FeS, Fe_2S_3 oxidizes to sulfates]. Any sulfide ion in solution would be precipitated. Most heavy metal sulfides (e.g., iron, nickel) are insoluble. Free sulfide ions or H_2S are rapidly oxidized if not complexed with metals.	Solid	No.
HCN	HASP	FeCN	Solid	No.
SO_2	HASP	Na_2SO_3 (sodium sulfite) [probably not stable in waste - will oxidize to Na_2SO_4]	Solid	No.
SO_3	HASP	Na_2SO_4 (sulfate) [See Na, SO_2, SO_4, $NaSO_4$]	Solid	No.
HF	HASP	NaF (fluoride) [See F^{-1}]	Solid	Yes - TLV-TWA = 2.5 mg/m^3.
		Metal fluorides [See F^{-1}]	Solid	No.
Ag (Fission product)	DST, SST	Ag_2O	Solid	No.
		AgCl - not much chloride	Solid	No.
$Al(OH)_4^{-1}$	DST, SST	$NaAlO_2$ [sodium aluminate; also written as $NaAl(OH)_4$] [See Al^{+3}]	Liquid or solid	Yes - not listed in ACGIH, NIOSH.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
As	DST, SST	As is the toxic concern	Solid	Yes - Soluble As compounds are toxic. TLV-TWA = 0.2 mg/m^3 as As.
		$NaAsO_3$ (metaarsenate) or Na_3AsO_4 (orthoarsenate) [Arsenites, like $NaAsO_2$, are very easily oxidized and probably don't exist in the waste]	Solid	Yes - absorbs CO_2 from air, toxic by ingestion and inhalation, covered by As. TLV - TWA = 0.2 mg/m^3.
B	DST, SST	Na_3BO_3 or $Na_2B_4O_7$ (sodium borate)	Solid (from common ion effect)	Yes - $Na_2B_4O_7$ is corrosive.
Ba	DST, SST	Ba is the toxic concern	Solid and possibly liquid	Yes - TLV-TWA = 0.5 mg/m^3.
		$Ba(OH)_2$	Solid	Yes - covered by Ba.
		$BaCO_3$	Solid	Yes - covered by Ba.
		$Ba(NO_3)_2$ will not exist under basic conditions because $Ba(OH)_2$ will predominate	Liquid	Yes - covered by Ba.
Be	DST, SST	Be is the toxic concern	Liquid	Yes - Be is a suspect carcinogen, and has a very low TLV-TWA of 0.002 mg/m^3 as Be.
		$Be(OH)_2$	Solid at pH 5-8 Liquid at pH > 8 because forms complex ions [e.g., $Be(OH)_4^{-2}$]	Yes - covered by Be.
		Na_2BeO_2 Same as $Na_2Be(OH)_4^{-2}$	Liquid	Yes - covered by Be.
CN^{-1}	DST, SST	NaCN [See FeCN; CN forms complexes with many metals] [See TOC]	Liquid (in solution as Na^+ and CN^- ions)	Yes - extremely toxic.
Cd	DST, SST	$Cd(OH)_2$	Solid	Yes - Cd is a suspect carcinogen.
Ce	DST, SST	$Ce(OH)_3$ (cerous hydroxide)	Solid (gel)	Yes - toxic.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Co	DST, SST	Co is toxic concern	Solid	Yes - Co is an animal carcinogen per ACGIH.
		$Co(OH)_2$ (cobaltic hydroxide)	Solid	Yes - Co is an animal carcinogen per ACGIH, covered by Co.
		$Co_2O_3*H_2O$ (same as cobaltic hydroxide)	Solid	Yes - Co is an animal carcinogen per ACGIH, covered by Co.
CrO_4 $CrO4^{-2}$	DST	Na_2CrO_4 (sodium chromate) [See Cr]	Liquid	Yes - Cr compounds are toxic. Cr^{+6} compounds are considered carcinogenic. (TLV-TWA = 0.05 mg/m^3 as Cr for Cr^{+6} compounds, and 0.5 mg/m^3 as Cr for Cr^{+3} compounds 0.5 mg/m^3 as Cr.). Covered by Cr.
Cu	DST, SST	$Cu(OH)_2$	Solid	Yes - TLV-TWA = 1 mg/m^3 for Cu dusts and mists.
Dy	DST, SST	$Dy(OH)_3$ [Dy is in tanks because it is a fission product]	Solid	Yes - not listed in ACGIH, NIOSH.
EDTA	DST, SST	Na_4*EDTA	Liquid	No.
HEDTA	DST, SST	Na_3*HEDTA	Liquid	No.
Hg	DST, SST	Hg is the toxic concern	Solid or liquid	Yes - (very toxic) TLV-TWA for (a) all forms of Hg except alkyl vapor is 0.05 mg/m^3, and (b) inorganic Hg compounds is 0.1 mg/m^3.
		$Hg(OH)_2$	Solid	Yes - covered by Hg.
		Hg metal, will probably exist as solid salt	Solid	Yes - metal very toxic and volatile, covered by Hg.
		HgOH	Solid	Yes - covered by Hg.
K	DST, SST	KNO_3	Liquid	No.
La	DST, SST	$La(OH)_3$	Solid	Yes - not listed in ACGIH, NIOSH.
		[La fluoride because of process used] LaF_3 [See F^{-1}]	Solid	Yes - not listed in ACGIH, NIOSH.
		Insoluble phosphates, including $LaPO_4$	Solid	No.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Li	DST, SST	$LiNO_3$	Liquid	Yes - not listed in ACGIH, NIOSH.
Mg	DST, SST	$Mg(OH)_2$	Liquid or solid	No.
		$MgCO_3$	Liquid Solid	No.
Mn	DST, SST	MnO_2	Solid	No.
Mo	DST, SST	Mo is the toxic concern	Solid	No.
		$Mo_2O_3{*}H_2O$ (a molybdate)	Solid	No.
		Na_2MoO_4 (another molybdate)	Solid	No.
Nd	DST, SST	$Nd(OH)_3$	Solid	No.
		NdF_3	Solid	No.
Ni	DST, SST	Ni is the toxic concern	Solid or liquid	No - not an acute inhalation hazard.
		$Ni(OH)_2$ (nickelous hydroxide)	Solid	No.
		More likely $Ni(OH)_3$ (higher oxidation state) (nickelic hydroxide)	Solid	No.
		$[Ni(OH)_4]^{-2}$	Liquid	No.
Np	DST	NpO_2OH	Solid	No.
P	DST, SST	phosphates	Solid	NA - see specific phosphate compounds.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Pb	DST, SST	$Pb(OH)_2$	Solid	No.
Pd (Fission product)	DST, SST	Possibly $Pd(OH)_2$ More likely $Pd(OH)_4$ (higher oxidation state)	Solid	No.
		Potentially some complex nitrosyl compounds	Liquid soluble complexes	No.
Pu	DST, SST	Pu hydroxide	Solid	No.
		$Pu^{+4}F_4$ Not in the tanks because all converts to hydroxide	Solid	No.
Re	DST, SST	Possibly $NaReO_4$ (rhenates)	Either liquid (as Na^+ and ReO_4^- ions), or solid (ReO_2) if behaves like permangenate (MnO_4^-) and is reduced in basic solution	No.
Rh (Fission product)	DST, SST	Rh is the toxic concern	Solid	No - not an acute inhalation hazard.
		Rh_2O_3	Solid	No.
		Nitrosyl compounds	Unknown	No.
Ru	DST, SST	Ru_2O_3	Solid	No.
		RuO_4 (volatile tetraoxide)	Probably gas	Yes - not listed in ACGIH, NIOSH.
		Na_2RuO_4 (sodium ruthenates have complex chemistry)	Liquid	No.
SO_4^{-2}	DST, SST	Na_2SO_4 (sodium sulfate) [See Na, SO_2, SO_3 and $NaSO_4$]	Liquid	No.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Sb	DST, SST	Sb is the toxic concern	Liquid or solid	Yes - soluble salts are toxic and TLV-TWA = 0.5 mg/m^3 as Sb.
		Possibly $NaSb(OH)_4$ (sodium antimonate)	Liquid (as Na^+ and $Sb(OH)_4^-$ ions)	Yes - covered by Sb.
		Possibly Sb_2O_5 (antimony pentoxide, antimonic anhydride, antimonic acid, stibic anhydride)	Solid	Yes - covered by Sb.
Se	DST, SST	Se is the toxic concern	Probably liquid	Yes - Se compounds TLV-TWA = 0.2 mg/m^3 as Se.
		Na_2SeO_4 (sodium selenate) Possibly Na_2SeO_3 (sodium selenite)	Liquid	Yes - covered by Se.
		SeO_2 (complex chemistry) Won't have this because can't exist in alkaline pH	--	Yes - covered by Se.
Sn	DST, SST	Sn is the toxic concern	Solid or liquid	Yes - TLV-TWA for Sn oxides and inorganic compounds = 2 mg/m^3 as Sn.
		$Sn(OH)_2$ (tin hydroxide)	Solid	Yes - covered by Sn.
		SnO_2*H_2O (tin oxide)	Solid	Yes - covered by Sn.
		Na_2SnO_3 (sodium stannate) Same as $Na_2Sn(OH)_6$ (differing only by three water molecules). Both are the hydroxide complex ions discussed in the note above (see Ni) $Na_2Sn(OH)_6$ is $NaOH^+$ stannic hydroxide	Liquid	Yes - covered by Sn.
Sr	DST, SST	Sr sulfates	Solid	No.
		Sr carbonates	Solid	No.
		Sr oxalates	Solid	Yes - not listed in ACGIH, NIOSH.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Ta	DST, SST	Possibly Na_3TaO_4 (sodium tantalate)	Liquid	No.
		Possibly $Ta_2O_5*H_2O$ (tantalum oxide)	Liquid	No.
Te	DST, SST	Te is the toxic concern	Solid or liquid	Yes - TLV-TWA for Te compounds = 0.1 mg/m^3 as Te.
		Na_2TeO_3 (sodium tellurite) Na_2TeO_4 (sodium tellurate)	Liquid	Yes - covered by Te.
		Possibly TeO_2*H_2O (tellurium dioxide)	Solid or liquid	Yes - covered by Te.
Th	DST, SST	Possibly ThO_2*H_2O (thorium oxide)	Solid	No.
		$Th(OH)_4$ (thorium hydroxide)	Solid	No.
Ti	DST, SST	TiO_2 (titanium dioxide) or $Ti(O_2)*H_2O$	Solid	No.
		$Ti(OH)_4$ (titanium hydroxide)	Solid	No.
		Na_2TiO_3 (sodium titanate or titanite)	Solid	No.
Tl	DST, SST	Tl is the toxic concern	Solid or liquid	Yes - TLV-TWA for soluble compounds = 0.1 mg/m^3 as Tl.
		$Tl(OH)_3$ (thallium hydroxide) Possibly TlOH if it is in +1 ion state	Solid at pH 8-12, liquid at pH >12 Solid	Yes - covered by Tl.
	DST, SST	$NaTlO_2$ (sodium thallate) Possibly $NaTl(OH)_4$	Solid or liquid	Yes - covered by Tl.
V	DST, SST	$Na_2[VO_3(OH)]$ (sodium vanadate)	Probably liquid	Yes - strong respiratory irritant.
		Na_4VO_4 (probably "sodium vanadite")	Probably liquid	Yes - strong respiratory irritant.
		$NaVO_3$ (probably "sodium vanadate")	Probably liquid	Yes - strong respiratory irritant.
W	DST	Na_2WO_4 (sodium tungstate) [See WO_4]	Liquid	No.
Zn	DST, SST	$Zn(OH)_2$ (zinc hydroxide)	Solid	No.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
Am	SST	$Am(OH)_3$ (americium hydroxide)	Solid	No.
$C_2H_3O_3$ (glycolate ion)	SST	Possibly sodium glycolate	Liquid	No.
$C_6H_5O_7^{-3}$	SST	$Na_3C_6H_5O_7$ (sodium citrate)	Liquid	Yes - not listed in ACGIH, NIOSH.
$C_2O_4^{-2}$	SST	$Na_2C_2O_4$ (sodium oxalate) Probably not there because heavy metals precipitate oxalates before sodium does	Solid	Yes - not listed in ACGIH, NIOSH.
		CaC_2O_4 (calcium oxalate)	Solid	Yes - not listed in ACGIH, NIOSH.
		SrC_2O_4 (strontium oxalate)	Solid	Yes - corrosive and toxic.
$NaAlO_2$	SST	$NaAlO_2$ (sodium aluminate) [See $Al(OH)_4^{-1}$]	Liquid	Yes - not listed in ACGIH, NIOSH.
Na_2CO_3	SST	Na_2CO_3 [See CO_3^{-2}]	Liquid	Yes - not listed in ACGIH, NIOSH.
$NaNO_2$	SST	$NaNO_2$ (sodium nitrite) [See NO_2^{-1}]	Liquid (in solution) Solid (crystallized salts)	Yes - not listed in ACGIH, NIOSH.
$NaNO_3$	SST	$NaNO_3$ (sodium nitrate) [See NO_3^{-1}]	Liquid (in solution) Solid (crystallized salts)	Yes - not listed in ACGIH, NIOSH.
NaOH	SST	NaOH (sodium hydroxide) [See OH^{-1}, Na]	Liquid (in solution) Solid (crystallized salts)	Yes - TLV-C = 2 mg/m^3.
Na_3PO_4	SST	Na_3PO_4 (sodium phosphate) Possibly polyphosphates [See PO_4^{-3}]	Liquid (in solution) Solid (crystallized salts)	Yes - strong irritant.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
$NaSO_4$ ion	SST	Na_2SO_4 [See Na, SO_2, SO_3, SO_4]	Solid	No.
S	SST	Na_2S	Solid	Yes - not listed in ACGIH, NIOSH.
		metal sulfides [See H_2S - FeS, Fe_2S_3 oxidizes to sulfates]	Solid	No.
SeO_4	SST	Na_2SeO_4 [See Se]	Liquid	Yes - Se compounds TLV-TWA = 0.2 mg/m^3 as Se. Covered by Se.
SiO_2	SST	SiO_2 (silica, quartz) [See Si]	Solid	No.
		Na_4SiO_4 [See Si]	Liquid	Yes - corrosive (because in liquid form).
		minerals [See Si]	Solid	No.
SiO_3 ion	SST	Na_2SiO_3 or Na_2SiO_4 (sodium silicate)	Solid	Yes - corrosive.

Table I-1. Toxicological Hazard Evaluation. (15 sheets)

Analyte	Where mentioned	Potential compounds in basic pH formed by addition of NaOH	Form	Relevant to toxicological analysis
WO_4 ion	SST	Na_2WO_4 (sodium tungstate) [See W]	Liquid	No.
ZrO	SST	NaZrO (sodium zirconate)	Solid	No.

Source: WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Note: Minor editing of the source document information presented in this table has been performed to enhance presentation and clarity for this Final Safety Analysis Report. Technical content between the source document and the information presented in this table remains unaffected.

ACGIH = American Conference of Governmental Industrial Hygienists. Document reference is ACGIH, 1996, *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

DST = Data for double-shell tanks taken from WHC-SD-WM-TI-543, 1993, *Radionuclide and Chemical Inventories for the Double-Shell Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

EDTA = ethylenediaminetetraacetic acid.

HASP = Health and safety plan information taken from WHC-SD-WM-HSP-002, 1995, *Tank Farm Health and Safety Plan*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

HCN = hydrogen cyanide.

HCR = historical characterization reports.

HEDTA = hydroxyethylethylenediaminetriacetic acid.

NIOSH = National Institute of Occupational Safety and Health. See WHC-SD-WM-SARR-011 for more information.

NPH = normal paraffinic hydrocarbon.

SST = Data for single-shell tanks taken from WHC-SD-WM-TI-565, 1993, *Radionuclide and Chemical Inventories for the Single-Shell Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

STEL = short-term exposure limit.

TBP = tributyl phosphate.

TLV = threshold limit value.

TOC = total organic carbon.

TWA = time-weighted average.

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APPENDIX J
PEAK CONCENTRATION CALCULATION METHODS FOR TOXIC MATERIAL RELEASES

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APPENDIX J
PEAK CONCENTRATION CALCULATION METHODS FOR TOXIC MATERIALS RELEASES

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APPENDIX J
PEAK CONCENTRATION CALCULATION METHODS FOR TOXIC MATERIAL RELEASES

J1.0 PEAK CONCENTRATION CALCULATION METHODS FOR SOLIDS AND LIQUIDS

For a continuous release of solid or liquid toxic material, the peak concentration is calculated using Equation J-1 (from WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*).

$$C(mg/m^3) = Q'(mg/s) \times \frac{\chi}{Q'}(s/m^3) \qquad \text{(J-1)}$$

where:

C = Peak concentration.
Q' = Toxic material release rate.
χ/Q' = Continuous release atmospheric dispersion coefficient.

Equation J-2 (WHC-SD-WM-SARR-011) is used to calculate the peak concentration for an instantaneous release of solid or liquid toxic material.

$$C(mg/m^3) = Q(mg) \times \frac{\chi}{Q}(1/m^3) \qquad \text{(J-2)}$$

where:

C = Peak concentration.
Q = Quantity of toxic material released.
χ/Q = Puff release atmospheric dispersion coefficient.

J2.0 PEAK CONCENTRATION CALCULATION METHODS FOR GASEOUS TOXIC CHEMICAL RELEASES

For a continuous release of gaseous toxic material, the peak concentration is calculated using Equation J-3 (WHC-SD-WM-SARR-011).

$$C\ (mg/m^3) = \left(\frac{\frac{\chi}{Q'}\left(\frac{s}{m^3}\right)}{1 + V'\left(\frac{m^3}{s}\right) \times \frac{\chi}{Q'}\left(\frac{s}{m^3}\right)} \right) \times S\left(\frac{mg}{m^3}\right) \times V'\left(\frac{m^3}{s}\right) \qquad \text{(J-3)}$$

where:

C = Peak concentration.
S = Gaseous toxic material source concentration.
χ/Q' = Continuous release atmospheric dispersion coefficient.
V' = Volume release rate of gaseous source.

For an instantaneous release of gaseous toxic material, the peak concentration is calculated using Equation J-4 (WHC-SD-WM-SARR-011).

$$C\ (mg/m^3) = \left(\frac{\frac{\chi}{Q}\left(\frac{1}{m^3}\right)}{1 + V\ (m^3) \times \frac{\chi}{Q}\left(\frac{1}{m^3}\right)} \right) \times S\left(\frac{mg}{m^3}\right) \times V\ (m^3) \qquad \text{(J-4)}$$

where:

C = Peak concentration.
S = Gaseous toxic material source concentration.
χ/Q = Puff release atmospheric dispersion coefficient.
V = Volume of gaseous source released.

J3.0 PEAK CONCENTRATION CALCULATION METHODS FOR TOTAL PARTICULATES

For a continuous release of particulates, the peak concentration is calculated using Equation J-5 (WHC-SD-WM-SARR-011).

$$C\ (mg/m^3) = \rho\ (g/cm^3) \times 10^6 \times Q'\ (L/s) \times \chi/Q'\ (s/m^3) \qquad \text{(J-5)}$$

where:

C = Peak concentration.
Q' = Toxic material release rate.
χ/Q' = Continuous release atmospheric dispersion coefficient.
ρ = Density of source material.

The constant 10^6 is a unit conversion, and results from multiplying a factor of 1,000 to convert liters to cubic centimeters and by another factor of 1,000 to convert grams to milligrams.

For an instantaneous release of particulates, the peak concentration is calculated using Equation J-6 (WHC-SD-WM-SARR-011).

$$C\ (mg/m^3) = \rho\ (g/cm^3) \times 10^6 \times Q\ (L) \times \chi/Q\ (1/m^3) \qquad \text{(J-6)}$$

where:

C = Peak concentration.
Q = Toxic material released.
χ/Q = Instantaneous release atmospheric dispersion coefficient.
ρ = Density of source material.

The constant 10^6 is a unit conversion, and results from multiplying a factor of 1,000 to convert liters to cubic centimeters and by another factor of 1,000 to convert grams to milligrams.

J4.0 REFERENCE

WHC-SD-WM-SARR-011, 1996, *Toxic Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX K
FLAMMABLE GAS HAZARDS AND CONTROLS IN HANFORD WASTE STORAGE TANKS AND WASTE TRANSFER FACILITIES

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EXECUTIVE SUMMARY

The flammable gas hazards present in the Tank Waste Remediation System (TWRS) facilities have been declared a redefined Unreviewed Safety Question (USQ) as described in Wagoner 1996, *Contract Number DE-AC06-96RL13200; the U.S. Department of Energy (DOE), Richland Operations Office (RL) Definition and Declaration of Flammable Gas Unreviewed Safety Question Issues*. This expands and replaces a previously declared USQ. The redefined flammable gas USQ is based on USQ Determination TF-96-0433 *Consolidation of Flammable Gas/Slurry Growth Unreviewed Safety Question Issues*. The flammable gas USQ was closed for TWRS single-shell tanks (SSTs) and double-shell tanks (DSTs) (Wagoner 1998a and Wagoner 1998b) but remains open for the remainder of TWRS facilities addressed by the USQ. This Appendix (1) clarifies the flammable gas hazards involved with safe storage of waste in TWRS facilities, (2) provides a logic for a control strategy including a basis for control grading, (3) specifies ventilation to address the flammable gas hazards, and (4) specifies the applicability of the requirements to the TWRS facilities covered in the scope of this Appendix. In this manner, this Appendix provides the basis for the flammable gas related controls that are included in the TWRS Technical Safety Requirements (TSRs).

The scope of this Appendix covers engineered structures, containers, or receivers managed and operated by the contractor at TWRS that may store Hanford high-level waste in a condition and for a period of time that may result in generation, accumulation, and/or release of flammable gas. These structures include single-shell tanks (SSTs); double-shell tanks (DSTs); aging waste facilities (AWF); double-contained receiver tanks (DCRTs); TWRS managed

inactive miscellaneous underground storage tanks (IMUSTs); catch tanks, including 204-AR-TK-1, and waste transfer systems. The scope of this Appendix also includes the 244-AR Facility, 242-S and 242-T Evaporators, 244-CR facility, and the pits associated with the 242-A Evaporator feed tank (241-AW-102). The Tank 241-SY-101 flammable gas hazard controls are described in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Actions and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change*.

Since the original identification of the USQ in 1990, the understanding of the hazards associated with flammable gas in tanks has expanded considerably. The understanding has been expanded to include the following hazards:

- Generation of potentially flammable concentrations of hydrogen, ammonia, and methane or other gases
- Steady state release of flammable gas from the waste
- Accumulation of flammable gas in ex-tank intrusive areas such as sealed pits, risers, and connected ventilation spaces
- Accumulation of flammable gas in the headspace
- Retention of flammable gas in the waste, allowing spontaneous and induced releases

- Deflagration in the waste

- Plume burns

- Accumulation of flammable gas in waste-intruding equipment such as drill strings and failed liquid observation wells.

This Appendix identifies the control strategy required to ensure safe storage and operations with the following exceptions:

(1) Rotary mode core sampling (RMCS), has an approved Authorization Basis (WHC-SD-WM-SAD-035, *A Safety Assessment of Rotary Mode Core Sampling in Flammable Gas Single-Shell Tanks: Hanford Site, Richland, Washington*), for RMCS activities (excluding flammable gas hazards);

(2) The safety basis describing the flammable gas controls for safe storage and operations in Tank 241-SY-101 is contained in HNF-3737.

(3) Adding and removing tanks from the Flammable Gas Watch List is not within the scope of this Appendix.

Instead of identifying other normal or anticipated operations that should be included or excluded, this Appendix provides a basis for the controls that must be applied (from a flammable gas perspective only) to perform work in and around the facilities within the scope of this Appendix. The acceptability of performing activities in and around the TWRS facilities must be evaluated for

each activity to ensure that all other Authorization Basis requirements are met. The process to ensure that tank farm activities are performed consistent with the control strategy and requirements specified in this Appendix is documented in Appendix EB.

The flammable gas hazard control strategy is twofold. First, to manage risk associated with steady state accumulation of flammable gas in the headspace, sealed pits, risers, and other ex-tank intrusive areas, adequate passive or active ventilation, where practical, is required to minimize the possibility for gas concentrations to exceed 25% of the Lower Flammability Limit (LFL). The use of 25% of the LFL as the maximum allowed gas concentration resulting from steady-state accumulation provides margin to the concentration where a deflagration is actually possible (100% of the LFL). Second, to manage risk associated with retention of flammable gas within waste, equipment and work controls are required to prevent spark sources in the tanks when and where flammable conditions may exist.

This Appendix also groups tanks that may be subject to large versus small gas release events (GREs). Large GREs may cause the headspace concentration of flammable gas in tanks to exceed 25% of the LFL (global impact). Small releases may elevate the concentration of flammable gas beyond 25% of the LFL in a localized area of the tank only (local impact).

To assign graded control sets, each TWRS-managed tank has been placed into one of three Facility Groups depending on which types of gas release events are associated with the tank. Tanks that have demonstrated a propensity for large spontaneous and induced GREs are in Facility Group 1.

Tanks that may be susceptible to large induced GREs but only small spontaneous GREs are in Facility Group 2. All remaining large underground waste storage tanks are assigned to Facility Group 3, where it is judged that spontaneous releases do not occur, but small induced releases may be possible in some tanks. Facilities where a GRE is judged to not be a concern are included as non-GRE facilities. The hazards and associated control sets for each group are highlighted and summarized in matrices.

The tank grouping is based, in part, on a published methodology that estimated the quantities of releasable gas in each tank (WHC-SD-WM-TI-724, *Methodology for Flammable Gas Evaluations*). Although this methodology cannot provide precise quantitative results, it indicates the presence of retained flammable gas. The technical uncertainties associated with this methodology are discussed in WHC-SD-WM-ER-594, *Evaluation of Recommendation for Addition of Tanks to the Flammable Gas Watch List*. Despite the technical uncertainty, this methodology, coupled with physical observations and sample results, provides a basis for the tank grouping described in this Appendix.

This document concludes that compliance with the described control strategy provides prudent risk management for storage and operations with respect to the flammable gas hazard. Controls identified in this Appendix have been implemented as Technical Safety Requirements (TSRs). (See HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*.)

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APPENDIX K
FLAMMABLE GAS HAZARDS AND CONTROLS IN HANFORD WASTE STORAGE TANKS AND WASTE TRANSFER FACILITIES

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LIST OF TERMS

A	Automatic FIC
AWF	Aging Waste Facility
BPE	barometric pressure evaluation
CAS	Continuous Air Sampler
CGM	combustible gas meter
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
FGEAB	Flammable Gas Equipment Advisory Board
FIC	Food Instrument Corporation (level gauge)
FSAR	Final Safety Analysis Report
GMS	gas monitoring system
GRE	gas release event
HEPA	High-efficiency particulate air (filter)
HLW	High Level Waste
IC	ignition source control
IMUST	inactive miscellaneous underground storage tank
LFL	Lower Flammability Limit
LPF	low pressure weather front
LOW	liquid observation well
M	Manual Tape
MIT	multiple instrument tree
NA	not available
nc	insufficient correlation
ND	not detected
NFPA	National Fire Protection Association
O/S	out of service
PAM	portable alpha monitor
PAS	PUREX acidified sludge
PFP	Plutonium Finishing Plant
PMCS	push mode core sampling
ppm	parts per million
ppmv	parts per million by volume
PRC	Plant Review Committee
PUREX	Plutonium Uranium Extraction (Facility)
PVC	polyvinyl chloride
R	Radar
RL	U.S. Department of Energy, Richland Operations Office
RMCS	rotary mode core sampling
SHMS	Standard Hydrogen Monitoring System
SLR	surface level rise
SST	single-shell tank
T/C	thermocouple
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
USQ	Unreviewed Safety Question
VDTT	velocity-density temperature tree
WG	water gauge

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DEFINITION OF TERMS

Gas Release Events. Gas release events are flammable gas releases that occur at a relatively high rate. The released gas must include gas that has been generated and retained in waste because gas release rates far exceed the gas generation rates. Gas release events are distinctive although in some tanks releases may be a part of a larger series of events (that is, episodic). Gas release events generally have a sudden onset, a sharp increase in gas release rate above steady state rates, and a short duration compared to the ventilation dilution time constants. Gas release events may occur spontaneously, be caused by outside natural phenomena such as seismic events, or be induced by operation or activity-related disturbances of the waste. The release rate can be so high that dilution by mixing with headspace air and dilution with ventilation cannot prevent flammable conditions from occurring, at least for some duration of time, in some portion of the headspace.

Steady State Releases. A steady state release is an ongoing release of generated flammable gases where the rate of release changes negligibly over time. The release rates are relatively slow (compared to gas release events) because the generation rates are relatively low. Steady state releases cause concern only where the released gases are allowed to accumulate to flammable concentrations in tank system headspace. Such an accumulation takes a relatively long time (hours to months) and can be managed by dilution using ventilation. Because radioactive tank wastes generate flammable gases on an ongoing basis, these releases and their potential accumulation are a chronic hazard for all waste-containing vessels.

Waste Intruding Equipment. Waste intruding equipment includes open-ended or breached objects that are inserted below the waste surface and create an unvented vapor space where flammable gases retained in the waste may accumulate.

The vapor space inside equipment inserted below the waste surface and properly sealed (e.g., thermocouple trees or liquid observation wells [LOWs]) is not considered to be waste intruding equipment.

FLAMMABLE GAS HAZARDS AND CONTROLS IN HANFORD WASTE STORAGE TANKS AND WASTE TRANSFER FACILITIES

K1.0 PURPOSE

This Appendix specifies the safety requirements and provides the basis and control strategy for the flammable gas hazards associated with safe storage of radioactive wastes in TWRS facilities. These safety requirements provide a basis to perform operations and activities for facilities where this Appendix applies.

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K2.0 SCOPE

The scope of this Appendix covers allowed conditions, operations, and activities in 176 high-level waste tanks and associated waste transfer systems; double-contained receiver tanks (DCRTs); catch tanks, including 204-AR-TK-1, the 242-T and 242-S Evaporators; the 244-AR Vault; the 244-CR vault; and inactive miscellaneous underground storage tanks (IMUSTs) relative to flammable gas hazards. The Tank 241-SY-101 flammable gas hazard controls are described in HNF-3737. This Appendix specifies:

(1) Flammable Gas Facility Group assignments

(2) Ventilation requirements related to flammable gas hazards

(3) Ignition source control requirements

(4) Flammable gas monitoring requirements

(5) Requirement grading and applicability to the TWRS facilities covered by this Appendix.

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K3.0 DEFINITION OF FLAMMABLE GAS HAZARDS

Nuclear waste stored at the Hanford Site generates flammable gases (primarily hydrogen) in most tanks. Hydrogen is generated by radiolysis of water, thermolytic decomposition of organics, and corrosion. Radiolysis also generates ammonia in nitrate- and nitrite-bearing waste, and thermolytic decomposition generates methane. Gas is released continually (that is, steady state) to the tank headspace or is retained by the waste matrix. The retained gas can be released as a spontaneous or induced gas release event that can significantly increase the flammable gas concentration in the tank headspace. The flammable gas hazard and the control strategy are summarized below.

K3.1 UNREVIEWED SAFETY QUESTIONS

The flammable gas issue was declared a USQ in May 1990 (Lawrence 1990, *Unreviewed Safety Question-Waste Storage Tank*). The original statement (Dougherty 1990, *Activity Plans for DST/SST*) said, "Recent Westinghouse reviews of the tank headspace flammability identified that the gas under the crust is potentially flammable because nitrous oxide and hydrogen can create flammable mixtures. This is considered an Unreviewed Safety Question." The phenomenon of gases being generated and entrapped in waste slurry and beneath the crust was called "slurry growth." The U.S. Department of Energy, Richland Operations Office (RL) sent notification (Lawrence 1990) to U.S. Department of Energy-Headquarters, which stated, "RL has determined that the matter of hydrogen and nitrous oxide evolution within the material in certain waste tanks and subsequent hypothetical ignition is an Unreviewed Safety Question."

The history and status of flammable gas related USQs are described in FSAR Section 3.4.2.2.1, "Background."

K3.2 REFINEMENTS TO THE UNDERSTANDING OF FLAMMABLE GAS HAZARDS

Since 1990, new information has been obtained from tank samples, monitoring data, laboratory experiments, and theoretical modeling and analysis. This information has led to increased understanding of the flammable gas and "slurry growth" phenomena and to refinements in the definition of the flammable gas hazards.

K3.2.1 Flammable Gas Composition

Radioactive waste generates hydrogen through the radiolysis of water, thermolytic decomposition of organic components, and corrosion of a tank's carbon steel walls. Radiolysis and thermolytic decomposition also generate ammonia. Non-flammable gases such as nitrogen, which act as diluents, are also produced. Additional flammable gases, such as methane and an oxidizer, nitrous oxide, are generated by chemical reactions between various degradation products of organic chemicals originally present in the tanks. Volatile or semivolatile organic chemicals in some tanks also produce organic vapors.

K3.2.1.1 Hydrogen. Hydrogen gas has been identified as a major component of flammable gas in tanks. A primary source of hydrogen gas is the thermolysis of organic components which is a function of total organic carbon, the liquid volume of waste, and waste temperature. Radiolytic decomposition of water is another primary source of hydrogen gas, and it is proportional to the radionuclide content or decay heat load of the tank. Corrosion of waste tank walls also produces hydrogen gas, but it is an insignificant portion of the overall generation rate.

Although hydrogen is a major component of gas samples, and hydrogen generation mechanisms are known, uncertainties still exist in the parameters of the equation used to estimate generation rates. Conservative calculations have been performed to estimate tank vapor space flammable gas concentrations based upon calculated tank gas generation rates or release of a significant fraction of the estimated retained gas in the tank. The resulting equilibrium hydrogen concentrations range from very low (less than 0.1% of the lower flammability limit [LFL]) to values above 25% of the LFL. The measured hydrogen concentrations in tanks sampled to date, including all single-shell tanks (SSTs) that have been calculated to exceed 25% of the LFL, have been lower than the calculated values and well below 25% of the LFL.

K3.2.1.2 Ammonia. In October 1993, an Occurrence Report (RL-WHC-TANKFARM-1993-0090, *Waste Tank 241-SY-101 Safety Analysis Calculation Error for Ammonia Release Mechanism Results in an Unreviewed Safety Question*) was issued because of the measurement of ammonia gas in the headspace of Tank 241-SY-101 during release event "I" and because of increased ammonia background level in the tank following mixer pump operation. The presence of ammonia gas was judged to increase the fuel content of the gases released, however, it did not reduce the ignition energy. This Appendix includes the available data, hazard conditions, and controls to address ammonia as an additional flammability hazard.

K3.2.1.3 Methane. In December 1993, an Occurrence Report (RL-WHC-TANKFARM-1993-0105, *Methane Gas in SY-101 Discovered to Add 10% Energy to the Burn Analysis Results Included in the Current Safety Assessment*) was issued because of the measurement of methane gas (1,000 parts per million [ppm]) in the headspace of Tank 241-SY-101 during Window I activities that occurred in June 1993. The presence of methane was judged to increase the fuel content of released gases; however, it did not reduce the ignition energy. This Appendix includes the available data, hazard conditions, and controls to address methane as an additional flammability hazard.

K3.2.1.4 Other Gases. Other flammable gases and oxidizers have been identified in waste tanks. Nonmethane organic compounds from past chemical processing operations have been found at very low concentrations (less than 0.1% of the LFL) in the headspaces of most tanks. By using a conservative concentration for methane in the LFL calculations, the contribution of nonmethane organic is assumed to have negligible impact; therefore, no additional hazards or controls for organic vapors are identified in this Appendix.

Nitrous oxide is not a flammable gas, but is an oxidizer. Its presence in trapped waste gases can cause the trapped gas mixture to be flammable without needing to mix with air. When gases are released from the waste and

diluted with the air in the tank vapor space, the effect of nitrous oxide on the LFL is significantly reduced.

Nitrogen is also a significant component of waste gas. It is not a flammable gas or oxidizer. Its presence will dilute flammable gases in the waste gas mixture, but is not accounted for in calculations of waste gas LFL. This is discussed further in Appendix KA.

K3.2.1.5 Hydrogen Concentration in Slurry Gas at 25% of the LFL. Slurry gas is composed of a number of fuel gases and an oxidizer, nitrous oxide. A major component is hydrogen, and hydrogen concentration is often the only gas measurement available for tank conditions. These measurements are obtained with a Standard Hydrogen Monitoring System (SHMS). Some evaluation and assumptions are needed to establish the correlation between the measured hydrogen concentration and the percent of the LFL for the mixture in the tank where the measurement was taken. In addition to variations in slurry gas composition, many measurements are taken in the tank headspace where the slurry gas has been mixed with headspace air, and oxygen is the predominant oxidizer. An evaluation to establish the hydrogen concentration measurement that represents 25% of the LFL for monitoring SHMS alarm set points and work control action limits is described in WHC-SD-WM-ES-346, *Flammable Gas Tank Safety Program: Technical Basis for Gas Sampling and Monitoring*. This evaluation concludes that a hydrogen measurement of 6,250 parts per million by volume (ppmv) is a conservative value to use for this purpose. Appendix KA evaluates additional data and assumptions to determine a reasonable hydrogen concentration that represents 25% of the LFL when evaluating sample data to better understand the actual condition relative to the LFL. This evaluation concludes that 7,500 ppmv is a reasonable yet conservative value to use for this purpose. However, this Appendix continues to use 6,250 ppmv to define the conservative SHMS hydrogen monitoring limit that represents 25% of the LFL when SHMS is used for work activity flammable gas monitoring.

K3.2.2 Vapor Space Accumulation of Flammable Gas Because of Steady State Releases

Flammable gases are generated by all radioactive wastes, and although a fraction of the gas may be retained in tanks containing waste solids, a portion of the generated gas is continuously released at a very low rate. These steady state releases are different from the acute, episodic releases of retained gas. Steady state releases are managed by diluting and removing the gases from the tank headspace through active or passive ventilation to prevent a steady accumulation of gas reaching flammable concentrations. Concentrations have been maintained very low with the existing ventilation configurations. In addition, maintaining low concentrations in headspaces reduces the severity of gas release events by providing relatively clean air in which to dilute the released gases.

For tanks having small waste volumes, low-decay heat loads, small concentrations of organic chemicals, and relatively large headspaces, steady state gas releases can be maintained at low concentrations with passive ventilation. Passive ventilation consists of atmospheric breathing combined with (1) a convective flow through tank openings and tank-to-tank connections caused by the buoyancy effects from gas temperature differences,

(2) a bernoulli flow caused by wind blowing past the tank exhausts, or
(3) instrument purge flows.

A number of SX and C Farm SSTs and all double-shell tanks (DSTs) are actively ventilated with exhausters and breather filters. Although the ventilation for each tank is established by procedure, and the flow rate can be estimated by design parameters or measured with portable instruments, actual tank ventilation flow rates are not monitored because of the lack of installed instrumentation.

Although the calculation of the theoretical steady-state gas concentration is simple and straightforward, the actual concentration is difficult to estimate precisely (Given a steady state gas generation rate (G) and a ventilation rate (V), the steady state gas concentration is defined as G/V.). However, because of uncertainties in calculating the hydrogen generation rates and the lack of accurate ventilation data, it is not possible to accurately calculate the steady state flammable gas concentrations (WHC-SD-WM-ER-594).

The ventilation effects may be reduced in the high points of sealed risers and sealed pits thereby enabling flammable gas to accumulate in concentrations that are higher than in the unobstructed headspace. Buoyancy effects may cause flammable gases to migrate upwards into risers or pits that are isolated from tank ventilation.

Formal vapor samples have been taken from approximately 55% of the SSTs as of January 1, 1997. An additional 31% of the SSTs have combustible gas meter (CGM) readings taken specifically for the TWRS Characterization Program (Appendix KA). The DSTs have been sampled during work activities, but the measurements have not been recorded in the gas sample results database. The actual steady state gas concentrations measured to date are consistently below 25% of the LFL. These measurements have demonstrated that measured values are significantly lower than calculated values for passively ventilated tanks (WHC-SD-WM-ER-526, *Evaluation of Hanford Tanks for Trapped Gas*). The results of the vapor space sampling are published annually in HNF-SD-WM-TI-797, *Results of Vapor Space Monitoring of Flammable Gas Watch List Tanks*.

For the purposes of this Appendix, it is concluded that the current ventilation configurations in SSTs, DSTs, and AWF tanks adequately address steady state accumulation of flammable gases. Therefore, ventilation requirements have been upgraded to reflect their importance in managing flammable gases more clearly.

K3.2.3 Gas Accumulation Within the Waste

Some generated gas is retained in the waste. Because retained gases can include fuel (for example, hydrogen, ammonia, methane) and an oxidizer (for example, nitrous oxide), the gases can be in flammable concentrations. Retained gas presents a flammability hazard in the following ways.

- It is theorized that the retained gas could burn below the waste surface if ignited; and the amount of gas, bubble type, size, and distribution could enable flame propagation.

- Gases can be released from the waste and burn in tank domes, connected vapor spaces such as pits, ventilation systems, and outside of tank openings such as ventilation inlet paths or open risers if still above 100% of the LFL.

- The retained gases can be released and ignited inside equipment inserted into the waste, such as core sample drill strings.

K3.2.3.1 Deflagrations Below the Waste Surface. Lawrence (1990) acknowledged that a flammable mixture of gases may exist in the waste thereby creating the possibility of a combustion event below the waste surface. The likelihood and consequences of such an event are not analyzed in the Tank Farm Authorization Basis (except for Tank 241-SY-101). The hazard of igniting flammable gases that may be retained below the waste surface is one of the flammable gas hazards and the controls in this Appendix address this hazard.

K3.2.3.2 Gas Accumulation in Equipment That Penetrates the Waste. On September 28, 1995, an Occurrence Report (RL-WHC-TANKFARM-95-0078, *Vapor Sampling of Core Sampling Drill String Exceed Lower Explosive Limit*) was issued because flammable gas inside the drill string used for push mode core sampling (PMCS) Tank 241-S-107 was in excess of the LFL. Another incident occurred one month later in Tank 241-BY-110. In both incidents, the cause was attributed to encountering gas pockets in the waste which in turn caused flammable gases to enter and accumulate in the drill string in concentrations that were in excess of the LFL. Flammable gas is known to have accumulated in drill strings in several other tanks. Accumulation of flammable gases in waste intruding equipment is considered another of the flammable gas hazards. The controls in this Appendix address this hazard.

Tank 241-BY-110 was not listed as a flammable gas USQ tank at the time of the occurrence. The USQ evaluation for these incidents concluded that although a tank may not contain sufficient trapped gas to warrant flammable gas controls because the potential is low for high headspace flammable gas concentrations, it still could be a concern for waste intruding equipment. There may be gas pockets encountered under the waste surface which have a high concentration of flammable gas. A somewhat similar situation occurred in the LOW in Tank 241-SX-104. The LOW accumulated flammable gases that were in excess of the LFL (102% of the LFL as read with a CGM). This event is described in an Occurrence Report (RL-WHC-TANKFARM-1994-0073, *High Flammable Gas and Ammonia Levels Discovered in SX-104 Liquid Observation Well (LOW) During Riser Liner Installation Activities*). The high gas concentrations were attributed to a breach in the LOW below the waste interstitial liquid level. This enabled gases to enter and accumulate in the LOW which is sealed at the top, thus preventing ventilation flow. The headspace in Tank 241-SX-104 was sampled. It was 0% of the LFL and had no indicated ammonia.

This Appendix specifies controls to be used with waste intruding equipment in all waste tanks where gas accumulation is a concern. These controls are judged to be adequate to manage risk from potential flammable gas accumulation in waste intruding equipment.

K3.2.3.3 Gas Release Events. Many wastes have the ability to retain a substantial fraction of generated gases in the waste matrix. Periodically, the waste may spontaneously release large volumes of the trapped gas which can

raise the gas concentrations in the headspace to flammable levels in a very short time. Many activities also may trigger an induced release of retained gas. These spontaneous or induced gas release events (GREs) contrast sharply with the continuous steady state releases described earlier.

For the purpose of applying controls, each DST, SST, DCRT, AWF tank, IMUST, and catch tank has been placed in one of four Facility Groups depending on whether the waste is postulated to present a hazard from large or small GREs and whether the GREs may be spontaneous or occur only during waste disturbing (induced) operations or no GREs are postulated. Ignition source controls and monitoring requirements are applied at times when and in locations where flammable conditions resulting from GREs can be present, as appropriate to this grouping scheme. Five tanks within the scope of this Appendix (excluding Tank 241-SY-101) that have had significant GREs are conservatively postulated to have the potential for large spontaneous and large induced GREs. These tanks have been assigned to Facility Group 1. If a tank is postulated to have the potential for a large induced GRE but only a small spontaneous GRE, it is assigned to Facility Group 2. The remaining SSTs, which show no propensity for spontaneous GREs but may produce a small induced GRE, are assigned to Facility Group 3. Facilities with little or no waste solids capable of retaining gases are categorized as non-GRE. All Facility Groups assume that the subject tanks undergo steady state gas generation at all times.

The grouping of facilities reflects a conservative approach even in light of uncertainties in the underlying methodology. It also enables a graded application of controls based on perceived hazards and frees less hazardous tanks from unnecessarily restrictive or burdensome controls. This method also enables a degree of simplicity in applying control sets to specific tanks.

Measured Gas Releases. Information about spontaneous GREs has been gathered by the SHMSs that continuously sample tank headspace hydrogen concentrations. The systems are installed on six DSTs and 22 SSTs. Tables K3-1, K-2, and K3-3 summarize data from the DSTs, 18 of the 22 SSTs, and headspace concentration predictions from the GRE evaluation (WHC-SD-WM-ER-526).

Table K3-1. Summary of Gas Release Measurements for SHMS Instrumented Double-Shell Tanks. (1 sheet)

Tank	Maximum measured H_2 concentration	When maximum was measured[1]	Observed release periodicity	Predicted concentration following acute release[2]
241-AN-103	3,000 ppm (10% LFL[3])	08/22/95	Once since 10/94	334% LFL (SLR[4]) 301% LFL (BPE[5])
241-AN-104	5,000 ppm (17% LFL)	10/08/95	Every 3-5 months	505% LFL (SLR) 246% LFL (BPE)
241-AN-105	17,000 ppm (57% LFL)	08/21/95	Sporadic. 15 months between last two events	743% LFL (SLR) 411% LFL (BPE)
241-AW-101	8,800 ppm (29% LFL)	10/94	About every 2 months	231% LFL (SLR) 233% LFL (BPE)
241-SY-101	53,000 ppm (177% LFL) 51,200 ppm (174% LFL)	12/04/91 09/03/92	Every 3-4 months (none since mixer pump installation)	825% LFL (SLR) 572% LFL (BPE)
241-SY-103	2,900 ppm (10% LFL)	05/95	About every 2 months	79% LFL (SLR) 57% LFL (BPE)

Notes:

[1]Dates are provided in the mm/dd/yy format.

[2]WHC-SD-WM-ER-526, 1997, Evaluation of Hanford Tanks for Trapped Gas, Rev. 1B, Westinghouse Hanford Company, Richland, Washington.

[3]LFL - Value shown is based on the use of 30,000 ppm of H_2 being measured when the tank headspace reaches the LFL.

[4]SLR - Tank headspace concentration (as a percent of LFL) predicted using the surface level rise (SLR) methodology.

[5]BPE - Tank headspace concentration (as percent of LFL) using the barometric pressure evaluation (BPE) methodology.

Table K3-2. A Comparison of Gas Release Events for SY-101. (1 sheet)

Event date[1]	08/27/91	12/04/91	04/20/92	09/03/92	02/02/93	06/26/93
Event start time	0933	1116	2002	1661	0124	1904
Days since event	102	99	138	136	152	144
Surface level drop. (in.[2])	5.5A	13.0M	7.2R	13.2R	8.5 (FIC)	9.75M
Estimated slurry-gas (ft^3)[3]	4043[3]	2565[3]	4600[4]	10480[7]	6500[7]	7000[3]
Estimated H_2 volume (ft^3)[4]	N/A	2883[4], 1078[5]	1530[4]	3773	2340	3200
Maximum tank pressure (in w.g.)	-2.82	+6.84	-2.0	+5.37	-0.079	-0.93
Maximum exhaust flow (cfm)	550	1300	675	2125	1170	1512
Maximum H_2 concentration in exhaust (vol%)						
Whittaker	N/A	N/A	N/A	N/A	2.25	2.77
Teledyne	0.51	2.69	1.34	0.82	N/A	N/A
Chromatograph	N/A	N/A	N/A	ND	0.21	3.4
Grab mass spectroscopy	N/A	2.17	1.18	N/A	N/A	N/A
Maximum H_2 concentration in riser 17B (vol%)						
Whittaker	0.38	5.30	1.36	5.12	2.74	2.73
Cont. mass spectroscopy	0.28	O/S[6]	1.48	3.51	2.06	3.12
Grab mass spectroscopy	N/A	N/A	O/S	N/A	N/A	N/A
Maximum N_2O concentration exhaust (vol%)						
Chromatograph	N/A	N/A	1.05	ND	N/A	N/A
Grab mass spectroscopy	N/A	1.87	1.09	N/A	N/A	N/A
Fourier transform infrared spectrometer	N/A	N/A	N/A	N/A	O/S	3.25
Maximum NH_3 concentration (ppm)						
OVM	N/A	438	1507	1060	N/A	N/A
Fourier transform infrared spectrometer	N/A	N/A	N/A	N/A	N/A	13,000

Notes:
[1] Dates are in the mm/dd/yy format.
[2] A = Automatic FIC, M = Manual Tape, R = Radar.
[3] Using 736 ft^3/in. assuming the gas is under a pressure of 2 atmospheres.
[4] Using integrated Whittaker H_2 concentration and average exhaust flow.
[5] Using integrated Teledyne H_2 concentration and integrated exhaust flow.
[6] ND = not detected, N/A = not available, O/S = out of service.
[7] Using the method outlined in Reynolds, D.A., 1993, Gas Release from Window G and Protocol for Calculating Gas Release (Internal Memo 7K210-93-502 to G. D. Johnson, January 4), Westinghouse Hanford Company, Richland, Washington.

Table K3-3. Summary of Gas Release Measurements for SHMS Instrumented Single-Shell Tanks. (2 sheets)

Tank	Maximum observed H_2 concentration change	Date maximum observed release occurred[1]	Periodicity	Predicted concentration following acute release[2]
241-BY-103	No release evident	--	--	0% LFL (SLR[3]) 26% LFL (BPE[4])
241-BY-106	1060 ppm (grab sample)	09/22/95	None evident	123% LFL (SLR) nc[5] (BPE)
241-BY-109	790 ppm	02/07/96 (LPF[6])	None evident	0% LFL (SLR) 27% LFL (BPE)
241-S-102	1000 ppm	03/96	None evident	190% LFL (SLR) 226% LFL (BPE)
241-S-111	1750 ppm	12/11/95 (LPF)	None evident	80% LFL (SLR) 181% LFL (BPE)
241-S-112	No release evident	--	--	30% LFL (SLR) nc (BPE)
241-SX-101	No release evident	--	--	0% LFL (SLR) 28% LFL (BPE)
241-SX-102	No release evident	--	--	30% LFL (SLR) 93% LFL (BPE)
241-SX-103	700 ppm	12/11/95 (LPF)	None evident	2% LFL (SLR) 216% LFL (BPE)
241-SX-104	200 ppm	12/11/95 (LPF)	None evident	6% LFL (SLR) 11% LFL (BPE)
241-SX-105	400 ppm	12/11/95 (LPF)	None evident	87% LFL (SLR) nc (BPE)

Table K3-3. Summary of Gas Release Measurements for SHMS Instrumented Single-Shell Tanks. (2 sheets)

Tank	Maximum observed H_2 concentration change	Date maximum observed release occurred[1]	Periodicity	Predicted concentration following acute release[2]
241-SX-106	600 ppm	12/11/96 (LPF)	Small releases during LPFs	67% LFL (SLR) 78% LFL (BPE)
241-SX-109	200 ppm	12/11/95 (LPF)	None evident	0% LFL (SLR) nc (BPE)
241-U-103	1200 ppm	12/11/95 (LPF)	Small releases during LPFs	77% LFL (SLR) 161% LFL (BPE)
241-U-105	1000 ppm	02/07/96 (LPF)	Small releases during LPFs	270% LFL (SLR) 129% LFL (BPE)
241-U-107	600 ppm	12/11/95 (LPF)	Small releases during LPFs	42% LFL (SLR) 87% LFL (BPE)
241-U-108	1800 ppm	02/20/96 (LPF)	Small releases during LPFs	301% LFL (SLR) 179% LFL (BPE)
241-U-109	700 ppm	12/11/95 (LPF)	Small releases during LPFs	81% LFL (SLR) 118% LFL (BPE)

Notes:
[1]Dates are in the mm/dd/yy format.
[2]WHC-SD-WM-ER-526, 1997, Evaluation of Hanford Tanks for Trapped Gas, Rev. 1B, Westinghouse Hanford Company, Richland, Washington.
[3]SLR - Tank headspace concentration (as a percent of LFL) predicted using the surface level rise (SLR) methodology WHC-SD-WM-ER-526.
[4]BPE - Tank headspace concentration (as percent of LFL) using the BPE methodology WHC-SD-WM-ER-526.
[5]nc - There was insufficient correlation between barometric pressure changes and waste level changes to use the methodology.
[6]LPF - Low pressure weather front.

DSTs. Data are documented for six of the 28 DSTs with SHMS. Tables K3-1 and K-2 show Tank 241-SY-101 has had headspace concentrations that exceeded the LFL. Tanks 241-AN-105 and 241-AW-101 have had hydrogen concentration measurements that exceeded 25% of the LFL for slurry gas in air. The hydrogen concentrations for all other instrumented tanks are less than 25% of the LFL. The measured concentrations are significantly less than the concentrations predicted by the GRE evaluation (WHC-SD-WM-ER-526). The data for Table K3-1 are from Wilkins (*Tank 241-AN-103 Data Review Update; Tank 241-AW-101 Data Review Update; Tank 241-AN-104 Data Review Update; Tank 241-AN-105 Data Review Update*). The data for Table K3-2 are from Wilkins (1995), *Recent Gas Release Events in 241-SY-103*. SHMS data is obtained on an ongoing basis and evaluated. The results are reported in HNF-SD-WM-TI-797 on an annual basis.

SSTs. Studies into the growth of bubbles in settled solids have demonstrated that the presence of a supernatant liquid layer enables large, buoyancy-induced rollovers that trigger large, spontaneous GREs (PNL-10120, *Mechanisms of Gas Bubble Retention*; PNL-10740, *Gas Bubble Retention and Its Effect on Waste Properties: Retention Mechanisms, Viscosity, and Tensile and Shear Strengths*; PNL-10893; *The Effect of Dilution on the Gas Retention Behavior of Tank 241-SY-103*). Because SSTs usually do not contain a supernatant layer (or at most a very small one), large buoyancy-induced rollovers are not possible.

The available SHMS data for SSTs, which are summarized in WHC-SD-WM-ER-576, *Compilation of Hydrogen Data for 22 Single Shell Flammable Gas Watch List Tanks*, is consistent with this hypothesis. The data indicate small gas releases that appear to coincide with low-pressure barometric fronts, but no other phenomena. In addition to SHMS data, vapor grab sample data was obtained during the calibration and baselining effort of SHMS start up. Table K3-3 summarizes the release events for tanks where SHMS data is available. As indicated in Table K3-3, however, the highest measured concentrations are well below 25% of the LFL, even when instrument errors and calibration drift are accounted for in the SHMS Whittaker cells.

K3.2.3.4 Spontaneous Gas Release Events. Five DSTs within the scope of this Appendix (Tanks 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103) have been observed releasing large gas quantities at times when no operations or activities disturbed the waste. In addition, Tank 241-SY-101 exhibited spontaneous GREs before the operation of the mixer pump in this tank. Because Tank 241-SY-101 has a unique flammable gas safety basis (see HNF-3737), it is not within the scope of this Appendix. The large "spontaneous" gas releases in these tanks are believed to be caused by instabilities that result from density differences between the gas retaining waste and the overlying supernatant liquid. As waste entrains more gases, it becomes more buoyant. When the density differences are large enough to overcome the forces that keep the gas retaining wastes in place, a waste rollover occurs and gas is released.

All DSTs with significant sludge to retain gas are considered to have the potential for spontaneous releases. They all have significant amounts of supernatant liquid and may be able to create instabilities that result from density differences between the gas-retaining waste and the supernatant liquid.

However, DSTs (other than the above-mentioned five and excluding Tank 241-SY-101) have not shown evidence of large spontaneous GREs based on historical monitoring of waste surface level rises and falls, tank vacuum levels, and waste temperature profiles. These DSTs are postulated to be prone to small spontaneous GREs.

As previously noted, SSTs are not likely to exhibit a large, spontaneous GRE, but some have exhibited small spontaneous releases. Other postulated release mechanisms for large releases have been reviewed by a team assembled by RL to evaluate the technical basis used by the Westinghouse Hanford Company in analyzing the hazards associated with flammable gas storage and release. The findings are documented in WHC-SD-WM-ER-594. The general view of the team is that the only mechanism likely to produce a rapid spontaneous release of a large fraction of a tank's retained gas is the buoyancy-induced rollover. Based on the physical conditions and phenomena affecting rollovers, it was considered improbable for such a release to occur in SSTs. Based on this understanding, this Appendix does not postulate large spontaneous GREs as a significant hazard in SSTs. However, certain SSTs have exhibited small spontaneous GREs.

K3.2.3.5 Induced Releases (Waste Disturbing Operations and Activities). Retained gas may be released during many waste disturbing operations or activities. It is hypothesized that these operations or activities may release gas directly from the waste in the local volume where waste is disturbed or indirectly by triggering a release from a larger volume, such as by triggering a rollover.

K3.2.3.6 Experience During Waste-Disturbing Activities. Forty-nine waste sampling activities and 38 LOW installation activities were evaluated to determine whether these activities caused a gas release (Schofield 1996a, *Evidence of Release Events During Waste Intrusive Activities in Flammable Gas Watch List (FGWL) and Proposed FGWL Tanks*). Based on the temperature data from 87 activities, the evaluations concluded that no gas releases were evident; however, waste level data could not rule out the possibility of two gas releases in the mid-1980s. Surface level data showed the waste level reading dropped several inches about the same time that one LOW installation and one sampling event occurred during the 87 activities. It is not possible to reconstruct whether the level reading drop was caused by an FIC or manual tape adjustment or a plummet flush or how close to the waste intrusion event the level reading change occurred, although one level reading change may have occurred a day or two before the intrusion.

Of 27 recent waste core sampling events where gas monitoring was available, small gas releases were indicated by CGM readings from the tank headspace during three events. The gas release volume was estimated for two of the events. Based upon CGM readings and conservatively assuming the entire tank headspace was at the indicated CGM value, less than 0.68 m^3 (24 ft^3) of hydrogen was released during the sampling event in Tank 241-S-102, and less than 1.33 m^3 (47 ft^3) of hydrogen was released in the Tank 241-U-109 sampling event (Schofield 1996b, *Volume of Gas Released for a Given Rise % Rise in the LFL in S-102 and U-109*). Readings from SHMS cabinets on the same tanks showed negligible hydrogen increases at the same time the CGMs showed the increases.

This provides evidence that the gas releases were small and did not fill the tank headspace to the CGM concentration. Therefore, the volume of hydrogen released in each event was likely to be less than the 0.71 to 1.42 m^3 (25 to 50 ft^3) range.

Although the fraction of retained gas released for each operation or activity has not been quantified, it is postulated for this Appendix that waste disturbing operations can be graded into local and global waste disturbing operations. Local waste disturbing operations can cause a small GRE in any tank, and a global waste disturbing operation can cause a large GRE in tanks that may retain a large amount of gas.

K3.2.3.7 Large Versus Small Gas Release Events. Actively ventilated tanks, which are DSTs, AWFs, and some SSTs, normally operate with the headspace at a slight vacuum. However, large gas releases can pressurize the headspace above atmospheric pressure. For this reason, the flow of headspace gases into pits, out open risers to the atmosphere, and through the ventilation system to other connected tanks must be postulated.

Tank 241-SY-101 experienced several gas release events prior to mitigation pump operation that were large enough to create flammable conditions in a large portion of the headspace and to pressurize the headspace. Table K3-2 summarizes two events where the pressure increased from -498 Pa (gauge) [-2 in. WG] to approximately 1,449 Pa (gauge) [+6 in. WG]. Gas concentrations were measured in the ventilation system about 4.9 m (15 ft) from Tank 241-SY-101 upstream of connections to other tanks. During GREs, the concentrations in the ventilation system are lower than in the headspace as demonstrated by the December 4, 1991, event. This GRE resulted in concentrations in the headspace of 53,000 ppm while vent duct concentrations remained below the LFL (maximum measured concentration was 26,000 ppm). The event also caused pressurization in the headspace that increased the ventilation flow rate from 0.23 m^3/s (500 cfm) to 1 m^3/s (2,125 cfm).

The headspace of passively ventilated tanks is normally at atmospheric pressure; therefore, large gas release events could cause a positive pressure and outflow of gases into pits, breather filters, and open risers. Large releases that can cause a significant portion of the headspace to exceed the LFL are postulated to cause flammable conditions outside the headspace in passively ventilated tanks.

Tanks estimated to retain relatively small amounts of gas are judged less likely to present a risk of creating flammable conditions outside the tank. Small releases would probably be mixed and diluted by headspace air before exiting. For this Appendix, tanks with estimated retained gas amounts too small to cause the headspace concentration to exceed 25% of the LFL (if 25% of the gas is released per WHC-SD-WM-ER-526) are considered too unlikely to create flammable conditions in vapor spaces located outside the headspace to warrant ignition source controls in these areas.

Small GREs pose some risk of creating localized flammable regions within the headspace (for example, plumes) until mixing occurs with headspace air. However, they are unlikely to cause flammable conditions outside the tank headspace.

K3.2.3.8 Estimated Gas Release Potential. WHC-SD-WM-ER-526 has documented 177 tanks that have been evaluated for gas retention and release potential. The first step was to estimate the quantity of retained flammable gases in the tank waste using the quick screen. If the quick screen method predicted headspace concentrations of less than 25% of the LFL, no further evaluation was done. If it predicted headspace concentrations of greater than 25% of the LFL, one of two additional methods was used to estimate retained and releasable gas: using waste surface rise to calculate that amount of retained gas or using the waste level variation with corresponding barometric pressure changes to indicate retained gas. This screening process identified tanks where the released gas was calculated to cause hydrogen concentrations to exceed 25% of the LFL in a well mixed tank headspace. Tables K3-1 and K3-3 show that the predicted concentrations following a gas release event WHC-SD-WM-ER-526 are much higher than the measured concentrations for GREs monitored to date.

K3.3 FACILITY GROUP (FG) ASSIGNMENT

The TWRS-managed facilities affected by this Appendix have been divided into four Facility Groups to enable control grading and minimize operational complexity. Control grading recognizes that flammable gas hazards vary widely and that technical uncertainties prohibit precise determinations about the hazard potentials of each facility. Facility Group assignments for ancillary facilities are described in Section K5.0 of this appendix.

K3.3.1 Facility Group 1

Facility Group 1 is made up of the facilities of greatest concern with respect to the flammable gas hazard. Specifically, the five tanks (241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103) within the scope of this Appendix that have undergone observed, significant GREs are conservatively postulated to have the potential for large spontaneous and induced GREs. The level of rigor for these tanks is the maximum possible to manage the risk while continuing to perform essential waste storage functions and meet planned TWRS mission objectives.

K3.3.2 Facility Group 2

Facility Group 2 is made up of tanks that are postulated to have the potential for a large induced GRE but only a small spontaneous GRE. For the purposes of this Appendix, SSTs that fail the GRE evaluation are considered to have the potential for large induced releases. SSTs that fail the GRE evaluation are those that are estimated to retain sufficient gas amounts to cause the headspace concentration to exceed 25% of the LFL if 25% of the gas is released. However, SSTs are not postulated to undergo large spontaneous releases.

Facility Group 2 reflects the uncertainty in fully understanding tank flammable gas hazards and characterizing tank specific contents and behaviors. It contains all DSTs and AWFs that are not in Facility Group 1 and all SSTs that are documented to "fail" the GRE evaluation.

The DSTs and AWFs are within their design life and are integral to the safe waste storage and disposal mission. They will receive new waste from other Hanford Site facilities and will undergo liquid reductions, waste consolidation, multiple transfers, and mixing. Procedures are in place to minimize the likelihood that these operations would create conditions resulting in large spontaneous gas release behavior. However, it is recognized that some operations may result in increased gas generation and retention. Therefore, it is appropriate to categorize these facilities in Facility Group 2 or higher. In the unlikely event that significant GRE behavior develops in these facilities, they will be moved to Facility Group 1.

Several ancillary facilities have been assigned to Facility Group 2 because they contain significant sludge and significant supernate, which are postulated to present the potential for gas retention and release, either spontaneously or as a result of waste disturbing operations.

K3.3.3 Facility Group 3

Facility Group 3 includes all remaining SSTs. The controls for Facility Group 3 reflect the widely accepted judgment that many SSTs, particularly those that have been stabilized, pose a significantly lower risk from flammable gas hazards than those in Facility Group 1 or Facility Group 2.

Two tanks (241-SX-104 and 241-AX-103) currently on the Flammable Gas Watch List are placed into Facility Group 3. The inclusion of these SSTs into Facility Group 3 is based on the results of the GRE evaluation (WHC-SD-WM-ER-526). The Watch List status for tanks is based on different evaluation methodologies that were used in the past.

K3.3.4 Facility Group non-GRE

Facility Group non-GRE consists of the facilities for which no GRE hazard is postulated. Flammable gas hazards are limited to steady state generation, release, and accumulation caused by low ventilation conditions. Waste containing facilities with little or no waste solids are in this group because gas retention and potential release are not postulated unless waste solids are present to retain the gas. Because these facilities contain little or no waste solids and gas accumulation is not postulated, waste intrusive and waste intruding locations and associated ignition source controls are not applicable. Facilities placed in the group include: catch tanks; DCRTs; 244-AR TKs 001, 003, and 004; 242-T TK-B1 and the evaporator vessel; and IMUSTs 231-W-151-001, 231-W-151-002, 241-S-302B, 241-TY-302B. No SSTs, DSTs, or AWF tanks are included in this group.

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K4.0 TANK CONTROL STRATEGY

To effectively manage the risk associated with steady state accumulation, this Appendix requires passive or active ventilation for tanks to ensure that steady state flammable gas concentrations are well below the LFL. For certain facilities where adequate ventilation has not been verified by a means such as gas sampling, installed equipment is required to meet ignition source controls or be deenergized. To manage the risks associated with retained gases and GREs, specific ignition source controls and continuing monitoring requirements are applied on a graded basis to Facility Groups 1, 2, and 3 tanks depending on the work performed.

Table K4-1 summarizes the application of the control strategies to address each flammable gas hazard discussed in Section K3.2.2, "Vapor Space Accumulation of Flammable Gas Because of Steady State Releases" and K3.2.3, "Gas Accumulations within the Waste" of this appendix. Each strategy is discussed in the following section.

K4.1 TANK REGIONS

This Appendix stipulates specific equipment and work controls for any TWRS-managed tank, container, or receiver that could present a waste-related flammable gas hazard and lead to a fire or explosion. These controls shall apply to all Facility Group tanks unless the equipment or work meets the definition of nonintrusive, as follows. For unique situations that are not clearly addressed by the following definitions and configurations, the applicable controls will be addressed by the TWRS Plant Review Committee (PRC) or their designee.

K4.1.1 Nonintrusive

Nonintrusive includes all equipment located in parts of the tank or ventilation system isolated from the tank head space by a seal barrier (i.e., compressive mechanical barriers, adhesive barrier, ventilation system seal loops, drain line seal loops, welded enclosures). The opening diameter is defined as the diameter of the smallest opening into the waste intruding equipment vapor space. For an actively ventilated system (when the ventilation system is operating), the inside of the ventilation system duct downstream of the first mixing point with flow from another tank is a nonintrusive region.

Table K4-1. Summary of Flammable Gas Controls Strategy.

Flammable Gas Hazard	Control Strategy
Steady state accumulation in headspaces	1. Dilution by ventilation and 2. Gas monitoring (characterization sampling and work activity entry gas monitoring) 3. If adequate ventilation cannot be verified, apply ignition source controls (Set 2) or deenergize
Accumulation in sealed risers and sealed pits	1. Ignition source controls (Set 2) at all times and 2. Work activity entry gas monitoring
Ignition of flammable gas retained within the waste	1. Ignition source controls (Set 1) at all times
Large spontaneous GREs	1. Ignition source controls (Set 2) in ex-tank and dome intrusive locations at all times 2. Continuous gas monitoring during manned work activity
Small spontaneous GREs	1. Ignition source controls (Set 2) for dome-intrusive locations at all times and 2. Continuous gas monitoring during manned work activity
Large induced GREs	1. Ignition source controls (Set 2) in ex-tank and dome intrusive locations during waste disturbing operations and activities and 2. Continuous gas monitoring during manned waste disturbing activities
Small induced GREs	1. Ignition source controls (Set 2) for dome intrusive locations during waste disturbing operations and activities and 2. Continuous gas monitoring during manned waste disturbing activities
Accumulation in waste intruding equipment	1. Purge or flush before energizing equipment and during use of equipment or 2. Ignition source controls (Set 1) at all times

There are no flammable gas controls for nonintrusive equipment or work, conversely, equipment and work meeting the definition of intrusive (ex-tank intrusive, dome intrusive, or waste intrusive) shall be subject to the control strategy specified in this Appendix. These intrusive tank regions are defined in Sections K4.1.2, "Ex-Tank Intrusive" through K4.1.4, "Waste Intrusive" and shown in Figures K4-1, K4-2, and K4-3 for passively ventilated tanks, actively ventilated tanks, and actively ventilated tanks where the ventilation system is not operating, respectively. The control strategy is based, in part, on the region in which equipment and activities are located.

K4.1.2 Ex-Tank Intrusive

Ex-tank intrusive includes the following:

- All vapor spaces that have a direct connection to the tank headspace, but do not meet the definition of dome or waste intrusive.

- Pits, such as pump pits and transfer pits, that are not isolated from the tank dome by a seal barrier.

- The environment outside of tank openings that are directly connected to the headspace out to a distance of 18 opening diameters; 4.57 m (15 ft); or the boundary of temporary containment devices, whichever is shorter. This portion of the ex-tank region is only a concern from a flammable gas standpoint, when a large GRE is postulated (i.e., Facility Group 1 at all times, Facility Group 2 during global waste disturbing operations). Flammable gas is not postulated to accumulate in these open air regions due to steady state gas releases.

- Inside ventilation system duct work, downstream of the first mixing point with flow from another tank, when the ventilation system is not operating. (When the ventilation system is operating, the inside of ventilation system ductwork downstream of the first mixing point with flow from another tank is not an intrusive region because of mixing and dilution provided by flow from other tanks.)

- Activities in direct contact with the outside of the boundary between the ex-tank region and nonintrusive regions, such as welding or grinding, that could result in an ignition source inside the boundary. Equipment in these areas shall have ignition source control requirements.

- The ex-tank intrusive region also includes the environment outside a tank opening, which is directly connected to the dome space, out to the shortest of the following distances:

- 18 opening diameters[1]
- 4.57 m (15 ft)
- The boundary of temporary containment devices.

K4.1.3 Dome Intrusive

Dome intrusive includes any location within the tank between the top of a riser and the surface of the waste. It also includes ventilation ducting up to the first mixing point with flow from another tank. Because the filter housing and connecting ducting extends the riser, the dome intrusive region extends to the open-air inlet/outlet of breather filters or active ventilation system inlet filters or bags/sleeving around an open riser. However, if shut down, the ventilation system downstream of the first mixing point is considered an ex-tank intrusive region. A sealed pit which is open to the tank dome region (a dome intrusive region) is considered dome intrusive region.

The dome intrusive region definition also applies to work and activities, such as welding or grinding, that are in direct contact with the outside of the boundary and that could result in an ignition source inside the boundary (e.g., welding on the outside of risers or breather filters).

During the operation of salt well pumps, salt well pits are considered part of the dome intrusive region. This designation and the accompanying control requirements are made according to WHC-SD-WM-ER-571, *Evaluation of Hydrogen Release During Saltwell Pumping for Tanks T107, S110 and S108* which concluded that released gases could be channeled to the pit by the salt well, thereby creating localized flammable conditions in the pit while the rest of the dome intrusive region is well below the LFL.

Ignition source controls are applied to equipment installed in the region at the top of sealed risers and pits. Higher concentrations may result in this region because of buoyancy effects and the reduced ventilation provided to these potentially stagnant areas. Based on anecdotal evidence from entry monitoring and the expected effects of diffusion, accumulation of gas concentrations above the LFL in this region is judged to be unlikely. Ignition source controls that are consistent with this judgement are applied. Once the riser or pit is opened and entry monitoring confirmed and gas concentrations are less than 25% of the LFL, normal GRE controls are applicable.

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[1]The opening diameter is defined as the hydraulic diameter of the most restrictive portion of the flow path.

Figure K4-1. Ex-Tank, Dome, and Waste Intrusive Regions in Passively Ventilated Tanks.

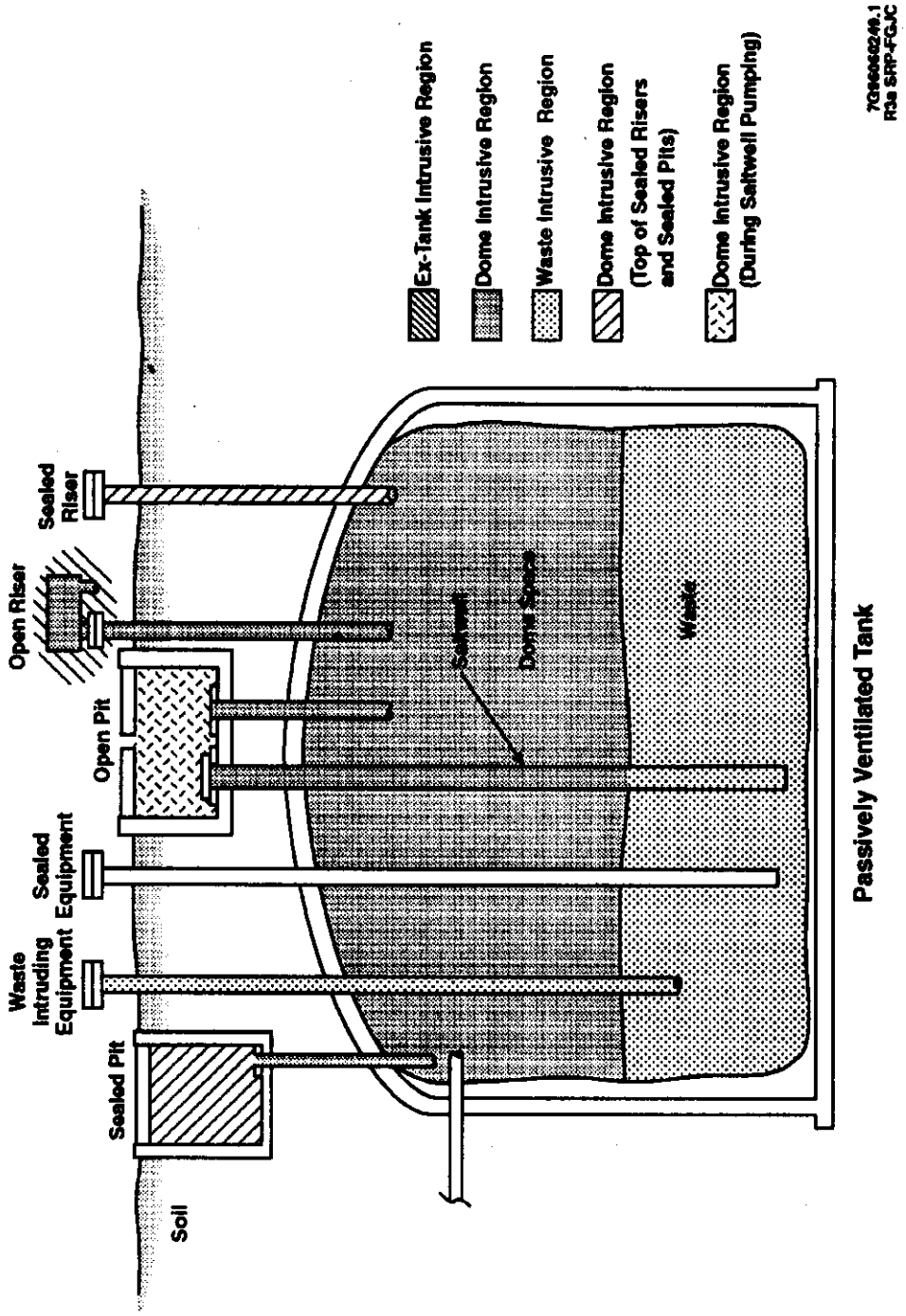


Figure K4-2. Ex-Tank, Dome, and Waste Intrusive Region in Actively Ventilated Tank (Ventilation On).

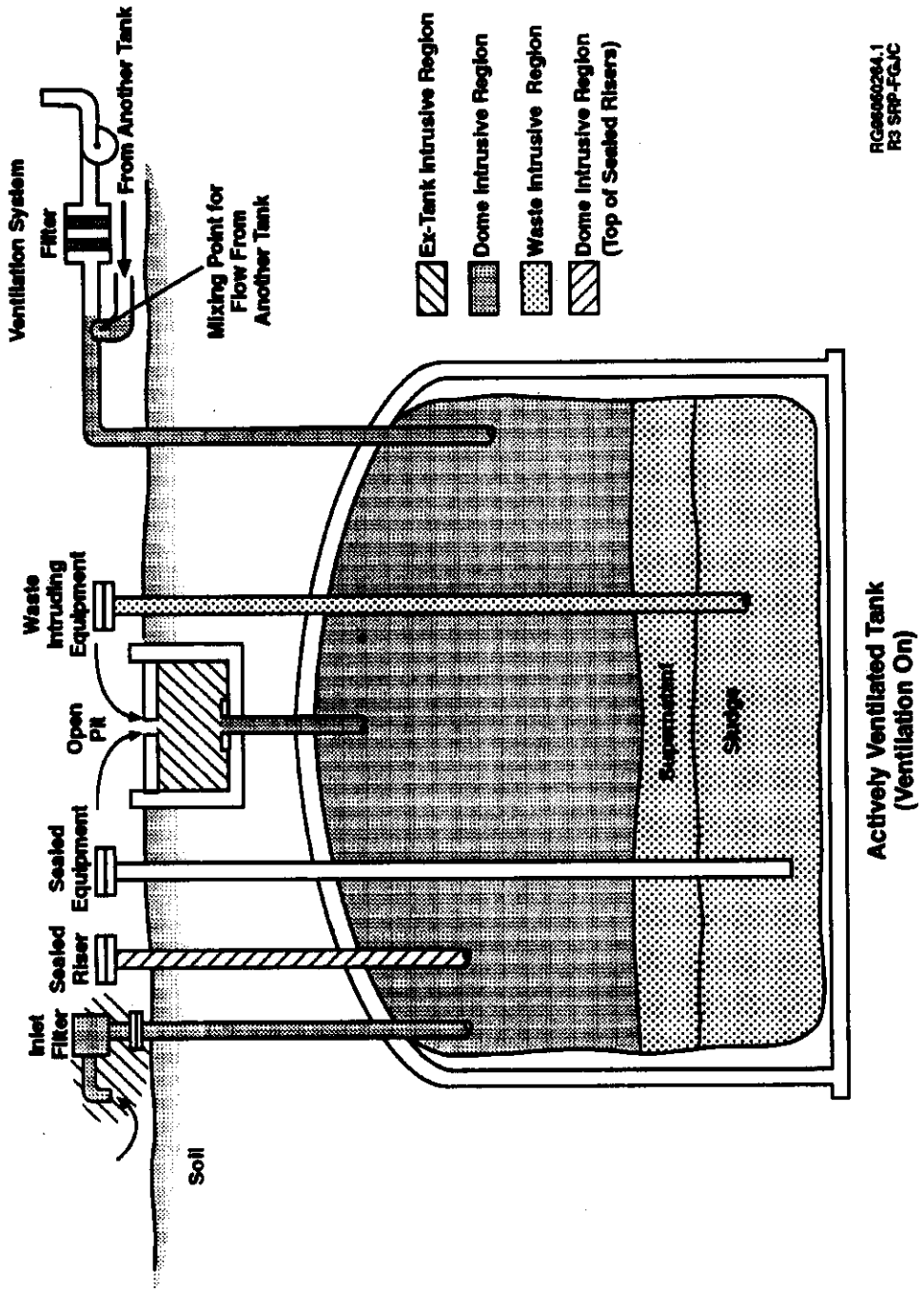
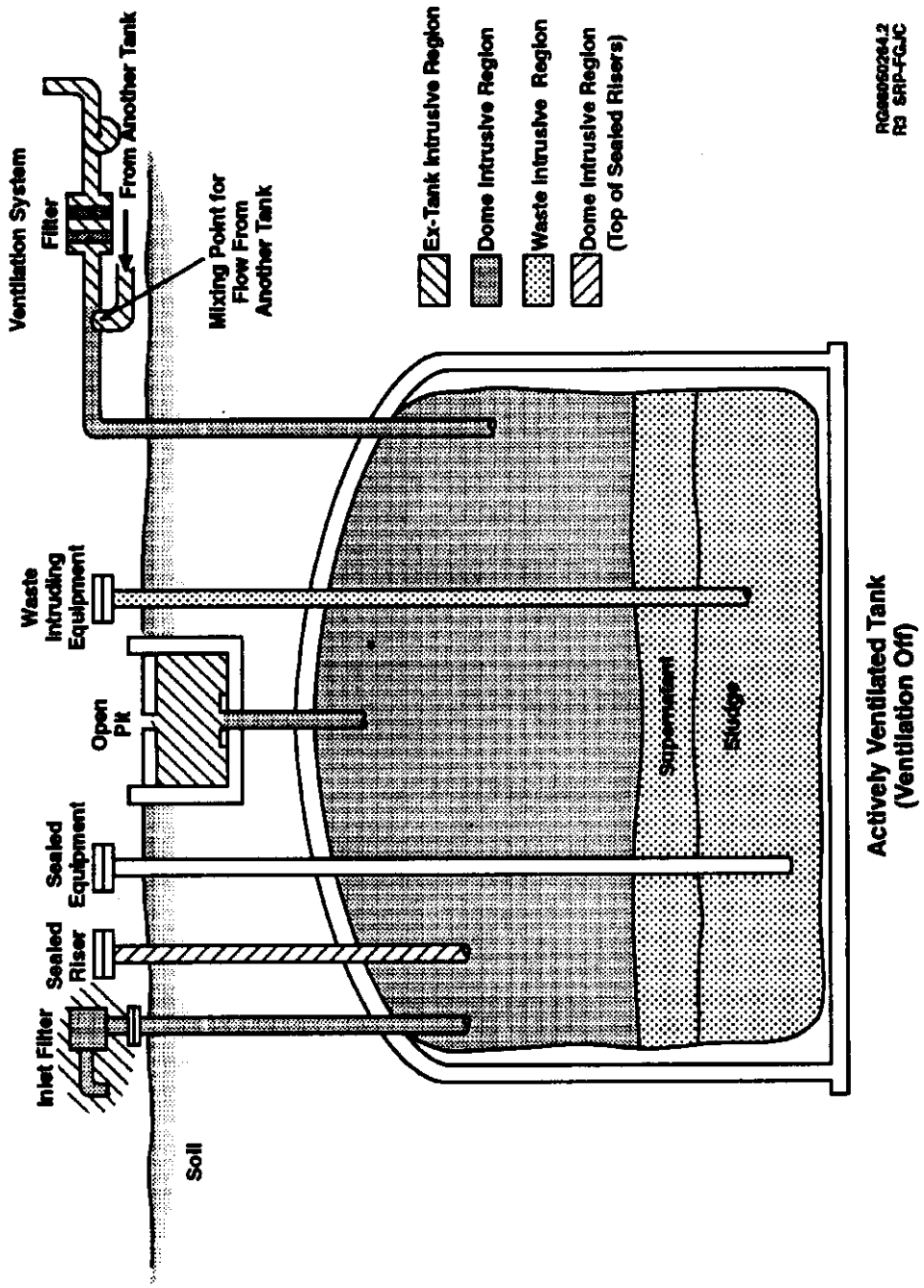


Figure K4-3. Ex-Tank, Dome, and Waste Intrusive Regions in Actively Ventilated Tanks (Ventilation Off).



K4.1.4 Waste Intrusive

Waste intrusive refers to the region below the waste surface. It also includes vapor space inside the waste intruding equipment, where flammable gas retained in the waste may accumulate. This region is defined so that gas retained within the waste is considered as a possible flammable environment. Significant gas retention is not postulated unless waste solids such as sludge or salt cake are present. Equipment that comes in contact with gas bubbles retained within the waste is therefore considered to be in a waste intrusive location.

Waste intruding equipment includes open-ended and breached objects that are inserted below the waste surface that may create an unvented vapor space where flammable gases retained in the waste may accumulate. Waste intruding equipment includes core sample drill pipes, pump suction legs, and weight factor dip tubes.

Equipment, such as thermocouple trees and LOWs, inserted below the waste surface and properly sealed is not considered waste intruding equipment. For LOWs, where the potential for accumulation for flammable gas only exists if the LOW is breached, swabbing for contamination will be performed at each entry and before potential ignition sources (LOW gamma or neutron scanning equipment) are inserted into the LOW. If swabbing indicates that the LOW is breached, waste intruding gas monitoring and entry requirements shall be followed. Equipment insertion and operation shall not proceed if flammable gases are above 25% of the LFL. Equipment used in a breached LOW shall meet ignition source control (Set 1) requirements.

K4.1.5 Waste Disturbing Operations and Activities

Waste disturbing operations or activities include all work that may result in significant motion under the waste surface. Waste disturbing operations and activities include global waste disturbing and local waste disturbing operations defined as follows:

- **Global Waste Disturbing.** Operations and activities that cause a large global disturbance of the waste. These activities include, but are not limited to: waste transfers into or out of a tank; the removal, installation, or operation of mixer pumps; and large water additions.

- **Local Waste Disturbing.** Operations and activities that disturb only a small, local portion of the waste. Operations and activities that disturb only a small, local portion of the waste, such as removal of air lances or thermocouple trees, are quite different than operations that can cause a large global disturbance such as the operation of a mixer pump.

Examples of global and local waste disturbing operations and activities are shown in Table K4-2.

Waste disturbances may also occur because of seismic events. No special controls are imposed by this Appendix that relate to flammable gas deflagrations which may be caused by a seismic event.

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Table K4-2. Representative Tank Waste Remediation System Waste Management Operations and Activities. (2 sheets)

Representative Ex-Tank Intrusive Operations and Activities
• Vent and balance activities • Exhauster (maintenance/operations) • High-efficiency particulate air (HEPA) filter change out without primary tank isolation • De-entrainer pad change out • Operation of portable exhausters • Ventilation system modifications • Filter housing relocation • Filter inlet installation • Filter changing • Pit cover block/cover plate removal • Pit jumper setup and valve alignment for transfer • Pit leak detection • Pit activities • Gas sampling in pits and ventilation systems • Activities outside of open risers • Use of greenhouse/plastic sleeving around open risers • Drywell vans/on top of tanks, vehicle control[1] • Construction/tie-in activities[1]
Representative Dome Intrusive Operations and Activities
• Riser preps (asbestos removal) • Riser examination with high intensity lamp • Riser geometry measurements • Shield plug installation and removal • Swabbing risers for radiation readings • Flange work • Gauge plugs • Gas sampling with heated vapor probes • SHMS/GMS • Ammonja gas sampling • ENRAF[2]/FIC/manual tape waste level measurements • Zip cord waste level measurements • ENRAF/FIC/manual tape repair, replacement, removal • DST high level detection and alarm • Use of camera, video, lights • Light Duty Utility Arm inspection missions • Surface moisture monitoring system • Equipment removal (that is located in the dome space and not inserted below the waste surface) including retrieval devices and de-con • Water wands used to flush contamination from equipment in the tank dome space • Welding and grinding on the outside boundary or in a location where sparks or hot slag can enter the tank.

Table K4-2. Representative Tank Waste Remediation System Waste Management Operations and Activities. (2 sheets)

Representative Waste Disturbing Operations

<u>Global Waste Disturbing Operations</u>
 	
• Salt well pumping
• Submersible pump operation
• Emergency pumping of supernatant
• Mixer pump operation
• Transfer pump operation
• Air lift circulator operation
• Jet pump operation
• Chemical additions
• Large water additions (for example, >2000 gallons)[3]
• Waste addition/removal or transfers
 	
<u>Local Waste Disturbing Operations</u>
 	
• Lancing (<2000 gallons of water added to waste)[3]
• Hydraulic jetting (with ultra-high-pressure)
• LOW installation
• Thermocouple (T/C) tree installation
• Salt well installation
• Multiple instrument tree (MIT) installation
• Instrumentation Installation/Operation
  Void meter
  Viscometer
  Densitometer readings
  Sludge level (weight) measurements
  Penetrometer testing
• Mixer pump installations
• Transfer pump installation
• Equipment removal if inserted below the waste surface, including retrieval devices and de-con
  Sludge weight removal
  Air lance removal
  Specific gravity probe removal
  LOW removal
  T/C tree removal
  MIT removal
  Pump removal
• Sampling
  Push mode core sampling
  Auger
  Grab
  Light Duty Utility Arm sampling missions

Notes:
[1] Within 15 ft or 18 opening diameters from the tank opening, whichever is less.
[2] ENRAF is a trademark of the ENRAF MONIUS Corporation.
[3] Based on dissolution of high void fraction wastes (see HNF-3737).

K4.2 VENTILATION CONTROLS FOR SST, DST, AND AWF TANKS

In-situ measurements have demonstrated that steady-state flammable gas concentrations are consistently below calculated values and 25% of the LFL in passively and actively ventilated tanks WHC-SD-WM-ER-526. Because current ventilation methods maintain steady state gas concentrations below 25% of the LFL, controls similar to existing ventilation controls should be maintained to manage the risk associated with gas added to the headspace by steady state and small induced or spontaneous releases. These controls require almost constant operation of DST and AWF exhausters. For passively ventilated tanks, breather filters are verified to be operable at least every 12 months and breather filter isolation valves are verified to be open weekly.

These historical operating practices have been used to form the basis for upgrading the operating requirements to controls that reflect the importance of ventilation performance in controlling flammable gas concentrations caused by steady state releases. Loss of normal ventilation can result in the build up of flammable gas concentrations to greater than the LFL for a number of tanks. The loss of normal ventilation condition has been assessed in HNF-SD-WM-CN-116, *Calculation Note: Hydrogen Generation Rates at Steady-State Flammable Gas Concentrations for Single Shell Tanks*, and HNF-SD-WM-CN-117, *Calculation Note: Calculation of Hydrogen Release Rate at Steady State for Double Shell Tanks*, for SSTs and DSTs respectively. These assessments form the basis for TSR surveillance frequencies and action times for the ventilation controls for this hazard. Section K5.0 describes ventilation of ancillary facilities.

K4.3 IGNITION SOURCE CONTROLS

Ignition source controls are applied to equipment installed or used during work activities in tank intrusive locations on a graded basis according to Facility Groups 1, 2, and 3. Additionally, controls shall be applied to all equipment used in waste intrusive locations at all times.

The location classifications in and around facilities are in accordance with National Fire Protection Association (NFPA) guidelines. They are documented in HNF-SD-WM-HC-017, *Electrical Classification Study for the Flammable Gas Watch List Tanks*, and will be updated according to available data, if necessary.

The ignition source controls in this Appendix are applied when and where flammable gases are postulated to be present. The controls are applied to a Facility Group or to an activity/operation type. Field implementation, however, accounts for the specific details of the facility and activity/operation under consideration. Implementation of these controls ensures that the ignition controls are met across facility configurations and the planned operations and activities. TSRs implement these controls. The ignition source controls described in this Appendix are the baseline in meeting the intent of industry standards.

A process is followed to specify the allowed safe conditions and control requirements to address the flammable gas hazards as described in this Appendix. A sample process is described in Appendix KB. Ignition source

control requirements and work activity compliance with the requirements is documented by this process. In cases where direct compliance with the ignition source controls cannot be accomplished, the equipment and activity can be evaluated to determine if equivalent safety can be established. A Flammable Gas Equipment Advisory Board (FGEAB) has been formed to determine when specific work level control implementation provides equivalent safety to the baseline controls in this Appendix. The development of equivalencies shall involve analysis, evaluation, or testing and will include appropriate documentation, review, and approval. The FGEAB, consisting of TWRS Engineering, representatives from the Hanford Electrical Codes Board, and the contractor NFPA Interpretive Authority, will review the design based on equivalent safety, and approve the equipment and its installation.

K4.3.1 Ignition Source Control Set 1

All equipment installed or used during work activities is evaluated and Set 1 is used for that portion of the equipment that can make contact with the gases retained in the waste (in waste intrusive locations) or undiluted gases which may be present in the vapor space of waste intruding equipment. The basis is that flammable conditions may be present in these locations; therefore the highest level of control consistent with NFPA 70 Class I, Division 1 is appropriate. The application of this control set is as indicated in Table K4-3.

1. Mechanical tooling, equipment, and materials (including lubricants, adhesives, gaskets, corrosion inhibitors, epoxies) shall be constructed of spark-resistant material, or shall be rendered incapable of sparking with sufficient energy to combust hydrogen, or shall have been analyzed and evaluated to be incapable of sparking with sufficient energy to combust hydrogen under the applied conditions (Johnson 1990, *Selection of Spark Resistant Tool Material for use in 101-SY*). Material compatibility shall be evaluated for thermite reaction potential (Ermold 1996, *Actions to Response to Spark Reported During Work on Tank 241-U-109*).

2. Electrostatic ignition sources shall be controlled by providing bonding or grounding according to NFPA 77, Recommended Practice on Static Electricity .

3. Exposed polymer materials shall be rendered incapable of electrostatic charge or discharge potential with sufficient energy to combust hydrogen by design or through acceptable workaround practices or by evaluation of the applied conditions (NFPA 77).

4. The surface temperatures of heat-generating devices (this includes potential compression heating mechanisms and open flames) shall not exceed 416 °C (780.8 °F). The surface temperature is limited to a maximum of 160 °C (320 °F) if the device can contact the waste and cause ignition by triggering exothermic (organic-nitrate) reactions in the waste. Internal temperatures of heat generating devices may exceed these temperatures (NFPA 70, National Electricity Code,

Articles 500-Hazardous (Classified) Locations and 501-Class 1 Locations) if the heat source is isolated (pressurized) from the gas environment, or if the design of the device enclosure meets the requirements for explosion-proof housings.

5. Electrical equipment shall be designed to meet NFPA 70, Class 1, Division 1, Group B criteria (NFPA 70) or provide equivalent safety. At a minimum, this shall be interpreted to mean that no single point failure of energized equipment can result in an arc, spark, or gas burn propagation to the environment external to the source enclosure (NFPA 70). In the case of waste-submerged equipment containing potential ignition sources, demonstration by design that the equipment is nonsparking under normal operation and is designed to be isolated from the waste environment is an acceptable alternative.

6. Shutdown of purged and pressurized electrical equipment and purged and pressurized heat-generating equipment, upon loss of protective gas pressure or flow, shall be automatic by design as defined by NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment, Type X pressurization.

7. Interlocked start-up of purged and pressurized electrical or purged and pressurized heat-generating equipment shall only be allowed when the system senses preset safety limits. An example would be adequate protective gas pressure established as defined by NFPA 496 (NFPA 77). If pressurized enclosures are used to isolate energized components, a minimum of 4 enclosure volumes shall be purged through the enclosure for energized components, and/or 10 volumes shall be purged for enclosed motors before controlled start-up of the system components (NFPA 70 and 496).

K4.3.2 Ignition Source Control Set 2

Set 2 is applied to vapor space locations (ex-tank intrusive and dome intrusive) when a GRE is postulated to create flammable conditions. Set 2 is similar to Set 1 except that requirements (5), (6), and (7) are modified to allow the use of more readily available equipment. The basis is that the flammable conditions are unlikely. Therefore, the use of equipment that meets the intent of NFPA 70 Class I, Division 2 or equivalent is adequate. The application of this control set is as indicated in Table K4-3.

1. Mechanical tooling, equipment, and materials (including lubricants, adhesives, gaskets, corrosion inhibitors, epoxies) shall be constructed of spark-resistant material, or shall be rendered incapable of sparking with sufficient energy to combust hydrogen, or shall have been analyzed and evaluated to be incapable of sparking with sufficient energy to combust hydrogen under the applied conditions (Johnson 1990). Material compatibility shall be evaluated for thermite reaction potential (Ermold 1996).

2. Electrostatic ignition sources shall be controlled by providing bonding or grounding according to NFPA 77.

3. Exposed polymer materials shall be rendered incapable of electrostatic charge or discharge potential with sufficient energy to combust hydrogen by design or through acceptable workaround practices or by evaluation of the applied conditions (NFPA 77).

4. The surface temperatures of heat-generating devices (this includes potential compression heating mechanisms and open flames) shall not exceed 416 °C (780.8 °F). The surface temperature is limited to a maximum of 160 °C (320 °F) if the device can contact the waste and cause ignition by triggering exothermic (organic-nitrate) reactions in the waste. Internal temperatures of heat generating devices may exceed these temperatures (NFPA 70) if the heat source is isolated (pressurized) from the gas environment, or if the design of the device enclosure meets the requirements for explosion-proof housings.

5. Electrical equipment shall be designed to meet NFPA 70, Class I, Division 2, Group B criteria (NFPA 70) or provide equivalent safety. As a minimum, this shall be interpreted to mean the equipment is nonsparking under normal operation or, if normally sparking, the sparking component(s) shall be continuously isolated (purged and pressurized) from the potentially flammable gas environment, or the design of the device enclosure shall be of sufficient strength (explosion-proof) to prevent propagation of a gas burn to the environment external to the enclosure.

6. Automatic shutdown or alarming with manual shutdown will be required upon loss of protective gas pressure or flow as defined by NFPA 496 Type Z pressurization.

7. Automatic or manual start-up of purged and pressurized electrical or purged and pressurized heat-generating equipment shall only be allowed on system sensing of preset safety limits, such as adequate protective gas pressure established as defined by NFPA 496. If pressurized enclosures are used to isolate energized components, a minimum of 4 enclosure volumes shall be purged through the enclosure for energized components, or 10 volumes shall be purged for enclosed motors before controlled start-up of the system components (NFPA 70, NFPA 496). When combustible gas detection shutdown systems are employed, start-up of equipment shall only be allowed once measured acceptable flammable gas levels are indicated.

Table K4-3. Flammable Gas Ignition Source Control Set Application Requirements.

Tanks	During Non-Waste Disturbing Activities		During Local Waste Disturbing Activities		During Global Waste Disturbing Activities		Waste Intrusive or Inside Waste Intruding Equipment
	Ex-Tank Intrusive	Dome Intrusive	Ex-Tank Intrusive	Dome Intrusive	Ex-Tank Intrusive	Dome Intrusive	
Facility Group 1	2	2	2	2	2	2	1
Facility Group 2	2B	2	2B	2	2A	2	1
Facility Group 3	2B	2B	2B	2A	2B	2A	1
244-AR TK-002	2B	2B	2B	2A	2B	2A	1
244-CR TKs-001, -002, -003	2B	2B	2B	2A	2B	2A	1
Non Tank Waste Transfer System	2B		2B		2B		Non-GRE
DCRT	2B		2B		2B		Non-GRE
244-AR TKs-001/-003/-004	2B		2B		2B		Non-GRE
244-CR TK-011	2B		2B		2B		Non-Gre
Catch Tanks and Catch Tank Pits	2C		2C		2C		Non-GRE
242-S	2B		2B		2B		Non-GRE
242-T	2C		2C		2C		Non-GRE
W-151-001, W-151-002, S-302B, TY-302B	2C		2C		2C		Non-GRE

Notes:

1 - Ignition Source Control Set #1 applies at all times

2 - Ignition Source Control Set #2 applies at all times

2A - Ignition Source Control Set #2 applies only for the duration of the waste disturbance

2B - Ignition Source Control Set #2 applies to activity related equipment and materials until work activity entry monitoring requirements (Table K4-5) are met. Ignition source controls are not required by 2B (ignition source controls during entry monitoring) in the ex-tank intrusive region defined as the environment outside of tank openings that are directly connected to the headspace out to a distance of 18 opening diameters; 4.92 m (15 ft); or the boundary of temporary containment devices, whichever is shorter.

2C - Ignition Source Control Set 2 applies to installed equipment, Ignition Source Control Set #2 applies to activity related equipment and materials until work activity entry monitoring requirements (Table K4-5) are met.

Non-GRE These are Facility Group Non-GRE because there is little or no waste solids, gas accumulation is not postulated for these facilities and therefore, waste intrusive and waste intruding locations and associated ignition source controls are not applicable.

K4.3.3 Exceptions to Ignition Source Control Requirements

Table K4-4 covers equipment and materials that do not meet the ignition source control requirements and do not have safety equivalency with ignition source controls (Set 1 or Set 2) established by the TWRS FGEAB. Most of these items are used throughout tank farm field activities. A few items are specific to certain activities, such as grab sampling and PMCS. Therefore, the exceptions in Table K4-4 are required to perform tank farm operations.

A number of items in Table K4-4 are considered to be "de minimus" exceptions because they are judged to pose a negligible risk as ignition sources. These de minimus items are judged to represent uncontrolled, but negligible spark sources. Most are associated with manned work. In these cases, the work location monitoring requirements, as called for in this Appendix, are in force. Several items, however, involve the materials that make up installed equipment. These items are therefore present in the tanks even when monitoring is not required.

Additional items in Table K4-4 are equipment, materials, and activities that do not meet the ignition source control requirements and do not have safety equivalency established by the TWRS FGEAB. These items do not meet the definition of "de minimus." Flammable gas risk management, therefore, depends on flammable gas monitoring (standard monitoring as required in Section K4.4 or augmented monitoring as indicted in Table K4-4), ventilation, and/or work practices (for example, slow insertion of non-spark-resistant thermocouple trees). These practices provide confidence that a spark source would not be present when a flammable gas environment exists. This second category contains items that are evaluated to have an associated small, incremental increase in risk, but the benefits associated with their use justify their continued application in the field. It is judged that the risk posed by these items is acceptable for ongoing operations. This decision is based on a qualitative assessment of the importance of the waste management and safety-related activities and operations that must use these items. Appendix KC describes the justification for each exception listed in Table K4-4.

Table K4-4. Exceptions to Ignition Source Control Requirements. (3 sheets)

Item #	Authorized Activities
1	Personal Protective Equipment (i.e., raingear, airline respirator hoses, rubber/plastic and canvas gloves, respirator masks, rubber/plastic boots, masking tape, Tyvek coveralls) are authorized for use in ex-tank locations, but may be used in a minimally dome intrusive location (e.g., at the plane of a riser).
2	Wearing of plastic badges, badge holders, and dosimeters.
3	Installation of, removal of, working on, or extended presence of nonconductive lead blankets in ex-tank (global waste disturbing) regions. Lead blankets shall not be used in a vapor trapping configuration
4	Installation, removal, or extended presence of nonconductive adhesive tape (e.g., green tape, white tape) in ex-tank regions, dome intrusive regions, and in waste intruding equipment.
5	Use of Portable Alpha Monitor (PAM) in ex-tank regions, dome intrusive regions, and in waste intruding equipment.
6	Use of nonconductive poly bottles in ex-tank and dome intrusive regions.
7	Use of zip cords in ex-tank regions, dome intrusive regions, and in waste intruding equipment (e.g., inside failed LOWs).
8	Use of nonconductive plastic ropes in ex-tank regions.
9	Use of nonconductive plastic tubing in ex-tank regions and dome intrusive regions (e.g., aerosol testing). Nonconductive plastic tubing shall not be used below the plane of a riser.
10	Installation and removal of Garlock gaskets in ex-tank regions.
11	Use of nonconductive plastic garden type sprayer (approximately 5 gallons, hand pump pressurizer and brass spray wand) in ex-tank regions.
12	Use of grab sample cap, sampling and sludge weight retrieval device and coated steel cable in ex-tank and dome intrusive regions.
13	Installation and removal of polyvinyl chloride (PVC) riser liners in dome intrusive regions.
14	Presence of PVC liners for manual tapes, FICs, flushing, ignition source control (IC) 1 compliant equipment, and authorized activities in dome intrusive regions.
15	Presence of manual tapes in ex-tank and dome intrusive regions.
16	Installation and removal of manual tapes in ex-tank and dome intrusive regions.

Table K4-4. Exceptions to Ignition Source Control Requirements. (3 sheets)

Item #	Authorized Activities
17	Installation of, removal of, working with, or extended presence of the pipe wiper (Frisbee) during PMCS with Truck 1, 2, and 3, in ex-tank and dome intrusive regions.
18	Installation of, removal of, or extended presence of plastic cam-lock caps during PMCS with Trucks 1, 2, or 3 in ex-tank and dome intrusive regions.
19	The presence of extension cords in ex-tank regions. Power strips (and outlet strips) are not allowed in these regions. Energized lines shall not be connected or disconnected in an ex-tank region.
20	Installation, removal, and use of low and high pressure spray whirlie and operation of valve handles in ex-tank and dome intrusive regions.
21	Electrical bonding is not required for removal or installation of fittings on openings less than or equal to 2.54 cm (1 in.) inside diameter during intrusive location entry.
22	Use of Type 4 vapor sampling head in ex-tank and dome intrusive regions. Conductive plastic sleeving shall be used during Type 4 vapor sampling.
23	Use of electric impact wrench in ex-tank regions.
24	Use of Type 4 vapor cart in ex-tank and dome intrusive regions.
25	Open pit work related equipment (e.g. Pike Poles, T-Bars, Sockets, Chokers, Shackles, and Bull Hooks) in ex-tank regions. Installation and removal of process blanks, vapor seals, jumpers, and leak detectors in ex-tank regions. Continuous monitoring in the tank dome and the pit is required during use of this exception.
26	Installation and removal of valve handles in ex-tank regions. This activity is performed in closed pits when no global waste disturbing activities are in progress.

Table K4-4. Exceptions to Ignition Source Control Requirements. (3 sheets)

Item #	Authorized Activities
27	Installation, removal, presence of, or movement of cover blocks, riser flanges, shield plugs, tank installed waste and non waste intrusive equipment items (e.g. T/C trees, steel LOWs, pumps, manual tapes, FICs, ENRAFs, radar gauges, heated vapor probes, MITs, corrosion probes, velocity-density temperature trees (VDTTs), water lances, void fraction meter, core sampling drill string, salt well screens, dip tubes, cameras/lights, viscometer, auger, sampler) each as used in ex-tank or dome intrusive or waste intrusive regions. Work packages and procedures will include practical measures to reduce the likelihood of a mechanical spark when equipment movement performed as part of an operation or activity can create mechanical sparks. Such measures may include: limiting insertion speeds, water bathing of equipment, prevention of contact with other non-spark resistent materials by use of collars or bumpers, use of critical lift procedures where appropriate. This exception does not cover the operation of large mixer pumps that might cause significant motion of installed equipment. Any other ignition source hazards (other than mechanical spark source potential) must comply with this Appendix's requirements for ignition source controls.
28	Use of pressure switches, limit switches, and leak detector for the salt well pumping system for Tank 241-T-104. Continuous monitoring of the pump pit is required during pumping with automatic shutoff at 10% of LFL.
29	Use of pressure switches, limit switches and leak detectors for the salt well pumping system for Tank 241-BY-109 after it is re-categorized to a Facility Group 3 tank. Continuous monitoring of the pump pit required during pumping with automatic shutoff at 10% of the LFL.
30	Presence of intact fiberglass and Tefzel LOWs in Facility Group 2 or 3 tanks or presence of failed fiberglass LOWs as waste-intruding equipment. (Work in a known failed LOW shall meet IC Set 1 controls).
31	Use of Continuous Air Samplers (CASs) in ex-tank regions in Facility Group 1 tanks or Facility Group 2 tanks during global waste disturbing operations. CASs shall be shutdown if 10% of the LFL is exceeded in the ex-tank area. Motor shall be placed outside the ex-tank region. Continuous monitoring in the tank dome and the pit is required during use of this exception.

K4.4 GAS MONITORING REQUIREMENTS

Flammable gas monitoring is used as part of the flammable gas hazard management strategy for the following reasons:

- To prevent the introduction of an uncontrolled or errant spark source into a location when and where flammable gas concentrations are above a level of concern for fire, deflagration, or detonation. This includes entry monitoring for all manned work to be performed in intrusive locations for the facilities within the scope of this Appendix. It includes monitoring of intrusive locations in non-GRE facilities before using equipment that does not meet ignition source controls in situations where ventilation has not been verified to be adequate to address steady state accumulation hazards, such as when operating pumps in catch tanks (Section K5.8). This function also is used if required ventilation is not operable so that equipment that does not meet ignition source controls can be shut down before concentrations of concern develop.

- To prevent the continued use of equipment and materials that may present uncontrolled spark sources or errant spark sources if flammable gas concentrations of concern develop during manned work activities. This includes manned activities in facilities when and where the effects of GREs must be considered. Continuous monitoring is required to satisfy this function.

- To halt global waste disturbing operations (e.g., salt well pumping) in passively ventilated tanks if pit or dome space concentrations exceed 25% of the LFL. Because equipment in use during such operations meets ignition source controls, monitoring is not used as the primary safety approach to preventing an accident. Therefore, periodic monitoring is adequate for this function.

These functions and requirements are discussed in the following paragraphs. The application of the monitoring requirements are identified in Table K4-5.

K4.4.1 Entry Monitoring (and Associated Ignition Source Controls)

Flammable gas concentrations in intrusive work locations must be verified to be below the flammable gas work control limits before beginning manned work. This requirement shall be applied to all manned work activities in waste containing vessels when the manned work activity is near an opening in the vessel containment. Meeting this requirement will ensure that flammable conditions in the work space are not present as a result of steady state accumulation and/or recent GREs.

For manned activities on tanks, the entry monitoring requirements are:

1. Monitor at breather filter or vent duct prior to start of activity.

2. For work in pits, monitor in pit prior to the start of pit work.

3. Monitor inside riser (passive or active ventilation) or allow for a one minute pause with riser opened (active ventilation only) prior to start of dome intrusive activities.

4. For dome intrusive work, follow 1 and 3 above, plus monitor below bottom of riser (passive or active ventilation) or in vent duct upstream of first mixing point (active ventilation only) prior to start of activity.

5. For manned activities inside of waste intruding equipment, monitor in the vapor space prior to start of activity.

For manned activities in non-tank waste transfer system regions, monitor in the vapor space where the activity is to be performed.

Manned work shall not begin or proceed if flammable gas concentrations are greater than 25% of the LFL except for gas sampling and necessary actions to reduce gas concentrations, deenergize ignition sources, etc. Installed qualified equipment (equipment that is qualified in accordance with the appropriate ignition source controls) may continue to operate (not be deenergized) if flammable gas concentrations are greater than 25% of the LFL.

Until gas concentrations of less than 25% of the LFL are verified, the equipment used to perform this verification shall meet the requirements of ignition source controls (Set 2).

K4.4.2 Manned Activities (Continuous Monitoring)

Because of the possibility of flammable conditions developing during work as a result of a GRE depending on the flammable gas Facility Group and activity type, work space (ex-tank intrusive or dome intrusive) monitoring is continued. This means using a continuous monitor, such as a SHMS, or portable CGMs that monitor continuously and is set to alarm before flammable gas concentration exceeds 25% LFL. Ignition source controls are also imposed in these locations to prevent ignition in the unlikely event that flammable conditions develop. The potential for an errant (uncontrolled) spark is judged to be higher during manned work activities even though all equipment must meet ignition source controls for manned activities and unmanned operations. The chance of an errant spark is judged to be higher during manned activities because equipment is being manipulated, and the chance for human error is present. Therefore, a distinction is made between manned and unmanned activities. Manned activities require continuous monitoring and work stoppage if the concentrations exceed 25% of LFL; unmanned operations generally do not require monitoring. Monitoring thus provides an additional safety measure to the ignition source controls during these activities. Therefore, all manned work activities must immediately halt if flammable gas concentrations exceed 25% of the LFL, with exceptions such as gas sampling and necessary actions to reduce gas concentrations, and deenergizing ignition sources.

K4.4.3 Unmanned Operations

Unmanned operations, such as waste transfers and operation of air lift circulators or mixer pumps in actively ventilated tanks, do not require continued monitoring because installed equipment must meet ignition source control requirements, and errant spark sources (that might result during manned activities) are minimal. Released gases will be diluted and swept from the tank by the ventilation flow. Adequate protection is provided by requiring installed equipment to meet ignition source controls.

During unmanned global waste disturbing operations in passively ventilated tanks, flammable gas concentrations from GREs may persist for a long time because of low ventilation flows. Because continued operation in this condition is judged to be imprudent if the flammable gas concentration is greater than 25% of the LFL, periodic monitoring is required. For long duration operations such as salt well pumping, periodic monitoring can be defined as follows:

- Monitor dome space and salt well pit once an hour for 5 hours following initiation of pumping
- Monitor dome space and salt well pit once a day for the next 3 days (or once each 24 nominal hours run time)
- Monitor weekly or once each 168 hours nominal run time). Revise sampling period:
  - If less than 15% of LFL, sample every 7 days, not to exceed 10 days
  - If greater than 15% to ≤25% LFL, sample daily
  - If greater than 25% LFL, stop waste disturbing operation.

K4.4.4 Monitoring Following a Loss of Ventilation

Monitoring is used to cause the shutdown of uncontrolled spark sources if flammable gas concentrations of concern develop because of a loss of required ventilation. Ventilation in many TWRS facilities is provided to prevent the accumulation of flammable gas caused by steady-state releases and to dilute released gases before they reach ventilation system equipment that does not meet ignition source control requirements (such as pressure switches and continuous air monitors in DST ventilation systems). If this ventilation is lost, flammable gas concentrations may increase, but in a steady manner. Following a loss of ventilation, periodic monitoring is required to trend the flammable gas concentrations and actions are taken to eliminate the uncontrolled spark sources if levels of concern are reached.

Table K4-5. Flammable Gas Monitoring Requirements.

Tanks	During Manned* Non-Waste Disturbing Activities		During Manned* Local Waste Disturbing Activities		During Manned* Global Waste Disturbing Activities		During Unmanned Non Waste Disturbing Activities	During Unmanned Local and Global Waste Disturbing Activities	Inside Waste Intruding Equipment
	Ex-Tank & Dome Intrusive (Riser or Duct only)	Dome Intrusive in Dome Space	Ex-Tank Intrusive	Dome Intrusive	Ex-Tank Intrusive	Dome Intrusive			
Facility Group 1	A2 or C, A3 for pit work	C	A2 or C	C	A2 or C	C		No applicable activities	E
Facility Group 2	A1	C		C	A2 or C	C		D	E
Facility Group 3	A1	B		C		C		D	E
244-AR TK-002	A1	B		C		C			E
244-CR Tks-001, -002, -003	A1	B		C		C			E
Non Tank Waste Transfer System	A1								
DCRT	A1	B							
244-AR TKs-001, -003, -004	A1	B							
244-CR TK-011	A1	B							
Catch Tanks and Catch Tank Pits	A1	B	G		G		G	G	
242-S	A1	B							
242-T	A1	B	F		F		F	F	
W-151-001, W-151-002, S-302B, TY-302B	A1	B	F		F		F	F	

A1 - 1. Monitor at breather filter (passive ventilation) or vent duct (active ventilation), when present, prior to start of activity.
2. Monitor inside riser (passive or active ventilation) or one minute pause with riser opened (active ventilation only) prior to start of dome intrusive activities. For open pit work, monitor inside pit prior to start of activity. This entry monitoring does not require the monitoring of the ex-tank region defined as the environment outside of tank openings that are directly connected to the headspace out to a distance of 18 opening diameters; 4.92 m (15 ft); or the boundary of temporary containment devices, whichever is shorter.

A2 - Continuous monitoring in ex-tank area during activity (See TSR Control AC 5.11.a.3).

A3 - Continuous monitoring of pit and dome space prior to and during work with tools listed as exceptions for pit work in Table K4-4, for pits connected to a Facility Group 1 DST vapor space.

B - A1 above, plus monitor below bottom of riser (passive or active ventilation) or in vent duct upstream of first mixing point (active ventilation only) prior to start of activity.

C - B above, plus continuous monitoring in dome intrusive regions where work is being performed such as below bottom of riser (passive or active ventilation), inside of breather filters, inlet filters or temporary glove bags, or in vent duct upstream of first mixing point (active ventilation only) during activity.

D - 1. No monitoring requirements for DSTs.
2. Monitor per requirements in TSR Control AC 5.11.b.2 for salt well pumping.

E - Monitor inside waste intruding equipment vapor space prior to entry. Monitoring outside of waste intruding equipment (e.g., open drill string) is not required.

F - Monitor prior to energizing or using equipment that does not meet IC 2 controls.

G - Monitor tank and pit prior to energizing or using installed equipment that does not meet IC 2 controls, or within 7 days prior to making transfer.

* Manned refers to personnel performing work related to activity only.

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K5.0 APPLICATION OF CONTROLS TO FACILITY GROUPS

The flammable gas Facility Group assignments are shown in Table K5-1 and described below. Flammable gas ignition source controls and monitoring requirements are graded based on the Facility Group assignment.

K5.1 FACILITY GROUP 1

Five tanks (241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103) that have undergone observed, significant GREs are conservatively postulated to have the potential for large spontaneous and induced GREs that could create flammable conditions in the ex-tank region. For this reason, stringent controls are applied to these Facility Group 1 tanks.

Ventilation controls shall be maintained to mitigate steady state gas accumulation.

Because of the possibility of a large spontaneous GRE in Facility Group 1 tanks, ignition source controls (Set 2) (Section K4.3.2, "Ignition Source Control Set 2") shall be applied to the ex-tank and dome intrusive regions at all times. Additionally, continuous flammable gas monitoring (Section K4.4, "Gas Monitoring Requirements") shall be in place for ex-tank and dome regions during ex-tank intrusive and dome intrusive manned work activities. These controls are aimed at managing the risk of ignition in the event of a large spontaneous or induced GRE that could cause flammable gas conditions and pressurization of the dome region and result in an outflow of flammable gases to ex-tank regions.

Ignition source controls (Set 1) (Section K4.3.1, "Ignition Source Control Set 1") shall be applied to all waste intrusive or waste intruding equipment.

The work practice of reviewing Facility Group 1 tank data before manned work is being pursued as a Defense-in-Depth measure (McClusky 1996, *Flammable Gas Waste Tank Data Review*). The data review is performed to determine, as closely as possible, whether gas retention and release behavior has changed in an unexpected manner or whether the data support the existence of a "potential near-term" gas release event. This review is performed before dome intrusive, waste intrusive, and waste disturbing activities in these tanks. This Appendix provides controls that are appropriate assuming a GRE can occur during the activity. The predictions about tank GRE behavior are sufficiently uncertain that this review process does not lend itself to be included as an Authorization Basis control and, therefore, will be implemented outside of the FSAR and TSRs.

K5.2 FACILITY GROUP 2

Facility Group 2 tanks differ from those in Facility Group 1 in that they are postulated not to be subject to large spontaneous GREs. The only large GREs postulated for Facility Group 2 tanks are those triggered by global waste disturbing operations. Because gas outflow to the ex-tank region is only postulated during global waste disturbing operations and activities, ignition source controls can be limited.

During non-waste disturbing and local waste disturbing operations, ignition source controls (Set 2) (Section K4.3.2) shall apply to the dome intrusive region only because of the decreased likelihood of gas release that can result in flammable concentrations outside the dome region. Similarly, continuous monitoring (Section K4.4) is required in the dome intrusive region only during manned work activities. These are judged to be sufficient to mitigate hazards posed by small spontaneous and induced GREs.

Global waste disturbing operations are postulated to be capable of triggering a large induced GRE that could result in flammable concentrations in ex-tank regions. For the duration of the global waste disturbing operation, ignition controls (Set 2) shall be extended to the ex-tank region. Continuous monitoring is also required for these ex-tank regions during manned activities. After completing a global waste disturbing activity and verifying that flammable conditions do not exist, these ex-tank controls can be removed for the ex-tank locations.

Ignition source controls (Set 1) (Section K4.3.1) shall be applied to all waste intrusive or waste intruding equipment.

Finally, ventilation controls (Section K4.2, "Ventilation Controls for SST, DST, and AWF Tanks") shall be maintained in Facility Group 2 tanks to mitigate steady state gas accumulation.

K5.3 FACILITY GROUP 3

Because Facility Group 3 tanks are postulated to be subject only to small induced GREs, its control set is the least restrictive. No event is postulated to cause a GRE that could cause flammability conditions to exist beyond the dome region. The control set is limited to the dome and waste regions.

During non-waste disturbing operations, ignition source controls (Set 2) shall apply to the initial entry. After flammable gas concentrations are verified as less than 25% of the LFL, the ignition source controls may be removed. Continuous gas monitoring is not required for non-waste disturbing activities if the initial sample is below 25% of the LFL.

Any local or global waste disturbing operation is postulated to induce a small GRE in the dome. For this reason, ignition source controls (Set 2) shall be applied to the dome intrusive region for the duration of the waste

disturbing activities. In addition, continuous monitoring is required in the dome intrusive region during manned, waste disturbing activities. After completing the waste disturbing activity and verifying that flammable conditions do not exist, these controls can be removed.

Ignition source controls (Set 1) (Section K4.3.1) shall be applied to all waste intrusive or intruding equipment.

Ventilation controls (Section K4.2) shall be maintained in Facility Group 3 tanks to mitigate steady state gas accumulation. Finally, ignition source controls (Set 2) are applied to sealed risers and sealed pits, at all times that they are sealed.

K5.4 NONTANK WASTE TRANSFER SYSTEM COMPONENTS

Miscellaneous transfer system components (e.g., transfer lines, valve pits, diversion boxes, process pits, transfer line clean out boxes) that are not directly connected to the waste tank headspaces are judged to pose a low flammable gas deflagration risk. The potential for flammable gases in these transfer system components is limited to the gas accumulation from chronic generation and release from contained waste and corrosion. Risk is reduced by flushing transfer lines after use. Historical evidence exists that the risk posed by this hazard is low. In addition, gas concentrations are monitored during entry to all vapor spaces, such as process pits, that might be connected to transfer lines. Gas monitoring verifies the risk is low. Flushing practices are required to be continued to maintain a low risk of flammable gas generation and accumulation. It is judged that additional controls are not warranted at this time.

K5.5 DOUBLE-CONTAINED RECEIVER TANKS

DCRTs are used primarily as lag storage facilities for supernatant and interstitial liquids for SSTs that are being pumped to complete the interim stabilization process. Tank 241-TX-244 also receives waste transfer from the Plutonium Finishing Plant (PFP).

The DCRTs consist of a steel tank located in an underground concrete vault. Mechanical exhausters provide the ventilation flow through the vault and suction to the tank. The inlet flow from the vault to the tanks is provided through leak paths at instrument connections with the tank (except for 244-U, which has a filtered inlet path). Because DCRTs contain waste heels and remnants of contaminated flush water, continued dip tube air flow is provided in these tanks. Gas generation rates from the heels and for waste temporarily stored in the DCRT during typical transfer operations are generally low enough that ventilation flow rates of a few cubic feet per hour are judged adequate for continued operations.

Ventilation flow is provided by instrument air injected into the tank at an estimated 0.08 m^3/hr (3 ft^3/hr) as part of the waste level dip tube operation.

Table K5-1. Flammable Gas Facility Group Assignments.

Facility Group 1	Facility Group 2	Facility Group 3	NON-GRE
DSTs: AN-103, 104, 105 AW-101 SY-103	DSTs: AN-101, 102, 106, 107, AP-101, 102, 103, 104, 105, 106, 107, 108; AW-102, 103, 104, 105, 106, AY-101, 102; AZ-101, 102; SY-102. SSTs: A-101, 103; AX-101, B-201, 202; BX-107; BY-101, 102, 105, 106; C-104; S-101, 102, 103, 105, 106, 107, 109, 111, 112; SX-101, 102, 103, 105, 106, 109[1]; T-201, 202, 204; TX-102, 111, 112, 113, 115; U-102, 103, 105, 106, 107, 108, 109, 111. IMUSTs: 216-BY-201, 216-TY-201, 240-S-302, 241-TX-302B, 241-TX-302B(R), 241-SX-302, 241-TX-302X, 241-AX-151, 241-A-302B, 241-B-301B, 241-S-302A, 241-T-301, 241-ER-311A, 243S-TK-1, 241-BX-302C, 242-T-135, 242-TA-R1, 241-C-301C, 241-B-302B, 244-BXR-003, 270-W, and 244-BXR-002	SSTs: A-102, 104, 105, 106; AX-102, 103[2], 104; B-101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 203, 204; BX-101, 102, 103, 104, 105, 106, 108, 109, 110, 111, 112; BY-103, 104, 107, 108, 109, 110, 111, 112; C-101, 102, 103, 105, 106, 107, 108, 109, 110, 111, 112, 201, 202, 203, 204; S-104[2], 108, 110; SX-104[2], 107, 108, 110, 111, 112, 113, 114, 115; T-101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 203; TX-101, 103, 104, 105, 106, 107, 108, 109, 110, 114, 116, 117, 118; TY-101, 102, 103, 104, 105, 106; U-101, 104, 110, 112, 201, 202, 203, 204. 244-AR TK-002 244 CR TKs 001, 002, 003 IMUSTs: 241-TX-302A, 241-TY-302A, 244-TXR-002, 241-BX-302A, 241-BX-302B, 244-TXR-001, 244-BXR-011, 244-BXR-001, 244-TXR-003, 241-Z-8.	DCRTs: 244-A, 244-BX, 244-S, 244-TX, 244-U Catch Tanks: 241-S-304, 241-TX-302-C, 241-U-301-B, 241-UX-302-A, 241-A-302-A, 241-A-417, 241-AX-152, 241-AZ-151, 241-AZ-154, 241-ER-311, 241-EW-151, 204-AR-TK-1, 241-A-350 244-AR TKs 001, 003 and 004 Evaporators: 242-T TK-B1 and evaporator vessel, 244-CR TK-011 IMUSTs: 231-W-151-001, 231-W-151-002, 241-S-302B, 241-TY-302B.

Notes:

[1]Tank 241-SX-109 passes the GRE evaluation documented in WHC-SD-WM-ER-526. As such it would be placed in Facility Group 3. However, it is included in Facility Group 2 because a number of tanks in the SX farm are Facility Group 2 tanks and, because of the unique ventilation configuration of the SX Farm, these tanks vent through the headspace of Tank 241-SX-109.

[2]Two tanks (241-SX-104 and 241-AX-103), which are currently on the Flammable Gas Watch List, are placed into Facility Group 3. The inclusion of SSTs into this group is based on the results of the GRE evaluation in WHC-SD-WM-ER-526. The watch list status for tanks is based on different evaluation methodologies used in the past.

Ventilation rates will be established and verified adequate to maintain DCRT gas concentrations below 25% of the LFL before placing new waste types (that is, waste types that may generate flammable gases at a higher rate than those handled currently) in the receiver tanks. The methodology for assessing the adequacy of the ventilation provided to the 244-BX, 244-S, 244-TX, and 244-U DCRTs during waste transfers is described in HNF-SD-WM-CN-118, *Calculation of Flammable Gas Mixtures in Double-Contained Receiver Tanks*.

Because of the limited storage time and small amounts of solids stored in DCRT waste, DCRTs are judged not to have significant GRE potential and are not subject to waste intrusive, waste intruding, or GRE controls.

Table K5-2 lists the DCRTs and the control requirements.

K5.6 244-AR VAULT LAG STORAGE TANKS

The 244-AR-Vault facility is an inactive canyon building that was used for waste transfers and lag storage enroute from the Plutonium Uranium Extraction (PUREX) Facility to B Plant and waste enroute from B Plant and the Waste Encapsulation Storage Facility to the tank farms. The facility was also used during waste sluicing/transfer operations from the A and AX Farms. The 244-AR vault has four storage tanks (TK-001, TK-002, TK-003, and TK-004).

Table K5-3 shows the best estimate of tank contents, gas sample results, required ventilation controls, and the Facility Grouping. TK-002 contains 87,000 L (23,000 gal) of radioactive waste, including 2,300 L (600 gal) of neutralized current acid waste sludge left from the sluicing/waste transfer operations in AX Farm. The remaining three tanks in this facility are believed to contain very dilute liquids from flushing operations. These liquids have been collected from facility sumps and, therefore, are primarily water which has little potential for gas generation.

When the facility was active, a vessel vent system (K4) controlled hydrogen buildup and provided confinement for the storage tanks. Because this system has been inactive for several years, ventilation flow is provided by dip tube air flow to all four tanks. TK-002 had the only nonzero flammable gas concentration measured, indicating a hydrogen concentration of 2,200 ppm or the equivalent of 5.5% of the LFL (0.222 %vol hydrogen). For this tank, 4.0 %vol hydrogen can be used for total flammable gas concentrations because the measured concentrations of methane and ammonia are less than 0.001 %vol. This concentration has resulted from operation of dip tube air purge of 0.08 m^3/hr. Based on these sampling results, continued operation of dip tube air is judged to be adequate to control flammable gases in TK-002 until the waste can be removed while TK-001, TK-003, and TK-004 are judged to be safe without dip tube air purging. The flammable gas-related ventilation controls for TK-002 maintain ventilation purge through two dip tubes.

TK-002 may contain a 2,300-L (600-gal) heel of sludge from Tank 241-AX-104 that may cause gas retention; therefore, waste intrusive and waste intruding regions apply. Because of the sludge heel, this tank is treated with Facility Group 3 controls to ensure that flammable gas controls mitigate the hazards posed by potential release of gas retained within the sludge during sludge disturbing operations.

Table K5-2. Double-Contained Receiver Tank Flammable Gas Control Information.

DCRT	Use	Ventilation Requirements	Facility Group[1]	Installed Equipment Ignition Source Controls
244-A	Cross-site, B-plant and some evaporator feed transfers. Drainage from transfer lines.	Dip tube operating to vent gases generated by waste heel. Assess dip tube flow requirements before placing new waste types in tank.	Non-GRE	None[2]
244-BX	Lag storage of 241-B, 241-BX, and 241-BY Tank Farm salt well liquids. Currently contains a significant sludge heel.	Dip tube operating to vent gases generated by waste heel. Assess before placing new waste types in tank.	Non-GRE	None[2]
244-S	Lag storage of 241-S and 241-SX Tank Farm salt well liquids and miscellaneous plant wastes. Drainage from cross-site transfer line.	Dip tube operating to vent gases generated by waste heel. Assess dip tube flow before placing new waste types in tank.	Non-GRE	None[2]
244-TX	Lag storage of 241-T Tank Farm salt well liquids. Lag storage for PFP waste transfers.	Dip tube operating to vent gases generated by waste heel. Assess dip tube flow requirements prior to placing new waste types in tank.	Non-GRE	None[2]
244-U	Lag storage of 241-U Tank Farm salt well liquids. Drainage from 241-SY Tank Farm transfer lines.	Tank/vault ventilation provided during lag storage of wastes.	Non-GRE	None[2]

Notes:

[1] DCRTs have been judged to pose little risk from GREs and therefore no GRE related controls are required.

[2] Flammable gas hazards are limited to steady state accumulation which is controlled by required ventilation; therefore, ignition source controls are not applied to installed equipment.

Table K5-3. 244-AR Storage Tank Flammable Gas Control Information.

Tank 244-AR	Contents	Gas Sample Results[1]	Ventilation Control Requirements	Facility Group	Installed Equipment Ignition Source Controls
TK-001	9100 L (2,400 gal) of mostly water from flushing and sump collection.	0% of LFL	None	Non-GRE	None
TK-002	2300 L (600 gal) of Tank 241-AX-104 sludge and 84,800 L (22,400 gal) of mainly water from flushing and sump collections.	5.4% of LFL	Continued dip tube air flow	Group 3	IC Set 2 during waste disturbing operations
TK-003	7600 L (2,000 gal) of mainly water from flushing operations and sump collections.	0% of LFL	none	Non-GRE	None
TK-004	380 L (100 gal) of mainly water from flushing of Tank 241-AX-104 sludge to TK-002.	0% of LFL	none	Non-GRE	None

Notes:

[1]Goheen (1996), *Analysis of the Samples from Four Catch Tanks.*

K5.7 INACTIVE MISCELLANEOUS UNDERGROUND STORAGE TANKS

The TWRS is responsible for managing 36 IMUSTs (WHC-SD-WM-PD-046, *Tank Waste Remediation System Inactive, Miscellaneous Underground Storage Tanks Program Plan*) that were physically isolated for at least 10 years. Knowledge about the contents of these tanks ranges from adequate to unknown, but they are all suspected to contain radioactive waste. Because many IMUSTs contain waste similar in composition to SST waste, it is postulated that flammable gas behavior (gas generation, retention, and release) is analogous to that in SSTs, but on a much smaller scale because of the small amount of waste present.

Because of the inactive and sealed condition of the IMUSTs, even slow gas generation rates can create potentially hazardous flammable gas accumulation over a long period. The gas generation rates, seal quality, and possible passive ventilation rates provided to the IMUSTs is unknown. For these reasons, this Appendix imposes flammable gas ignition source and work activity monitoring controls required by the Facility Group control set assigned in Table K5-4.

The IMUSTs were evaluated for flammable gas generation and accumulation rate (WHC-EP-0861, *Status Report for IMUSTs at Hanford Site 200 Areas*) to obtain estimates of gas generation based on the radiolysis of water given the best available information regarding ^{137}Cs and ^{90}Sr inventories and the assumption of a completely sealed tank. Based on this estimate, the IMUSTs were assigned a flammable gas relative hazard ranking as defined in Table K5-4. These rankings are for information purposes and are not used to establish flammable gas control requirements. Actual gas samples taken from three IMUSTs (241-C-301C, 241-TY-302A, 241-TY-302B) have indicated flammable gas concentrations of less than 1% of the LFL.

The Facility Group control sets were assigned based on the amount of waste solids and overlying supernatant known or suspected to be contained in the tank. The IMUSTs with significant solids but little supernatant (either less than 378.5 L [100 gal] or less than 1% of the tank capacity) were assigned to Facility Group 3. Conversely, IMUSTs with significant solids and a large supernatant layer were assigned to Facility Group 2. If the waste solid and liquid volumes of an IMUST were unknown, the tank was assigned to Facility Group 2 as a prudent measure until better knowledge of the waste contents is obtained. A group 2 assignment is judged to be conservative because the IMUSTs generally have been interim stabilized by removing as much liquid as technically and economically practical. Because a significant supernatant is unlikely to exist in these tanks, a spontaneous GRE is judged to be very unlikely. Finally, those IMUSTs containing mostly liquids with only a small amount of solids (less than 378.5 L [100 gal]) are judged not to warrant GRE controls.

The IMUSTs generally do not have energized equipment, so the potential for ignition sources is judged to be very low. Liquid levels are monitored in four tanks: Tanks 241-A-302B and 241-TX-302B are monitored for liquid level using a manual tape and Tanks 240-S-302 and 241-S-302A are monitored with FIC level detectors in the intrusion mode. These level measurement systems meet ignition source controls (Set 2) requirements.

Table K5-4. Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tank Flammable Gas Control Information. (4 sheets)

Facility	Capacity (gal)	Inventory		Relative Flammable Gas Accumulation Hazard[1] (Sample Results if Available, % LFL)	Facility Group
		Material	Volume (gal)		
216-BY-201	no data	no data	no data	---	Group 2
216-TY-201	no data	no data	no data	---	Group 2
231-W-151-001	4,000	floor drainage from 231-Z	Solids: 0 Supernatant: 1,430 Total waste: 1,430	Low	non-GRE
231-W-151-002	1,000	floor drainage from 231-Z	Solids: 12 Supernatant: 955 Total waste: 967	Low	non-GRE
240-S-302	17,684	HLW[2]	Total waste: 2,276	Low	Group 2
241-A-302B	13,500	HLW	Total waste: 3,600	Low	Group 2
241-AX-151	11,000	no data	no data	---	Group 2
241-B-301B	36,000	HLW	Solids: 21,660 Supernatant: 590 Total waste: 22,250	Low	Group 2
241-B-302B	17,684	HLW	Solids: 690 Supernatant: 4,240 Total waste: 4,930	Low	Group 2
241-BX-302A	17,684	HLW	Solids: 835 Supernatant: 0 Total waste: 835	Low	Group 3
241-BX-302B	11,389	HLW	Solids: 950 Supernatant: 94 Total waste: 1,044	Low	Group 3
241-BX-302C	11,378	HLW	Solids: 635 Supernatant: 228 Total waste: 863	Low	Group 2

Table K5-4. Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tank Flammable Gas Control Information. (4 sheets)

Facility	Capacity (gal)	Inventory		Relative Flammable Gas Accumulation Hazard[1] (Sample Results if Available, % LFL)	Facility Group
		Material	Volume (gal)		
241-C-301C	36,000	HLW	Solids: 9,016 Supernatant: 1,470 Total waste: 10,486	Low (< 0.06% LFL)	Group 2
241-ER-311A	no data	no data	no data	-	Group 2
241-S-302A	17,684	HLW	Total waste: 5,130	Low	Group 2
241-S-302B	14,314	Tank considered empty	probably empty	Low	non-GRE
241-SX-302	17,684	HLW	Solids: 1,050 Supernatant: 305 Total waste: 1,355	Low	Group 2
241-T-301	36,000	HLW	Solids: 21,658 Supernatant: 588 Total waste: 22,246	Low	Group 2
241-TX-302A	17,684	HLW	Solids: 2,450 Supernatant: 30 Total waste: 2,480	Low	Group 3
241-TX-302B	17,684	HLW	Total waste: 1,320	Low	Group 2
241-TX-302B (R)	12,000	HLW	no data	-	Group 2
241-TX-302X	14,314	HLW	Solids: 108 Supernatant: 245 Total waste: 353	Low	Group 2
241-TY-302A	17,684	HLW	Solids: 450 Supernatant: 0 Total waste: 450	Low (<0.01% of LFL[3])	Group 3

Table K5-4. Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tank Flammable Gas Control Information. (4 sheets)

Facility	Capacity (gal)	Inventory		Relative Flammable Gas Accumulation Hazard[1] (Sample Results if Available, % LFL)	Facility Group
		Material	Volume (gal)		
241-TY-302B	14,314	Tank is empty	Tank is empty	none (<0.01% of LFL[4])	non-GRE
241-Z-8	15,435	Backflush of feed filters for the RECUPLEX process	Solids: 500 Supernatant: 0 Total waste: 500	Low	Group 3
242-T-135	no data	no data	no data	---	Group 2
242-TA-R1	4,200	no data	no data	---	Group 2
243S-TK-1	550	no data	no data	---	Group 2
244-BXR-001	50,000	Metal waste slurry from BX and BY tanks	Solids: 7,215 Supernatant: 0 Total waste: 7,215	High	Group 3
244-BXR-002	15,000	Metal waste slurry from BXR-001 mixed with nitric acid	Solids: 1,805 Supernatant: 380 Total waste: 2,185	Low	Group 2
244-BXR-003	15,000	Metal waste slurry from BXR-001 mixed with nitric acid	Solids: 1,449 Supernatant: 356 Total waste: 1,805	High	Group 2
244-BXR-011	50,000	Metal waste slurry and nitric acid from BXR-002 & BXR-003	Solids: 7,020 Supernatant: 98 Total waste: 7,118	High	Group 3
244-TXR-001	50,000	Bismuth phosphate metal waste from T and TX tanks	Solids: 2,291 Supernatant: 49 Total waste: 2,340	Low	Group 3
244-TXR-002	15,000	Waste slurry from TXR-001 mixed with nitric acid	Solids: 2,945 Supernatant: 0 Total waste: 2,945	Low	Group 3

Table K5-4. Tank Waste Remediation System Inactive Miscellaneous Underground Storage Tank Flammable Gas Control Information. (4 sheets)

Facility	Capacity (gal)	Inventory		Relative Flammable Gas Accumulation Hazard[1] (Sample Results if Available, % LFL)	Facility Group
		Material	Volume (gal)		
244-TXR-003	15,000	Waste slurry from TXR-001 mixed with nitric acid	Solids: 6,460 Supernatant: 0 Total waste: 6,460	Low	Group 3
270-W	3,780	Neutralized process condensate from 224-U	no data	---	Group 2

Notes:

[1]The criteria for determining the priority rank of high, moderate, or low with regard to hydrogen generation and buildup as a potential safety issue are as follows.
High: Hydrogen accumulation reaches more than 1 %vol of the tank headspace (25 percent of the LFL) in 10 years or less.
Moderate: Hydrogen accumulation reaches more than 1 %vol of the tank headspace in 10 to 25 years.
Low: A tank is empty or hydrogen accumulation reaches more than 1 %vol percent of the headspace in more than 25 years.
If there are no data to calculate hydrogen generation, and there is less than a 50 percent void space ratio, the tank is ranked moderate.
If there are no data to calculate hydrogen generation, and there is greater than or equal to a 50 percent void space ratio, the tank is ranked low.

[2]HLW indicates waste contents could be any or a mixture of a number of typical High Level Wastes (HLW) similar to those found in the SSTs. More details are contained in WHC-EP-0861, 1995, Status Report for Inactive Miscellaneous Underground Storage Tanks at Hanford Site 200 Areas, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[3]Goheen (1995a, Gas Sample Analysis from Tank 302-A)

[4]Goheen (1995b, Gas Sample Analysis from Tank 302-B)

K5.8 CATCH TANKS

Catch tanks are underground storage tanks used to collect drainage of waste from diversion boxes, valve pits, and other waste transfer system equipment. Although newer catch tanks are contained within concrete vaults that provide secondary containment, older catch tanks are buried directly in the ground. Generally, catch tanks are located below pits that contain pumps and leak detection equipment.

The ventilation provided to each catch tank is unknown and may vary due to differing designs. Ventilation may be provided by tie-ins to tank ventilation systems, passive ventilation through breather filters, and/or passive ventilation through cracks in tank connections and pit cover blocks. Exact ventilation performance in each catch tank is difficult to quantify because of a lack of instrumentation. Furthermore, these tanks use manual tape, FIC, or ENRAF level measuring devices rather than dip tubes so purge air is not provided to the catch tanks. Therefore, this Appendix must assume that adequate ventilation has not been verified.

Because of the small amounts of waste solids stored in the catch tanks, waste intrusive and waste intruding regions do not apply. Small induced GREs are not postulated for these tanks. The flammable gas hazard is thus limited to steady state release and accumulation. Because a steady state hazard exists if waste heels or contaminated flushwater remnants are present, unless adequate ventilation is verified, including gas sampling, the control strategy for catch tanks in this Appendix is to verify that equipment in the vapor spaces connected to the catch tanks meets the requirements of ignition source controls (Set 2) (Section K4.3.2). Additionally, catch tanks shall be verified to be less than 25% of the LFL during work activities using standard work entry controls. Ignition source controls for manned work activities are applied only during work entry until flammable gas concentrations are verified to be less than 25% of the LFL.

Tank 241-A-350 differs from other DCRTs or catch tanks. It is used as a catch tank as it receives drainage from the 241-A Tank Farm in the event of a waste transfer leak.

Tank 241-A-350 is also used for lag storage during the transfer of evaporator condensate from 207-A to Tank 241-AW-102. This condensate is very dilute in radionuclides and is not a significant gas generation source; therefore, active ventilation, such as a required dip tube air supply, is judged to not be required for this lag storage operation.

Tank 241-A-350 is treated as a catch tank in terms of flammable gas controls.

Table K5-5 lists the catch tanks addressed in this Appendix and the flammable gas control requirements.

K5.9 242-S AND 242-T EVAPORATORS

K5.9.1 242-S Evaporator

The 242-S Evaporator facility was placed in a shutdown/standby condition in 1985, as documented in WHC-SD-WM-SSP-002, *242-S Facility Shutdown/Standby Plan*. The facility was flushed and radioactive liquids were removed. The aqueous makeup tanks, feed and slurry lines, acid addition lines, Tank 241-C-100 and evaporator vessel CA1 were flushed with water, along with having the lines blanked.

A facility walkdown was done in accordance with the WHC-SD-WM-FHA-022, *Fire Hazards Analysis for the 242-S Evaporator*. No reservoirs were found containing solely flammable or combustible liquids in excess of 3.7 L (1 gal) in the process areas.

Because this facility is inactive, additional flammable gas controls beyond those required for normal industrial hazards are not needed.

K5.9.2 242-T Evaporator

Operations in the process areas of 242-T Evaporator were discontinued in November of 1980. SD-HS-SAR-009, *242-T Evaporator Facility Shutdown/Standby to Condition V Safety Analysis Report*, was issued to maintain the facility process areas in a safe shutdown mode until decommissioning work could be initiated.

Facility records indicate that drain and transfer lines from the facility have been cut and capped, isolating the facility from SSTs, DSTs, and DCRTs, but the records do not describe flushing or waste removal from the process tanks. Hydrogen can arise from the corrosion of iron as well as the radiolytic degradation of water and organics such as tributyl phosphate. However, hydrogen generation in aqueous solutions low in fission products, such as PFP waste is expected to be slow. Because PFP waste was the last waste handled in the process tanks and the evaporator tanks are passively ventilated, flammable gas concentrations are expected to be low.

Because of uncertainties about the amount of remaining residual waste, it is prudent for this Appendix to impose flammable gas ignition source and work activity monitoring controls for the blend tank (TK-B1) and the evaporator vessel in 242-T. Until gas sampling is performed to verify that flammable gases are not accumulating, equipment installed in these tanks must meet ignition control (Set 2) requirements or be deenergized. Entry monitoring must be performed before performing work activities. These controls are justified based on the type of waste and the manner in which it was processed through these tanks.

Table K5-5. Catch Tank Flammable Gas Control Information. (2 sheets)

Catch Tank	Use	Manual Work Activity Controls	Ventilation and Installed Equipment Requirements
241-S-304	Drainage from Diversion Box DB-241-S-151, precipitation and run-off	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-TX-302-B	Drainage from DB-241-TX-155, precipitation and run-off	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-TX-302-C	Drainage from DB-241-TX-154, precipitation and run-off	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-U-301-B	Drainage from DB-241-U-151, DB-241-U-152, DB-241-U-153 and DB-241-U-252	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-UX-302-A	Drainage from DB-241-UX-154, 291-U stack, precipitation and run-off	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-A-302-A	Drainage from DB-241-A-151	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-A-417	Drainage from 241-AY/AZ ventilation condensate system and possibly steam condensate from 241-AX-501 valve pit and 241-AZ-154	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-AX-152	Drainage from 241-AX-152 diverter station, DB-241-AX-155, AY-501 and 702-A seal pot	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-AZ-151	Drainage from DB-241-AZ-152, AZ ventilation seal loops, leak detection pits, 801-AZ Instrument Building, precipitation and run-off	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2

Table K5-5. Catch Tank Flammable Gas Control Information. (2 sheets)

Catch Tank	Use	Manual Work Activity Controls	Ventilation and Installed Equipment Requirements
241-AZ-154	Condensate from Tank 241-AZ-101, 102 steam coils, precipitation and run-off	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-ER-311	Drainage from DB-241-ER-151 and DB-241-ER-152	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-EW-151	Vent station for cross-site transfers	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
204-AR-TK-1	204-AR Waste Unloading Facility catch tank	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2
241-A-350	Received drainage from 241-A Tank Farm. Lag storage of condensate transfers from 207-A Retention Basin to Tank 241-AW-102	IC Set 2 until entry monitoring is completed	Verify adequate ventilation or meet IC Set 2 when waste is present. No requirements during transfer/lag storage of condensate.

K5.10 244-CR VAULT LAG STORAGE TANKS

The 244-CR-Vault facility is an inactive facility that functioned as a lag storage and transfer station for various waste streams including liquid discharge from Hot Semiworks and fission product "crudes" being transported between PUREX and B Plant. Until 1973, 244-CR Vault served as an interface facility providing lag storage and transfer service for PUREX acidified sludge (PAS) in transit from the 244-AR Vault to B Plant. The facility has also been used for routing waste transfers from 241-C Tank system to the DST system. The 244-CR Vault is a reinforced structure that houses two 40,000 gallon tanks (TK-CR-001 and TK-CR-011) and two 15,000 gallon tanks (TK-CR-002 and TK-CR-003).

Table K5-6 presents a summarization of the best estimate of the tank contents, volumes, required ventilation controls, and applicable Facility Grouping. TK-CR-001 was last used during the uranium recovery program in the 1950's. It contains a residual heel, less than 7,600 L (2,000 gal). TK-CR-002 contains less than 5,700 L (1,500 gal) of radioactive waste, consisting primarily of PAS transferred from Tank 244-AR-001 to B Plant for strontium recovery. TK-CR-003 was last used in 1995 during the SST stabilization campaign for Tank 241-C-102, Tank 241-C-107, and Tank 241-C-110. Those waste streams have since been removed from TK-CR-003. The current waste volume in TK-CR-003 is approximately 15,000 L (4,000 gal). This remaining heel in TK-CR-003 consists of PAS and Hot Semiworks waste. In the 1970's, TK-CR-011 was used as the sump receiver for 244-CR-Vault and for Hot Semiworks. Small rainwater accumulations were jetted from the other three 244-CR-Vault sumps and from Tank 69 at Hot Semiworks. As of 1986, TK-CR-011 contained approximately 133,000 L (35,000 gal) of liquid. The bulk of this inventory is approximately 21,000 gal of Tank 241-CX-70 supernatant liquid transferred to TK-CR-011 in 1979; and the remaining inventory is rainwater from Hot Semiworks and 244-CR-Vault sump drainage.

The 244-CR-Vault ventilation consists of a gravity or ambient air supply with air directed and controlled through the vault by operation of the 291-CR ventilation, air filtration, and exhaust system. The 244-CR Vault is divided into an upper and lower section. The upper section is considered the pump pit and riser pit areas, and the lower vault section houses the primary tanks which are separated from the vault by annular spaces. The upper and lower vault sections are connected by exhaust ports allowing air flow between the two sections. Air is removed from the lower vault section at the floor level and routed into a filter plenum. The air is then treated by a double bank of HEPA filters prior to being exhausted to the atmosphere through the stack. However, there is no separate vessel ventilation system for the tanks themselves. Exhaust air from the tanks enters the lower and upper vault sections via floor drains and exhaust ports; and is then swept away by the vault ventilation system air flow.

There are no ventilation flow instruments for the tanks themselves. In addition, no gas monitoring has been performed for these tanks to determine if the ventilation provided to these tanks by the vault ventilation system is adequate to maintain the flammable gas concentrations within acceptable levels

(i.e., less than 25% of the LFL). Until adequate ventilation is verified, and controls for maintaining it operable are implemented, equipment located in the headspace of these tanks must meet ignition source controls (Set 2) or be deenergized.

Gas sampling of Tanks TK-CR-001, 002 and 011 is impractical in the near term as riser access has been eliminated as part of the intrusion prevention effort (i.e., the risers have been foamed over). Tank modifications are planned for the future to re-establish access as part of the facility clean out process. Because TK-CR-003 is desired to be maintained in an active status (for the possible use of providing lag storage of pumped liquids during the salt well pumping of Tank 241-C-103), and gas sampling is more practical (tank access is available via the manual tape access riser) the adequacy of the ventilation provided to TK-CR-003 will be verified by obtaining gas samples of the TK-CR-003 vapor space. Air purging will be provided in this facility if sample results indicate concentrations $\geq$ 25% LFL. With adequate ventilation being provided, ignition source controls can be removed (during non-waste disturbing operations). LCO 3.2.4 requires the operability of the ventilation to Tank TK-CR-003 (HNF-SD-WM-TSR-006). In addition, AC 5.11.2.d requires that the ventilation flow be verified to be adequate for new waste types prior to placing new waste types in this tank (HNF-SD-WM-TSR-006).

Due to the remaining sludge heels in Tanks TK-CR-001, -002 and -003, these tanks are categorized as Facility Group 3. This conservative categorization ensures that the potential hazard of releasing gases that may be retained by the waste solids is adequately considered during waste disturbing operations (e.g., sludge heel removal). The supernate contained in TK-CR-011 is judged to have no significant gas retention potential and therefore this tank is categorized as non-GRE and is not subject to waste intrusive, waste intruding, or GRE controls as identified in this Appendix.

Table K5-6. 244-CR Vault Storage Tank Flammable Gas Control Information.

244-CR Vault	Contents	Ventilation Control Requirements	Facility Group	Installed Equipment Ignition Source Controls
TK-CR-001	Less than 7,600 L (2,000 gal) of waste from Uranium Recovery Program (mostly waste solids)	None[1]	Facility Group 3	IC set 2 or deenergize
TK-CR-002	Less than 5,700 L (1,500 gal) of radioactive waste consisting primarily of PAS (mostly waste solids)	None[1]	Facility Group 3	IC Set 2 or deenergize
TK-CR-003	15,000 L (4,000 gal) of PAS and Hot Semiworks discharge (mostly waste solids)	Verify vault ventilation system is adequate via gas sampling or purging if necessary. Assess ventilation flow requirements prior to placing new waste in tank	Facility Group 3	None during non-waste disturbing operations IC Set 2 during waste disturbing operations
TK-CR-011	133,000 L (35,000 gal) of supernate and rainwater from Tank 241-CX-70, Hot Semiworks, and 244-CR Vault sumps	None[1]	Non-GRE	IC Set 2 or deenergize

[1] Although ventilation may be provided to this tank by the vault ventilation system, verification of its adequacy is not practical at this time. Until adequacy can be established by gas sampling, no ventilation requirements can be implemented. Until adequate ventilation is verified and a requirement (e.g., TSR) implemented, installed equipment must meet IC Set 2 or be deenergized.

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K6.0 ADEQUACY OF CONTROLS AND RESIDUAL RISK FROM CONDITIONS, OPERATIONS, AND ACTIVITIES IN FACILITIES INVOLVING FLAMMABLE GAS HAZARDS

K6.1 EFFECTIVENESS OF CONTROLS FOR MANAGING THE RISK POSED BY FLAMMABLE GASES

The control strategy for flammable gas includes ventilation, ignition sources, and monitoring. Ventilation controls limit the risk of flammable gas accumulation by removing continuously evolved gases (steady state) and diluting gas release events. Monitoring flammable gas levels validates ventilation effectiveness and provides a basis for managing the risks posed by tank intrusive activities. If flammable gas concentration exceeds the LFL, control of ignition sources introduced into intrusive environments limits the risk of igniting flammable gas mixtures.

HNF-3737 should be referenced for the controls that have been developed for remediation operations and activities associated with Tank 241-SY-101.

K6.1.1 Effectiveness of Ventilation

K6.1.1.1 Control of Flammable Gases Released in a Steady State Manner. All available tank headspace data are judged to imply that current ventilation procedures are generally effective in managing the risk of steady state flammable gas accumulation in waste storage tanks. Measurements for 77% of the SSTs, which were taken as part of vapor space characterization and flammable gas monitoring, indicate that concentrations are well below flammable levels. For this reason, this Appendix continues current practices related to tank ventilation. The longer term effort to upgrade the Authorization Basis with respect to management of flammable gas hazards will benefit from additional vapor space sampling and quantitative bases for ventilation performance requirements.

The DCRT ventilation provided by the vault ventilation system is not verified as adequate. Therefore, DCRTs are required to be purged with instrument air. The adequacy of instrument air purge will be verified before placing new waste types in DCRTs. 244-CR TK-003, which does not have instrument air purge, must be sampled to verify that the vault ventilation system is adequate.

Instrument air purge of Tank 244-AR TK-002 is required and has been verified as adequate. Tanks TK-001, TK-003, and TK-004 have been sampled for flammable gas concentration and do not require air purges.

K6.1.1.2 Gas Release Events. The ventilation rate through the tank has little effect on the peak concentration after a GRE. Because the headspaces are generally quite large in SSTs and DSTs (850 to 2,830 m^3 [30,000 to 100,000 ft^3]) compared to active ventilation rates (typically 0.85 to 5.7 m^3/min [30 to 200 ft^3/min]), the ventilation effects on the concentrations in the tank headspace after a GRE are not dramatic. For releases that can cause concentrations that significantly exceed the LFL in a well mixed headspace, the time at risk could easily exceed several hours, even with high

ventilation rates (WHC-SD-WM-SAD-034, *A Safety Assessment for Salt Well Pump Operations in Tank 241-A-101: Hanford Site, Richland, Washington*).

Ventilation controls cannot guarantee concentrations will be maintained below the LFL during GREs although concentrations above the LFL have not been measured except during a few GREs in Tank 241-SY-101. Ventilation system modifications and controls (tank vacuum levels, flow rates, mixing effects) directly aimed at reducing risk from GREs are not included as part of this Appendix. Refinements to ventilation controls are being developed as part of the Final Safety Analysis Report/Technical Safety Requirement effort.

For GRE events, deflagration and combustion are prevented by controlling ignition sources through equipment design and by properly monitoring headspace concentrations during work activities. The controls described in this Appendix provide these defensive measures.

K6.1.2 Effectiveness of Ignition Source Controls

If flammable gas concentrations accumulate above the LFL, the primary defense against the flammable gas hazard is the control of ignition sources. Although such controls cannot eliminate all possible ignition sources, the selected controls meet the intent of industry standards and allow continued tank farm operations and prudent use of TWRS resources.

Ignition source controls, as presented in Section K4.3, include the following: modifications to installed electrical equipment, control of electrostatic sparks, use of spark-resistant materials for tools and equipment, use of nonsparking or intrinsically safe or purged equipment.

K6.1.2.1 Installed Electrical Equipment. Most electrical equipment installed in tanks and in connected headspaces existed before the flammable gas USQ determinations. Although the majority of equipment is considered adequate, some electrical equipment must be replaced or modified to manage the risk from flammable gases and allow important waste management functions to continue.

K6.1.2.2 Control of Electrostatic Sparks. Electrically conductive objects are bonded in accordance with NFPA 77 during intrusive work. Exceptions are listed in Section K4.3; "Ignition Source Controls"; justifications are described in Appendix E. In most situations where verbatim compliance is not practical, work activity monitoring provides confidence that an electrostatic spark situation will not exist if flammable conditions exist.

The differences of potential between risers or other earth grounds may vary, typically by a fraction of a volt and at relatively high impedances. *Intrinsically Safe Apparatus for Use in Hazardous Locations* (UL 1988) provides information about ignition curves for hydrogen that show that, in the most conservative applications, nothing less than 12 volts could generate enough energy on faulting to ignite hydrogen. Therefore, riser ground loops are considered intrinsically safe.

K6.1.2.3 Spark Resistant Materials. Spark resistant materials are used in tools and some equipment in an intrusive manner to reduce the likelihood of mechanical "impact sparks" and "thermite reactions." The use of such

materials is not practical in all applications, such as existing thermocouple trees, auger guide tubes, and core drill strings. The use of nonspark resistant materials is justified if they are nonsparking during normal use or if measures are taken to reduce the likelihood of creating mechanical sparks when and where flammable conditions might exist. Mechanical spark control measures can include the following: restraints to prevent dropping equipment, slow insertion and removal rates through risers, riser sleeves made of spark resistant materials, and wetting down of risers during equipment insertion and removal. Such measures are included in work packages and procedures if they are relied upon to establish ignition source control equivalencies or to utilize ignition source control exception (Table K4-3, Item 27).

K6.1.3 Effectiveness of Monitoring Controls

Flammable gas monitoring is the third aspect of the flammable gas control strategy. Before and during intrusive work, the headspace is monitored for flammable gases in the environment where flammable gas might exist and the work, or possible ignition sources, are located. Under all circumstances, manned work shall immediately halt if flammable gas concentrations exceed 25% of the LFL.

Monitoring may be conducted using continuous monitoring with alarmed CGM, SHMS, or installed combustible gas monitors. Although a requirement for two redundant continuous monitors was considered, this was not judged to be warranted at present because this Appendix provides ignition source controls as the primary defense against deflagrations. Monitoring is used as an additional control feature when manned work activities are in progress and errant ignition sources are more likely. It is not considered prudent to continue manned work if 25% of the LFL has been exceeded even though equipment ignition source control requirements are met. Installed, qualified equipment may be allowed to operate (not be deenergized) if concentrations are above 25% of the LFL.

Periodic monitoring during unmanned, global waste disturbing operations, such as salt well pumping, in passively ventilated SSTs is prudent. According to this Appendix's logic, safety is maintained independent of this monitoring by using equipment that is acceptable in a flammable environment. Acceptable equipment meets ignition source control Set 2. Ongoing, but periodic, monitoring as specified in this Appendix will be required as a prudent additional measure in passively ventilated tanks during global waste-disturbing operations. Continuous monitoring for this function is judged to not be warranted.

K6.2 UNCERTAINTIES AND RESIDUAL RISK

K6.2.1 Tank Flammable Gas Categorization and Grading of Controls

The sorting of TWRS-managed tanks into four Facility Groups enables consistent application of control sets for similarly situated tanks and provides a practical degree of consistency in controls. This method also

permits the relaxation of controls to the maximum extent possible given the existing uncertainties in tank conditions and tank flammable gas hazards phenomena.

Although the methodology used to estimate gas release volumes has weaknesses, it is the only methodology currently available and will continue to be used cautiously until a better methodology is developed. Errors associated with underlying assumptions and calculations tend to be conservative and do not negatively impact safety. The use of the methodology in this Appendix is limited to distinguishing Facility Group 2 and Facility Group 3 SSTs.

The risks associated with relaxing the controls for DCRTs, IMUSTs, catch tanks, and other facilities that contain only small amounts of waste solids are judged to be low. Because these ancillary tanks contain very little waste solids, they are not postulated to retain flammable gases in the waste matrix. Should a particular tank in this group subsequently be shown to contain a substantial quantity of waste solids, Facility Group 3 controls are applied to that particular tank.

K6.2.2 Risk From Natural Phenomena

The risks of a flammable gas deflagration resulting from natural phenomena, such as lightning and seismic events, are being investigated as part of the TWRS Final Safety Analysis Report upgrade effort.

K6.2.2.1 Lightning. The lightning hazard was addressed recently in WHC-SD-WM-ES-387, *Probability, Consequences and Mitigation for Lightning Strikes to Hanford Site High-Level Waste Tanks*. This analysis determined that demonstrating quantitatively that an unacceptable lightning-caused combustion (organic-nitrate, organic solvent, flammable gas) event is not credible is impossible at this time. The lightning strike probability evaluation indicates the possibility of a strike in the tank farms during the rest of the waste storage mission. The qualitative factors that are known, however, support the conclusion that the likelihood of igniting the waste is low. However, because of the uncertainty associated with this analysis, it has been concluded that providing additional mitigation for the tank farms is appropriate. Installation of lightning arresters on existing poles in the tank farms and improving grounding of tank risers that have high riser-to-ground resistance measurements are planned. These measures are expected to reduce risk from lightning ignition of flammable gases and are an acceptable basis for continued operation.

K6.2.2.2 Seismic Events. The risk of seismic events is uncertain. A concern is for a common cause scenario where the seismic event induces a GRE while causing a spark within the headspace. Currently, no near-term controls for such a scenario have been identified. The benefits of possible mitigation actions for such a scenario need to be evaluated and weighed against the penalties. The penalties include possible loss of tank monitoring, waste management capability such as interim stabilization and transfer capability, before implementation.

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[1]Only the portion of the references which is reflected in Table KA-2 and KA-3 are used in this Appendix. Any control strategies proposed in these documents are superseded by these contained in this Appendix.

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APPENDIX KA

FLAMMABLE GAS SAMPLE RESULTS AND SLURRY GAS LOWER FLAMMABILITY LIMIT

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LIST OF TERMS

CGM	combustible gas meter
DST	double-shell tank
GRE	gas release event
IHT	industrial hygiene technologist
IMUST	inactive miscellaneous underground storage tank
JCO	Justification for Continued Operation
LFL	lower flammability limit
LOW	liquid observation well
NFPA	National Fire Protection Association
OVM	organic vapor monitor
ppm	parts per million
ppmv	parts per million by volume
PUREX	Plutonium Uranium Extraction (Facility)
RGS	retained gas sample
SHMS	Standard Hydrogen Monitoring System
SST	single-shell tank
TNMHC	total nonmethane organic hydrocarbon
TOC	total organic carbon
USQ	Unreviewed Safety Question

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APPENDIX KA

FLAMMABLE GAS SAMPLE RESULTS AND SLURRY GAS LOWER FLAMMABILITY LIMIT

KA1.0 FLAMMABLE GAS CONTROL LIMIT BASIS

This appendix provides the basis for establishing the flammable gas control limit at 25% of the lower flammability limit (LFL). It also derives a conservative hydrogen concentration value to use as 25% of the LFL when hydrogen is the only flammable gas being monitored for and other flammable gases may be present. A discussion is included regarding flammable gas monitoring to ensure compliance with the limit.

The National Fire Protection Association (NFPA) recommends (NFPA 69, *Explosion Prevention Systems*) that processes be controlled so that flammable gas concentrations are less than 25% of the LFL, when relying on vapor space flammability levels to preclude the possibility of an ignition. For this reason, a control of less than 25% of the LFL has been established for performing manned activities in and around the facilities identified in this Justification for Continued Operation (JCO).

Because of the uncontrollable nature of gas release events (GREs), it is not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are in place to minimize the potential for a tank to exceed 25% of the LFL and to cease work in areas common with the tank vapor space, if the flammable gas concentration exceeds this level.

KA2.0 FLAMMABLE GAS COMPOSITIONS AND ASSUMPTIONS REGARDING THE LOWER FLAMMABILITY LIMIT

The flammable gas limit is stated as a percent of the LFL rather than a specific gas concentration. The primary flammable gas generated in the Hanford Site waste tanks is hydrogen which has an LFL of 4.0 volume percent (vol%) (40,000 parts per million by volume [ppmv]) in air. Other flammable gases are frequently present. The gases of potential concern for determination of LFL are ammonia, methane, and carbon monoxide.

KA2.1 AVAILABLE GAS COMPOSITION AND CONCENTRATION DATA

Table KA-1 summarizes the readily available flammable gas, organic vapor and other vapor results from specific combustible gas meter (CGM) readings and samples taken to support the safety program, and from formal vapor samples (Type 2, 3 or 4) taken from single-shell tank (SST) headspaces. The result from one inactive miscellaneous underground storage tank (IMUST) (241-C-301C) is also included.

The specific safety program samples were taken in the tank headspace a nominal 20 feet down from the riser top or a minimum of 3 feet below where the riser enters the tank. These samples were obtained to meet safety program

requirements. They included CGM readings, and drager tube ammonia measurements and total organic carbon (TOC) measurements. Although the CGM readings were essentially the same as routine measurements taken by industrial hygiene technologists (IHTs), they were obtained in specific, controlled work packages. Routine vapor monitoring results taken as part of daily maintenance or operations tasks are not reported in Table KA-1. Of the 46 samples taken, 41 (89%) read 0% of the LFL. Of the 5 samples that showed positive values, all were small, ranging from 1 to 7% of the LFL, and averaged 2.6%. CGM readings are high by approximately 100% per the manufacturer when calibrated on pentane and used for hydrogen monitoring. Applying the manufacturers 0.5 correction factor, the average for the positive reading samples was about 1.3% of the LFL for hydrogen in air. Onsite testing indicates that in concentrations below 1200 parts per million (ppm) hydrogen (3.0% of the LFL for hydrogen in air) the meters are unreliable or read zero. At 1200 ppm they read about the actual % LFL, without the correction factor applied. Above 1200 ppm the units read somewhat high even with the correction factor applied. The CGMs were also shown to indicate conservatively high when used in hydrogen-ammonia and nitrous oxide mixtures. See Section KA4.0 for discussion on CGM accuracy.

Type 2, 3, and 4 vapor samples were taken from the tank headspace using approved procedures. The percent LFL was calculated using Le Chatelier's rule for flammable gases and exclude organic hydrocarbons other than methane. The highest hydrogen, ammonia, and methane values were used, where a range is given. Where below detection limit "<" values are reported, the "<" value was used in the calculations. Carbon monoxide was not included in Table KA-1 because the values were insignificant.

Of the 81 samples reported in Table KA-1, 59 (73%) reported a < value for hydrogen or, when the reported values for hydrogen, ammonia, and methane were used to calculate a percent of the LFL, the result was ≤0.5%of the LFL. For the 22 samples that did not have a < value reported for hydrogen and resulted in a calculated concentration greater than 0.5% of the LFL, the values ranged from 0.54 to 2.51% and averaged 1.48% of the LFL.

The % LFL values shown in Table KA-1 are based upon the highest concentration of the flammable gases present in the respective samples. The highest calculated % LFL shown is for 241-A-101. A flammable gas mixture of 786 ppm hydrogen, 800 ppm ammonia and 12 ppm methane (49.19% hydrogen, 50.01% ammonia, 0.80% methane) has a calculated LFL of 63,759 ppm, or 6.4 vol%. With 1,598 ppm of flammable gases present, the percent LFL is (1,598 ÷ 63,759) x 100 = 2.51%. If only hydrogen was being monitored for, the hydrogen at 100% of the LFL for the flammable gas mixture would be 0.4919 x 63,759 = 31,363 ppm, or 3.1% hydrogen. An alarm at 25% of the LFL would be extremely conservative when set at 0.25 x 31363 = 7840 ppm hydrogen. For higher volume gas releases that would result in 60,000+ ppm flammable gases in the vapor space, the hydrogen:ammonia would be much larger than the 0.492:0.501 ratio assumed. This is due to ammonia being a soluble gas that would be in equilibrium with ammonia in solution. In order to get to 30,000 ppm ammonia in the vapor space, the waste concentration would have to have a very high ammonia content, i.e., ammonia would have to be present in the waste as a major chemical constituent, not as a degradation product. The last significant volumes of ammonia bearing wastes sent to tank farms were

declad wastes from Plutonium-Uranium Extraction Facility (PUREX) in the mid-1980s which went to a few selected double-shell tanks (DSTs) in AW and AP farms. Any SSTs which received ammonia wastes from PUREX in the late 1960s or early 1970s would have had the majority of the ammonia evaporated by now.

Nitrous oxide was not considered in the LFL calculations for Table KA-1. Although it is present at about 28% of the hydrogen concentration in Tank 241-A-101, its effect on the calculated vapor phase LFL is negligible. The vapor phase for Tank 241-A-101 has an oxygen concentration approximately 1,000 times the nitrous oxide level.

The total nonmethane organic hydrocarbon (TNMHC) percent LFL was calculated separately from the "normal" LFL and assumed that 45,000 mg/m^3 is equivalent to 100% LFL. The TNMHC values referred to in this appendix includes organic vapors in equilibrium with small quantities of organics in the tank liquids. A concentration of 46,000 mg/m^3 is the LFL for the kerosene hydrocarbons used as an organic diluent in PUREX and some B Plant processing operations (Bates, 1996, *Transmittal of Letter Report "Preliminary Retained Gas Sampler Results for Tank 241-AW-101"*). Further, a value of 45,000 mg/m^3 is normally used as the LFL for the range of organic vapors occasionally found in the Hanford Site waste tanks. Only four tanks showed greater than 0.49% LFL for organic vapors and mists. The four values ranged from 0.49% to 3.80%. Only two tanks (241-C-103 and 241-BY-108) have shown nonmethane organics above 1% of the LFL in the tank headspace (Table KA-1). These organics are mostly kerosene-type hydrocarbons. They are associated with past chemical processing operations that have entered the waste tanks in minor quantities along with aqueous waste streams. Methane is included in the LFL calculations in Table KA-1, but not in the few organic % LFLs. Gaseous nonmethane hydrocarbons such as ethane and propane were not included in the organic vapor LFL calculations, but were included as methane with the LFL calculations supporting Figure KA-1.

Gaseous hydrocarbons such as methane, and to a lesser extent ethane and propane, occasionally are present in low concentrations in waste gases (Table KA-4). They are believed to be formed from degradation of organic chemicals present in the waste in some tanks. By using a conservative concentration for methane (about 0.5 vol% in the undiluted waste gas) in the LFL calculations for Figure KA-1, the contribution of other organics to the LFL can be assumed to have negligible impact on the LFL.

The CGM reading and Type 3 sample for one IMUST were taken from approximately the middle of the tank headspace. No detectable flammable gas was found.

Table KA-1 summarizes the analytical results available for 81 formal vapor samples as of January 1, 1997, and the results of the 46 special tank safety program CGM reading and samples. Fourteen tanks had both types of samples taken. Thus, readily available headspace sample results for 114 SSTs (77% of the total) indicate that 70 to 90% of the sampled tanks show negligible or nondetectable flammable gas levels when no waste intrusive work is being done, and the remaining nominal 10 to 30% of the tanks average about 1.2 to 1.5% of the LFL. The highest CGM reading (7%) equates to approximately 3.5% of the LFL. The highest vapor sample was calculated to correlate to

2.51% of the LFL. One IMUST tank sampled showed no flammable gas present. The highest organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. This waste tank is known to have a significant floating organic layer on top of the waste.

The flammable gases of concern in the waste tanks require an oxidizer to burn. The primary oxidizer in the tank headspace is oxygen, which is present in air at about 20.95 vol%. Nitrous oxide is present in the waste slurry gas, at an estimated nitrous oxide:hydrogen ratio of 0.85 for Tank 241-SY-101 (LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*). Eight core sampling drill strings and one failed liquid observation well (LOW) have shown high LFL readings. Samples obtained from these locations (Table KA-4) indicated nitrous oxide:hydrogen ratio of 0 to 0.86, with an average of 0.40. Analytical results are available (Bates, 1996) from 5 tanks which have had retained gas samples (RGS) taken to date. These show a range of nitrous oxide:hydrogen ratio of 0.06 to 0.40 with an average of 0.17. Nitrous oxide in high concentrations can affect the calculated LFL for the undiluted waste gas as it acts as an oxidizer in addition to any oxygen present. When waste gas is diluted by air in the tank vapor space the nitrous oxide is overshadowed by the oxygen in the air and will thus have little effect on the calculated LFL for the tank vapor space (Section KA2.4).

KA2.2 TECHNICAL BASES FOR LFL

The potential reactions between flammable gases and oxidizers in the waste tanks are in WHC-SD-WM-SARR-002 and -004, (WHC-SD-WM-SARR-002, *Safety Basis for Activities in Double-Shell Tanks with Flammable Gas Concerns* and WHC-SD-WM-SARR-004, *Safety Basis for Activities in Single-Shell Tanks with Flammable Gas Concerns*) and repeated in Table KA-2.

The internal energy of the combustion reaction is defined as the enthalpy of the combustion reaction minus any pressure-volume work done by the process. Mathematically this is:

$$U_{RP} = h_{RP} - RT(n_P - n_R)$$

where h_{RP} is the enthalpy of combustion
- R is the ideal gas constant
- T is the temperature of the vapor space after mixing (34 °C assumed)
- n_P is the number of moles of products
- n_R is the number of moles of reactants.

As shown in Table KA-2, the reaction of hydrogen with oxygen generates the least heat per mole of the reactions given. Because of the predominance of hydrogen and ammonia as flammable gases, the major contributor to the total energy released in an ignition event in a tank headspace would be hydrogen or ammonia combining with oxygen.

Waste Slurry Gas Composition. To calculate an LFL for a waste gas mixture, it is necessary to know the waste gas concentration. The waste gas composition has been evaluated extensively for Tank 241-SY-101 and to a lesser extent for other tanks by analyzing the diluted off gas and backing out the contribution from nitrogen and oxygen in air.

Table KA-3 summarizes the values used in LA-UR-92-3196, WHC-SD-WM-SARR-002 and WHC-SD-WM-SARR-004, and WHC-SD-WM-ES-346, *Flammable Gas Tank Safety Program: Technical Basis for Gas Sampling and Monitoring*, as conservative gas mixtures in calculations of tank LFLs. These compositions were based upon DST releases, for which sample results were available, because only negligible significant observed releases from SSTs have occurred since the flammable gas Unreviewed Safety Question (USQ) was declared.

In the fall of 1995, monitoring for flammable gases was initiated inside core sampling drill strings. Since then, eight gas samples have been taken from inside drill strings which have exhibited high LFL readings. The sample results are given in Table KA-4. The samples represent an opportunity to obtain waste gas samples prior to dilution in the tank headspace. Some of the samples have been diluted by nitrogen or argon purge gas, or air in the drill string. Ammonia results from these samples are low, however, due to absorption during the informal grab sampling process, but the ratios of nitrous oxide, carbon monoxide, carbon dioxide, methane, or other C_nH_{2n+2} to hydrogen are useful data. Where the effect of air can be accounted for, the ratio of nitrogen to hydrogen is also given. In mid-1995 a grab sample was retrieved from a failed LOW. Results from this sample are also included in Table KA-4.

In 1996, the first RGSs were taken from Tank 241-AW-101. These samplers were designed to trap waste gases and liquid/solid waste taken during core sampling operations. The samples will allow analysis of concentrated waste gases and provide other information on waste gas makeup. Bates (1996) describes the sampling and analytical process and summarizes the results from the samples obtained to date. These results are given in Table KA-5. The gases in the RGS samples are extracted in the laboratory by repeatedly evacuating the sample and trapping the off gas. Because ammonia is a soluble gas, the ammonia in the gas phase in a waste gas pocket is in equilibrium with ammonia in solution in the waste around it. Thus, more ammonia is drawn out of solution to return the gas phase to equilibrium when an RGS sample is evacuated. Therefore, RGS sample results for ammonia in the gas phase will be biased high if all the recovered ammonia is reported. The ammonia values given in Table KA-5 are calculated quantities based upon the Henry's law constant. The derivation of this value and the calculations performed to estimate the lower bound on the ammonia vapor concentration in the waste gas is described in detail in Bates (1996).

KA2.4 DERIVATION OF 25% OF THE LFL ALARM LIMIT WHEN MONITORING FOR HYDROGEN ONLY

The LFL used in this JCO is the lowest concentration of a flammable gas mixture that will support combustion in the presence of a given oxidizer. The LFL will vary with the oxidizer. Table KA-6 summarizes values from the referenced sources of the LFLs for the flammable gases of concern in air and in nitrous oxide.

Using Le Chatelier's rule, the LFL of an ideal gas mixture can be calculated by

$$LFL_{mix} = \frac{1}{\frac{f_{fg1}}{LFL_{fg1}} + \frac{f_{fg2}}{LFL_{fg2}} + \frac{f_{fg3}}{LFL_{fg3}} + \cdots \frac{f_{fgn}}{LFL_{fgn}}}$$

where f_{fg1} = mole fraction of flammable gas #1
LFL_{fg1} = LFL of flammable gas #1

The LFL_{mix} and the mole fractions of flammable gas 1, 2, etc. are based on the flammable gases present only, i.e., all nonflammable constituents are excluded.

Assumptions, evaluations, and results of previous estimates for hydrogen concentrations that represent the LFL or 25% of the LFL are summarized for consideration in establishing the values used in this JCO.

KA.2.4.1 Tank 241-SY-101

LA-UR-92-3196, Appendix B. This reference estimated the LFL for Tank 241-SY-101 waste gases based on Le Chatelier's rule and using the concentrations given in column 2a of Table KA-3 (after revising to a flammable gas constituent only basis) with the LFL in air values in column 2 of Table KA-6.

The LFL value of the mixture calculates to 5.3 vol% in the tank vapor space based on the flammable gas constituents only, or 11.1 vol% if all waste gas constituents are included. This means that 11.1% of the tank dome space would have to be filled with all the gases in Table KA-3, in the ratios given, with the remaining 88.9% being air, for the tank dome space to be at 100% of the LFL. Monitoring for all the waste slurry gases in the tank dome space is impractical, so the hydrogen concentration at 100% of the LFL is calculated and used as a basis for monitoring. The hydrogen concentration at a waste gas concentration of 11.1 vol% in the tank vapor space calculates to 3.5 vol%. LA-UR-92-3196 gives 3.5% hydrogen in the tank vapor space as a conservative value that would indicate the presence of waste gas at 100% of the LFL in the tank vapor space, with 25% of the LFL being 8,750 ppm. LA-UR-92-3196 recommends using 8,750 ppm as 25% of the LFL, but with an administrative control of 7,500 ppm hydrogen as a monitoring limit to account for instrument uncertainties.

LA-UR-92-3196 discusses the effect of nitrous oxide on the LFL for 241-SY-101. Using the "conservative" composition for 241-SY-101 waste gas, the dome space would contain about 12.7% waste gas when the concentration of

hydrogen reached 4% in the tank dome. With a hydrogen concentration of 4%, the concentrations of ammonia and nitrous oxide would be about 1.9% and 3.4%, respectively. Bureau of Mines data referenced in LA-UR-92-3196 showed that at up to 2% ammonia in a stoichiometric mix of hydrogen and nitrous oxide diluted with air, Le Chatelier's law was appropriate for determining the LFL.

KA.2.4.2 All Tanks

WHC-SD-WM-SARR-002 and -004 Appendices B, and WHC-SD-WM-ES-346. These references used Le Chatelier's rule to arrive at a ppm hydrogen limit that could be used for the vapor space of all tanks. The method included the effect of nitrous oxide on the LFL and looked at varying the hydrogen level in the waste gas. These documents recommended using 6,250 ppm hydrogen as the alarm point for hydrogen monitoring systems to indicate when 25% of the LFL may have been reached in a tank vapor space.

The 6,250 ppm limit is very conservative because the following assumptions were used:

- A LFL of 3.5% was used for hydrogen in air
- A LFL of 8% was used for ammonia in air
- A plot was presented of the waste gas LFL versus the hydrogen concentration in the waste slurry gas excluding noncombustibles. Interpretation of the plot assumed an extremely conservative hydrogen concentration in the waste slurry gas.

KA.2.4.3 Current Data

The sample data from Table KA-1 was used to calculate the % LFL for each tank with formal sample analyses. The tank % LFLs are repeated in Table KA-8 from Table KA-1. The LFL of the flammable gas mixture and the equivalent hydrogen concentration at 25% of the LFL were calculated for the flammable gas mixture in the tank vapor space for all 81 samples. This information is presented in Table KA-8. Also included in Table KA-8 are calculations based upon the sample data from Table KA-4 for the Tank 241-BY-110 drill string and the Tank 241-SX-104 failed LOW.

Where a range was given in Table KA-1, the highest gas concentrations were used. Where a < value is stated, the < value was used as the concentration. The calculated tank vapor space flammable gas LFLs ranged from 4.27% to 10.78% by volume. Hydrogen concentration equivalent to 25% of the LFL ranged from 1,270 ppmv to 9,720 ppmv. The average LFL for all samples (excluding the Tanks 241-BY-110 and 241-SX-104 waste gas samples) was 6.36% and the average hydrogen concentration at 25% of the LFL was 6,150 ppm. The average LFL including only samples with detectable concentrations calculating above 0.5% of the LFL (again, excluding Tanks 241-BY-110 and 241-SX-104 waste gas results) was 5.32% and the average hydrogen concentration at 25% of the LFL was 7,700 ppm. The average of the LFL for the Tanks 241-BY-110 and 241-SX-104 waste gases was 4.29%, and the average hydrogen concentration at 25% of the LFL was 9,310 ppm.

These results are skewed due to the low flammable gas concentrations present, and by using < values instead of zero in the LFL calculations. The results should not be extrapolated to higher flammable gas concentrations, and should not be used as valid hydrogen concentrations at 25% of the LFL. Hydrogen, ammonia, and methane are generated by radiolysis within the waste.

Ammonia is a soluble gas and largely remains in solution. Being in solution in the waste, ammonia will be present in the tank vapor space in equilibrium with dissolved ammonia. For this reason ammonia is present in detectable concentrations in most tank vapor spaces. Hydrogen and methane, being insoluble, can be trapped in pockets instead of being released. This explains the low or non detectable levels of these gases in many tanks. Basing calculated LFLs or hydrogen concentrations at 25% of the LFL on low level tank vapor results is misleading. At low levels of flammable gases in a tank, ammonia will predominate and skew the sample results to give a high tank LFL and a low hydrogen concentration at a calculated 25% of the LFL. Flammable gas levels approaching 25% of the LFL would only occur following a release of significant hydrogen or methane from the waste, which will mean a much lower ratio of ammonia to these gases than is present during steady state releases. Should a GRE occur, significant hydrogen and methane could be released, but the ammonia should be no more than what would be in equilibrium with ammonia in the liquid waste at the tank bottom.

This effect can be seen in the data in Table KA-8. Including all tank vapor space data the calculated hydrogen concentration at 25% of the LFL was 6,150 ppm. This rises to 7,460 ppm when only vapor spaces above 0.5% of the LFL are considered, to 7,700 ppm when only vapor spaces above 2% of the LFL are included, and reaches 9,310 ppm for the waste gas samples at 650% and 64% of the LFL. Based upon this data, 7,500 ppm is a reasonable value for the hydrogen concentration at 25% of the LFL.

KA.2.4.4 Calculated Limit

Limit As Applied To This JCO. LA-UR-92-3196, WHC-SD-WM-SARR-002, WHC-SD-WM-SARR-004, and WHC-SD-WM-ES-346 calculated hydrogen concentrations that give 25% of the LFL for a conservative waste gas composition, but may have some limitations. The method in LA-UR-92-3196 is for Tank 241-SY-101 only. The other references vary the hydrogen content of the waste slurry gas to provide a range of LFLs. They use conservative values for the LFLs for hydrogen and ammonia in air, and a conservative assumption is used in interpretation of the results.

The LFL calculations were redone for this document using the following assumptions:

- The ratios of ammonia:methane:carbon monoxide were kept constant and equal to those in column 2b of Table KA-3.
- The values for LFL in air were assumed equal to those in column 7 of Table KA-6 CRC Handbook of Chemistry and Physics and for LFL in nitrous oxide were assumed equal to those in column 6.

- The LFL values used in subsequent calculations were based on a gas of 92.6% air/7.4% nitrous oxide, as was done for WHC-SD-WM-SARR-002 and -004. This is conservative as the ratios of oxygen to nitrous oxide present in the tank vapor space will be far greater than this, and result in the oxygen swamping the nitrous oxide. A linear interpolation was made between the values for LFL in air and in nitrous oxide for hydrogen, ammonia, and methane. The value for LFL in air was used for carbon monoxide. These resulted in using conservative LFL values of 3.84 for hydrogen, 14.5 for ammonia, 4.69 for methane, and 12.5 for carbon monoxide in the air/nitrous oxide mix.

- The LFL was calculated for a waste slurry gas consisting of the four flammable constituents, with the hydrogen concentration varying, but the other three constituents kept in the same ratio to each other, and making up the remainder of the flammable gas mixture. The percent hydrogen that would occur in the tank vapor space at 100% of the LFL for the waste slurry gas in the tank vapor space was then plotted as a function of the percent hydrogen in the waste slurry flammable gases, (i.e., excluding all noncombustible constituents).

This plot is provided as Figure KA-1 for this JCO. The conservative hydrogen concentration in the 241-SY-101 waste slurry gas (and as used in References 3 and 4), from Table KA-3 column 2a, is 31.41% hydrogen, which is 66.3% of the flammable gases. From Figure KA-1, this equates to a vapor space hydrogen concentration of about 3.4% hydrogen, which is essentially the same as the 3.5% recommended in LA-UR-92-3196.

Estimates of the actual hydrogen concentration in the tank waste gases range from 30 to 70% per WHC-SD-WM-SARR-002 and -004, but this range includes the presence of noncombustibles for significant releases. Including just the combustibles, the hydrogen concentration is expected to be 60% or higher. The "best estimate" gas compositions from LA-UR-92-3196, WHC-SD-WM-SARR-002 and -004, and WHC-SD-WM-ES-346 are given in Table KA-7.

According to this table, the percent hydrogen based on the flammable gases in the waste slurry gas only is 61 to 71%. As shown in Table KA-1, the ratio of hydrogen to ammonia found in tank vapor spaces from chronic releases shows hydrogen could range from less than 10% to greater than 90% of the flammable gases in a tank at very small (<3% of the LFL) concentrations. Experience with monitoring from larger DST releases (the basis for Tables KA-3 and KA-7), and as shown by the waste gas drill string sample results shown in Table KA-4 and RGS sample results in Table KA-5, indicate the majority of flammable gas in GREs or concentrated waste gas samples is hydrogen.

Using Figure KA-1, and assuming 60% of the flammable gas in a waste slurry gas is hydrogen, the hydrogen concentration at 100% of the LFL in a tank vapor space conservatively calculates to 3.22%. Setting a hydrogen concentration that equals 25% of the LFL based on this reasoning calculates to approximately 8,000 ppmv.

KA3.0 SUMMARY

A value of 6,250 ppmv hydrogen shall be assumed as 25% of the LFL for work in tank farms, when hydrogen is the only flammable gas monitored for. This is based on the following:

- LA-UR-92-3196 calculated a value of 8,750 ppm hydrogen as 25% of the LFL for Tank 241-SY-101 waste slurry gas in the tank dome space

- WHC-SD-WM-SARR-002 AND -004 and WHC-SD-WM-ES-346 recommended that a value of 6,250 ppm hydrogen be used as 25% of the LFL for SSTs or DSTs. Overly conservative assumptions were used to derive this number. WHC-SD-WM-SARR-002 and -004 states a value of 7,375 ppm hydrogen should be used as 25% of the LFL if a value of 15% is used for the LFL of ammonia in air.

- Per Table KA-8, the calculated hydrogen concentration at 25% of the LFL could be anywhere from 1,300 ppm to 9,700 ppm for gas mixtures present in very low concentrations. The calculated hydrogen concentration at 25% LFL rises with increasing flammable gas levels and averaged 7,700 ppm for the 7 tanks above 2% of the LFL.

- In this document, a value of about 8,000 ppm hydrogen is calculated as being ≤25%of the LFL for tank waste slurry gas in the tank dome space for any tank.

- Based upon the evaluation provided in this appendix, a 7,500 ppm value for hydrogen at 25% of the LFL is reasonable for use in evaluating gas measurements to understand the actual hazard present. However, the conclusion and supporting analysis for the value to use in setting monitoring alarm setpoints and action limits is described in WHC-SD-WM-ES-346. Until this document is revised and reviewed, 6,250 ppm hydrogen will be used for monitoring alarm and action setpoints.

KA4.0 FLAMMABLE GAS MONITORING METHODS

Several methods are used to monitor for various flammable gases or vapors in the tank farms. These include CGMs, organic vapor monitors (OVMs), Drager tubes, Standard Hydrogen Monitoring Systems (SHMS), gas chromatographs, and taking Type 2, 3, and 4 vapor samples. Because this section covers monitoring for hydrogen or flammable gases to demonstrate compliance with the 25% of the LFL control limit, the discussion will address only CGMs, SHMS, and Belhaven monitors.

KA4.1 COMBUSTIBLE GAS METERS

The CGM predominantly used in the tank farms is the Industrial Scientific Corporation model LTX 310. This unit is calibrated on pentane before and after each shift it is used, in accordance with Industrial Hygiene procedures. The manufacturer provides a table of conversion factors to be applied when the model LTX 310 is used for monitoring for gases other than pentane. Following

the manufacturer's information, the CGM reading should be multiplied by a correction factor of 0.5 when monitoring for hydrogen. Thus, a reading of 20% of the LFL on the LTX 310 means that the actual hydrogen concentration is 10% of the LFL, assuming hydrogen is the only flammable gas present. For conservatism, and to avoid confusion in the field, the LTX 310 reading is not multiplied by the correction factor, so a 20% of the LFL reading is treated as 20% of the LFL, not 10%.

According to the manufacturer, the conversion factors to be applied when monitoring for other gases are accurate to about +/-25%. A 25% of the LFL indication on the LTX 310 means that the actual hydrogen concentration is in the nominal range of 9.4% to 15.6% of the LFL. Therefore, without applying the correction factor, the indicated CGM reading is 60 to 167% higher than the actual percent of the LFL for hydrogen, assuming hydrogen is the only flammable gas present. Tank farm procedures require a reading to be treated at the indicated value, so when performing work a 25% of the LFL indication on a CGM is assumed to mean 25% of the LFL for a flammable gas mixture is present.

WHC-SD-WM-TRP-256, *Test Evaluation of Industrial Hygiene Hand Held Combustible Gas Monitor* evaluated the response of the CGMs to hydrogen in air. The data showed that below 3% of the LFL for hydrogen in air (about 1,200 ppm hydrogen), the units were unable to accurately measure the LFL as the concentrations were too low. Around 1,200 ppm the units were fairly accurate without applying the 0.5 correction factor. As the percent hydrogen rose above 1,200 ppm the indicated LFL, even after applying the 0.5 correction factor, was 5 to 40% above the actual. The CGM response was also checked in the presence of nitrous oxide and ammonia. The presence of ammonia and/or nitrous oxide also resulted in the indicated LFL reading being higher than actual after applying the correction factor.

The LTX 310 CGM, as employed in the tank farms, is not applicable for characterization of tank vapor spaces, but can be safely and conservatively used for LFL monitoring to an indicated 25% of the LFL, and is expected to read high for any gas mixture present. Therefore, a 25% of the LFL monitoring limit is acceptable when using these instruments. When 25% of the LFL is indicated, response shall be as required by the flammable gas specification limit of this JCO.

KA4.2 STANDARD HYDROGEN MONITORING SYSTEMS

These monitors are installed on many of the tanks currently on the Flammable Gas Watch List. They operate using a Whittaker cell to detect hydrogen only. These monitors currently have a 6,250 ppm hydrogen set point.

KA4.3 CONTINUOUS INSTALLED COMBUSTIBLE GAS METERS

These meters are currently used to monitor the salt well pit vapor space of several tanks being salt well pumped. These units are calibrated on methane approximately monthly. According to the manufacturer the correlation is 1:1 (no correction factor) when monitoring hydrogen. Based on a test gas mixture of hydrogen, ammonia, and methane in air, the unit read slightly

higher for hydrogen than the level present in the test gas. When measuring a gas with an LFL of 2.5% for hydrogen in air, a value of 3.2% was indicated. Below 5% of the LFL the units appear to read high. The units work best on a concentration of 5 to 30% of the LFL. Based on experience, the installed CGMs can be used to adequately monitor for compliance with the 25% LFL limit using the recommended monitoring limit.

KA4.4 OTHER HYDROGEN/FLAMMABLE GAS MONITORS

Some tanks have gas chromatographs installed to analyze the vapor space. Other hydrogen monitors may be selected for use in the future. Any such monitor may be used for monitoring for compliance with the flammable gas specification limit as long as it is shown to read conservatively at less than 25% of the LFL for a conservative waste gas mixture.

KA5.0 REFERENCES

See Appendix K, K7.0, "REFERENCES."

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
A-101	6/9/95 (3)	743-786	728-800	<12	21.9	217-219	26.3-27.1				2.51	69-71
A-102	11/10/95 (3)	294-302	248-263	<4	6.1	225-229	26-28.3				0.93	89-90
A-103	4/6/95 (3)	271-278	256-273	<4	8.2	219-226	25.2-27.7				0.88	93-100
A-104	1/14/96							0	<5	0	0	
A-105	1/19/96							0	30	2.5	0	
A-106												
AX-101	6/15/95 (3)	102-103	39-44	<12	2.6	0	12.6-13.8				0.31	47-51
AX-102	6/29/95 (3)	<98	30-37	<12	9.0	50-51	12.7-14.2				<0.29	71-80
AX-103	6/27/95 (3)	<98	37-44	<12	1.5	23-24	14.7-15.8				<0.30	51-55
AX-104												
B-101	3/26/96							0	20	10.7	0	
B-102	4/18/96 (3)	<17	3.7-5.5	<25	4.2-4.3	59-68	12.7-13.1				<0.1	
B-103	2/8/95 (3) 10/17/96 (4)	<99	7.7-10	<61	12.8	75.9	10.3-11.1				<0.38	87-92
B-104	3/26/96							0	0	1.8	0	
B-105	6/6/96 7/30/96 (4)	<17	5.2-5.9	<25	0.75-0.78	19-31	10.1-12	1	12	3	1 <0.1	
B-106	4/26/96							0	0	0	0	
B-107	6/6/96 7/23/96	<17	17-26	<25	<0.6	<17	13-14.1	2	25	3	2 <0.11	
B-108	4/26/96							0	30	2.4	0	
B-109	6/12/96							0	35	1.8	0	
B-110	4/26/96							0	50	5.5	0	
B-111	3/19/96							0	25	0	0	

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
B-112												
B-201	6/4/96							0	<5	0	0	
B-202	6/4/96 7/18/96 (4)	<17	2.6	<25	<0.6	<17	3.2-14.8	0	<5	0	0 <0.09	
B-203												
B-204	4/26/96							0	<5	0	0	
BX-101	4/24/96							0	50	3.3	0	
BX-102	6/24/96 7/31/96 (4)	<17	2.4-2.5	<25	0.41-0.46	<17	9.2-17.6	0	0	0	0 <0.09	
BX-103	3/26/96							0	70	6.4	0	
BX-104	12/30/94 (3) 8/22/96 (4) 12/13/96 (4)	<94	229-238	<61	77.9	136-150	6.1-7.1				<0.51	
BX-105	4/24/96 (3)	45-56	141-155	<25	4.4-4.5	116-118	10.1-11.1				0.29	
BX-106	12/9/95 8/15/96	<17	42-47	<25	0.9-1.1	43-44	9.3-11.2	0	50	6.7	0 <0.12	
BX-107	11/16/95 (3)	10-14	76-89	<4	2.5	11-13	15.4-17.6				<0.10	92-100
BX-108												
BX-109	4/24/96 (G)							0	20	1.7	0	
BX-110	10/2/95 (G) 4/30/96 (3)	<17	58-66	<25	1.8-2.1	<17	8.5-9.2	0	50	3.8	0 <0.14	
BX-111	4/24/96 (G) 8/27/96 (4)	no data						0	45	2.2	0	
BX-112												
BY-101	8/29/96 (4)	no data										

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
BY-102	11/20/95 (3)	33-37	170-180	<4	18.3	17-18	14.5-16				0.22	
BY-103	11/1/94 (3)	21-22	24-30	<61	10.7	16-49.2	11.4-16				<0.20	54-76
BY-104	6/24/94 (3)	204-312	242-255	8-9	54.7	195-308	14.1-16.7				0.96	62-73
BY-105	7/7/94 (3)	84-87	41-44	3.8	11.6	49-122	16.5-17.6				0.25	70-75
BY-106	7/8/94 (3)	40-104	72-78	3.6	12.7	70-98	11.4-18.9				0.32	47-75
BY-107	10/26/94 (3)	687-698	963-978	<20	151.9	587-827	13.1-15.9				2.42	55-68
BY-108	10/27/94 (3) 1/26/96 (3/4) 3/28/96 (3/4) 9/10/96 (3) 11/15/96 (3)	335-647 all data not availabl e	779-1140	7.8-20	177-610	440-762	11.2-63.6				2.39 1.17 org	48-100
BY-109	?				18.1							
BY-110	11/11/94 (3)	<160	385-426	<61	43.8	81-125	8.9-12.5				<0.80	40-54
BY-111	11/16/94 (3)	65-69	57-61	<61	8.5	98-99	6.9-9.1				0.33	37-48
BY-112	11/18/94 (3)	<94	54-71	<61	12.6	33-44	11.3-13.8				<0.40	72-74
C-101	9/1/94 (3)	434-439	96-99	12	221.6	639-650	36-37				1.19 0.49 org	97-100
C-102	8/23/94 (3)	131-165	183-192	12	279.5	108-156	22-26				0.56 0.62 org	100
C-103	4/15/94 (3)	676-894	308-349	13.2-17 .7	1709.6	505-947	15.7-81				2.50 3.80 org	100
C-104	3/3/94 (3)	60-76	44	neg	25.4	62-67	13.9-15.5				0.22	55-58
C-105	2/16/94 (2)	20-24	1.9-2.7	neg	1.4	5-5.5	6.1-8.7				0.06	42-60
C-106	2/15/94 (2)	8-12	0.2-8.8	neg	0.4	3.4-4.3	0.9-23.3				0.04	50-100

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m³	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
C-107	9/29/94 (3) 1/17/96 (3/4) 3/26/96 (3/4) 9/6/96 (3) 12/17/96 (3)	110-258 all data not availabl e	45-87	<20	2.8-3.7	35-78	29-85				0.74	100
C-108	8/5/94 (3)	14-16	2.4-3.3	0.1	0.3	343-345	18-22				0.04	85-100
C-109	8/9/94 (3)	124-125	9.1-11.4	0.9	1.4	367-371	21-24				0.32	85-100
C-110	8/24/94 (3)	12	120-130	<61	20.5	6.6-22	13-15				<0.24	88-100
C-111	9/13/94 (3)	10-14	4.7-6.8	0.3	1.0	98-100	23-27				0.04	87-100
C-112	8/11/94 (3)	200-210	22-23	1.0	3.0	534-547	24-28				0.54	100
C-201	6/19/96 (4)	<17	<1.4	<25	2.6-2.7	<17	8.6-11.6				<0.09	
C-202	6/26/96 (4)	<17	<0.7	<25	1.0-1.4	<17	7.6-8.3				<0.09	
C-203												
C-204	6/3/96 7/2/96	<17	0.7-0.8	0.16-21	76-82	0.7-0.9	7.6-8.1	0	0	13.7	0 <0.09	
S-101	4/3/96 6/6/96 (4)	439-444	764-777	0.2-177	8.3	267-274	17.8-20.9	7	600	31	7 1.96	
S-102	3/6/95 (3) 1/26/96 (3/4) 4/3/96 (3/4) 9/19/96 (3) 12/19/96 (3)	613-740 all data not availabl e	402-642	<12	15-20	487-707	12-16.4				2.29	75-100
S-103	5/17/96 6/12/96	78-81	147-153	<0.2-16	1.2-1.3	134-139	10.9-11.5	0	300	2.6	0 0.33	
S-104	3/19/96 (G)							0	25	0	0	
S-105	12/13/95 (3)	20-22	34-38	<4	2.6	7-8	10.1-11.3				0.09	60-69

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
S-106	5/17/96 (G) 6/13/96 (4)	<17	32-39	<0.8-16	1.76-1.91	<0.2-17	8.5-9.2	0	40	1.6	0 <0.10	
S-107	6/18/96 (4)	360-366	176-187	<25	3.52-3.57	91-92	22.8-23.6				1.09	
S-108	12/15/95 (3)	21-23	24-27	<4	2.9	3	12-13.4				0.08	72-81
S-109	5/17/96 (G) 6/4/96 (4)	<17	43-48	<25	3.08-4.11	<17	10.6-11.1	0	80	3	0 <0.12	
S-110	12/4/95 (3)	132-139	141-153	<4	4.2	39-40	15.9-17.6				0.45	68-70
S-111	3/13/95 (3)	390-392	115-124	<23	3.7	46-50	12.4-12.8				1.11	80-85
S-112	7/11/95 (3)	<25	86-90	<25	5.5	0	13.3				<0.17	80-82
SX-101	7/19/95 (3)	<25	3.4-4.2	<25	1.5	0	11.3-12.4				<0.12	23-26
SX-102	7/21/95 (3)	<25	15-16	<25	1.6	0	4.9-12.4				<0.12	15-37
SX-103	3/20/95 (3)	<23	71-80	<23	2.0	0	13.9-14.7				<0.16	37-38
SX-104	7/25/95 (3)	<25	24-26	<25	1.6	0	8.6-9.9				<0.13	29-33
SX-105	7/26/95 (3)	<25	25-30	<25	1.7	0	10.6-13.9				<0.13	31-38
SX-106	3/27/95 (3)	<98	171-188	<12	2.4	14	16.5-16.7				<0.39	64-65
SX-107												
SX-108												
SX-109	8/1/95 (3) (Duct)	<25	16-18	<25	1.6	0	7.1-8.7				<0.12	8-10
SX-110												
SX-111												
SX-112												
SX-113												
SX-114												

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
SX-115	3/8/96							0	0	0	0	
T-101												
T-102	5/9/96							0	0	0	0	
T-103	2/15/96							0	0	0	0	
T-104	2/7/96 (3/4)	4-17 all data not availabl e	102-110	<4	1.9	7-8	11.6-12.6				0.12	90-100
T-105	5/9/96							0	150	4.9	0	
T-106	5/9/96							0	100	2.4	0	
T-107	1/18/95 (3)	<94	122-127	<61	3.8	35.6-48	13.1-13.5				<0.44	98-100
T-108	5/9/96							0	20	1.2	0	
T-109	5/9/96							0	5	1.2	0	
T-110	8/3/95 (3)	<25	108-109	<25	1.6	0	16.6-17.1				<0.18	100
T-111	1/20/95 (3)	<94	225-227	<61	22.5	0	12.5-13.1				<0.50	98-100
T-112	5/9/96							0	40	1.2	0	
T-201												
T-202												
T-203	3/19/96							0	0	1.6	0	
T-204												
TX-101	6/14/96							0	20	6.8	0	
TX-102	6/20/96							0	100	15.5	0	
TX-103	6/17/96							0	100	14.9	0	

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
TX-104												
TX-105	12/20/94 (3)	<99	19-21	<61	4.6	12.8	14.1-16.3				<0.38	72-82
TX-106												
TX-107												
TX-108												
TX-109												
TX-110												
TX-111	10/11/95 (3)	107-110	588-638	<25	13.1	175-178	12.8-14.5				0.74	89-100
TX-112												
TX-113	6/18/96							0	20	2	0	
TX-114	6/18/96							0	150	8	0	
TX-115												
TX-116	3/19/96							0	0	6	0	
TX-117	3/19/96							0	25	0	0	
TX-118	12/16/94 (3)	96-98	31-36	<61	10.7						0.39	50-62
TY-101	4/5/95 (3)	<93	15-17	<12	1.7						<0.27	81-83
TY-102	4/12/96 (3)	<3.1	4.0-4.1	<4.3	3.08-4.11	66-88	9.3-10				<0.02	
TY-103	4/13/95 (3) 11/6/96 (4)	<93	47-51	<12	55.6	130-201	12.6-12.9				<0.29	94-100
TY-104	4/26/95 (3)	<49	57-62	<23	2.8						<0.21	100
TY-105												
TY-106												
U-101	2/14/96							1	100	7.4	1	

Table KA-1. Single-Shell Tank and Inactive Miscellaneous Underground Storage Tank Vapor Sample Data. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results						Grab Sample Results			Calculated Values	
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	Nitrous Oxide ppmv	Water Vapor mg/L	% LFL	Ammonia ppmv	TOC ppmv	% LFL for Flammable Gases	Relative Humidity
U-102												
U-103	2/15/95 (3)	552-557	720-761	<61	20.9						2.01	90-100
U-104	5/10/96 (M) 7/16/96 (4)	no data						0	<5	0	0	
U-105	2/24/95 (3)	<49	275-354	<23	7.9						<0.40	97-98
U-106	2/26/95 (3)	203-214	931-1013	<61	19.1						1.31	98-100
U-107	2/17/95 (3)	496-505	425-474	<12	15.4						1.59	88-93
U-108	8/18/95 (3)	518-524	679-701	<25	14.5						1.81	77-80
U-109	8/10/95 (3)	724-770	556-608	<25	14.4						2.37	66-70
U-110	3/19/96							2	450	26	2	
U-111	2/20/95 (3)	244-250	671-682	<12	12.3						1.09	79-85
U-112	7/9/96 (4) 12/6/96 (4)	231-233	289-326	<25	1.85-2.16	394-400	7.5-14				0.84	
U-201												
U-202												
U-203	8/9/95 (3)	<25	0.8-1	.25	13.4						<0.11	90-95
U-204	8/7/95 (3)	<25	0.1-0.2	<25	6.5						<0.11	100
C-301 IMUST	9/29/95 (3)	<25	N/A	N/A	2.1			0	0	0	0 <0.06	

Notes: [1]Dates are in the mm/dd/yy format.

Table KA-2. Combustion Reactions and Internal Energy of Reaction.

Reaction	U_{RP} kJ/mole fuel
$H_2 + 0.5\ O_2 \rightarrow H_2O$	-240.55
$H_2 + N_2O \rightarrow H_2O + N_2$	-323.80
$NH_3 + 0.75\ O_2 \rightarrow 1.5\ H_2O + 0.5\ N_2$	-317.44
$NH_3 + 1.5\ N_2O \rightarrow 1.5\ H_2O + 2\ N_2$	-442.45
$CH_4 + 2\ O_2 \rightarrow H_2O + CO_2$	-798.31
$CH_4 + 4\ N_2O \rightarrow 2\ H_2O + CO_2 + 4\ N_2$	-1,132.10
$CO + 0.5\ O_2 \rightarrow CO_2$	-281.72
$CO + N_2O \rightarrow CO_2 + N_2$	-365.04

Table KA-3. Conservative Estimates of Waste Gas Composition Used in Previous LFL Calculations.

Gas	LA-UR-92-3196, Rev 14, App B WHC-SD-WM-SARR-002/004 Rev 1, App B		WHC-SD-WM-ES-346 Rev 0	
	Composition	Gas/H_2 Ratio	Composition	Gas/H_2 Ratio
Hydrogen	31.41 vol %	1	28.42 vol %	1
Ammonia	14.95 %	0.48	22.15 %	0.78
Methane	0.53 %	0.017	0.48 %	0.017
Others	0.5 %	0.016	0.50 %	0.018
Nitrous Oxide	26.69 %	0.85	24.16 %	0.85
Nitrogen	23.51 %	0.75	21.23 %	0.75
Water	2.4 %	remainder	3.07 %	remainder

LA-UR-92-3196, 1995, Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington, Rev. 14, Los Alamos National Laboratory, Los Alamos, New Mexico.

WHC-SD-WM-ES-346, 1995, Flammable Gas Tank Safety Program: Technical Basis for Gas Sampling and Monitoring, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-002, 1996, Safety Basis for Activities in Double-Shell Tanks with Flammable Gas Concerns, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-004, 1996, Safety Basis for Activities in Single-Shell Tanks with Flammable Gas Concerns, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table KA-4. Waste Gas Sample Results From Drill String Grab Samples/Failed LOWs (all values in Vol %).

Gas	Composition									Hydrogen:Gas Ratio								
H_2	0.68[1]	24	0.315	6.2	2.69	0.65	6.8	9.6	2.4	1	1	1	1	1	1	1	1	1
NH_3[7]	-	0.28[2]	<0.001	<0.01	<0.01	none	<0.001	<0.001	0.045 field?	-	86	-	-	-	-	-	-	53
CH_4	0.011[1]	0.83[3]	0.0002	0.08	0.021	0.011	0.183	0.041	0.02	62	29	>1000	78	128	59	37	234	120
C_2H_x	-	1[3]	<0.001	0.02	<0.001	<0.001	0.104	0.047	-	-	24	-	310	-	-	65	204	-
C_3H_x	-	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	960	-
Oth C_xH_y	-	0.6[3]	<0.001	0.001	<0.001	<0.001	0.01	0.02	-	-	40	-	>1000	-	-	680	480	-
ΣC_xH_y	0.011	2.43	0.0002	0.101	0.021	0.011	0.297	0.118	0.02	62	9.9	>1000	61	128	59	23	81	120
N_2O	0.09[1]	15	<0.01	5.31	1.61	0.423	2.29	1.04	0.64	7.6	1.6	-	1.2	1.7	1.5	3.0	9.2	3.8
Oth NO_x	-	-	-	0.05	0.005	-	-	-	-	-	-	-	124	538	-	-	-	-
CO_2	-	-	0.028	-	-	-	-	-	0.0017	-	-	11	-	-	-	-	-	-
N_2	-	57	79.9	88.3	89.3	94.87	38.2 (10.0)[6]	43.8 (9.5)[6]	-	-	-[4]	-[8]	-[4]	-[4]	-[4]	0.68[6]	1.0[6]	-
O_2	-	1	18.8	0.047	6.1	3.86	7.3	9.2	-	-	-[4]	-[8]	-[4]	-[4]	-[4]	-[6]	-[6]	-
Ar	-	-	0.96	-	.293	0.18	45.1[5]	36.3[5]	-	-	-	-	-	-	-	-	-	-
CO	-	-	-	-	-	-	-	-	0.39	-	-	-	-	-	-	-	-	6.2

1 Remaining gas concentrations not readily available for S-107 drill string grab sample.
2 A drager tube sample of the drill string taken about the time of the gas sample indicated about 1000 ppm ammonia (0.1 %).
3 OVM reading of the drill string taken about the time of the gas sample indicated an organic level of 234 ppm (0.02 %).
4 Nitrogen and oxygen ratios not meaningful as majority of nitrogen believed from drill string purge gas, and oxygen present believed from air inleakage.
5 Argon present due to argon used to purge drill string of flammable gases.
6 Nitrogen in waste gas derived by calculating nitrogen contamination from air at 3.7279[oxygen], and subtracting this from total nitrogen.
7 Ammonia values may be low due to gas absorbing on walls of sampling equipment, or for S-107, AN-104 and AN-103 due to absorption in the LiBr solution in the drill string.
8 Nitrogen and oxygen ratios not meaningful as majority of nitrogen/oxygen believed from air inleakage.

Table KA-5. Summary of RGS Sample Results.

	AW-101	A-101	AN-105	AN-104	AN-103
Maximum Percent Waste Gas in The Non-Convective Layer	4.2 ±0.4%	17.8 ±1.1%	11.1 ±0.9%	13.3 ±1.3%	11.0 ±1
Mole % H_2 in Vapor	31 ±2.5%	75 ±3.8%	63 ±3.8%	47 ±3.9%	61 ±7.7
Mole % N_2O in Vapor	4.3 ±0.4%	5.6 ±0.3%	11 ±0.8%	19 ±1.7%	3.8 ±0.
Mole % N_2 in Vapor	60 ±5.2%	16 ±0.9%	25 ±2.2%	32 ±3.1%	34 ±4.5
Lower Bound on Mole % NH_3 in Vapor	0.02 ±0.02%	2.4 ±1.3%	0.02 ±0.02%	0.02 ±0.02%	0.05%

Table KA-6. Summary of Lower Flammability Limit Values for Selected Waste Slurry Flammable Gas Constituents in Air and Nitrous Oxide Used in Lower Flammability Limit Calculations.

Gas	LA-UR-92-3196 App B Rev 14	WHC-SD-WM-ES-346 Rev 0		WHC-SD-WM-SARR -004 Rev 1		CRC Handbook 68th Edition
	Air	Air/O_2	N_2O	Air	N_2O	Air
Hydrogen	4%	3.5[1]	1.8	3.5[1]	1.8	4.00
Ammonia	15%	8.0	2.0	8.0[2]	2.0	15.50
Methane	5.5%	5.0	0.8	5.0	0.8	5.00
Carbon Monoxide	12.5%	12.5	--	12.5	--	12.50

[1]LFL @ 400 °K (127 °C). Other LFLs given at 20-25 °C.

[2]Based upon an LFL for upward propagation. Per footnote in reference, further investigation does not show support for using this value.

CRC Handbook of Chemistry and Physics, 68th Edition, R. C. Weast et al, 1987.

LA-UR-92-3196, 1995, A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington, Rev. 14, Los Alamos National Laboratory, Los Alamos, New Mexico.

WHC-SD-WM-ES-346, 1995, Flammable Gas Tank Safety Program: Technical Basis for Gas Sampling and Monitoring, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-004, 1996, Safety Basis for Activities in Single-Shell Tanks with Flammable Gas Concerns, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table KA-7. "Best" Estimates of Waste Gas Composition.

Gas	LA-UR-92-3196 App B Rev 14 and WHC-SD-WM-SARR-002/ 004 Rev 1, Appendix B	WHC-SD-WM-ES-346 Rev 0
Hydrogen	28.77 vol %	26.66 vol %
Ammonia	10.95 %	16.53 %
Methane	0.35 %	0.33 %
Others	0.25 %	0.25 %
Nitrous Oxide	24.45 %	22.66 %
Nitrogen	32.82 %	30.40 %
Water	2.4 %	3.07 %

LA-UR-92-3196, 1995, A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington, Rev. 14, Los Alamos National Laboratory, Los Alamos, New Mexico.

WHC-SD-WM-ES-346, 1995, Flammable Gas Tank Safety Program: Technical Basis for Gas Sampling and Monitoring, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-002, 1996, Safety Basis for Activities in Double-Shell Tanks with Flammable Gas Concerns, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-004, 1996, Safety Basis for Activities in Single-Shell Tanks with Flammable Gas Concerns, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
A-101	6/9/95 (3)	743-786	728-800	<12	21.9	2.51	6.38	3.14	7840
A-102	11/10/95 (3)	294-302	248-263	<4	6.1	0.93	6.10	3.24	8090
A-103	4/6/95 (3)	271-278	256-273	<4	8.2	0.88	6.31	3.16	7910
A-104									
A-105									
A-106									
AX-101	6/15/95 (3)	102-103	39-44	<12	2.6	0.31	5.13	3.32	8310
AX-102	6/29/95 (3)	<98	30-37	<12	9.0	<0.29	5.02	3.35	8370
AX-103	6/27/95 (3)	<98	37-44	<12	1.5	<0.30	5.18	3.30	8240
AX-104									
B-101									
B-102	4/18/96 (3)	<17	3.7-5.5	<25	4.2-4.3	<0.096	4.95	1.78	4420
B-103	2/8/95 (3) 10/17/96 (4)	<99	7.7-10	<61	12.8	<0.38	4.52	2.63	6580
B-104									
B-105	7/30/96 (4)	<17	5.2-5.9	<25	0.75-0.78	<0.096	4.97	1.77	4410
B-106									
B-107	7/23/96	<17	17-26	<25	<0.6	<0.11	6.22	1.56	3890
B-108									
B-109									
B-110									
B-111									
B-112									
B-201									

Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () * Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
B-202	7/18/96 (4)	<17	2.6	<25	<0.6	<0.094	4.74	1.81	4510
B-203									
B-204									
BX-101									
BX-102	7/31/96 (4)	<17	2.4-2.5	<25	0.41-0.46 *	<0.094	4.73	1.81	4520
BX-103									
BX-104	12/30/94 (3) 8/22/96 (4) 12/13/96 (4)	<94	229-238	<61	77.9	<0.51	7.70	1.84	4600
BX-105	4/24/96 (3)	45-56	141-155	<25	4.4-4.5	0.29	8.14	1.93	4830
BX-106	8/15/96	<17	42-47	<25	0.9-1.1	<0.12	7.25	1.38	3460
BX-107	11/16/95 (3)	10-14	76-89	<4	2.5	<0.10	10.66	1.39	3490
BX-108									
BX-109									
BX-110	4/30/96 (3)	<17	58-66	<25	1.8-2.1	<0.14	8.00	1.26	3150
BX-111	8/27/96 (4)	no data							
BX-112									
BY-101	8/29/96 (4)	no data							
BY-102	11/20/95 (3)	33-37	170-180	<4	18.3	0.22	10.20	1.71	4270
BY-103	11/1/94 (3)	21-22	24-30	<61	10.7	<0.20	5.75	1.12	2800
BY-104	6/24/94 (3)	204-312	242-255	8-9	54.7	0.96	5.98	3.24	8100
BY-105	7/7/94 (3)	84-87	41-44	3.8	11.6	0.25	5.32	3.43	8580
BY-106	7/8/94 (3)	40-104	72-78	3.6	12.7	0.32	5.85	3.28	8190
BY-107	10/26/94 (3)	687-698	963-978	<20	151.9	2.42	7.02	2.89	7220

Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
BY-108	10/27/94 (3) 1/26/96 (3/4) 3/28/96 (3/4) 9/10/96 (3) 11/15/96 (3)	335-647 all data not available	779-1140	7.8-20	177-610	2.39 1.17 org	7.55	2.70	6760
BY-109									
BY-110	11/11/94 (3) 10/24/95 (DS)	<160 240,000	385-426 2800	<61 8,300 CH_4 10,000 C_2H_6 6,000 C_xH_y	43.8 234 ppmv	<0.80 650 (DS)	8.12 4.10	2.01 3.69	5020 9220
BY-111	11/16/94 (3)	65-69	57-61	<61	8.5	0.33	5.72	2.07	5170
BY-112	11/18/94 (3)	<94	54-71	<61	12.6	<0.40	5.61	2.33	5830
C-101	9/1/94 (3)	434-439	96-99	12	221.6	1.19 0.49 org	4.64	3.70	9260
C-102	8/23/94 (3)	131-165	183-192	12	279.5	0.56 0.62 org	6.58	2.94	7360
C-103	4/15/94 (3)	676-894	308-349	13.2-17.7	1709.6	2.50 3.80 org	5.05	3.58	8960
C-104	3/3/94 (3)	60-76	44	neg	25.4	0.22	5.49	3.48	8700
C-105	2/16/94 (2)	20-24	1.9-2.7	neg	1.4	0.06	4.32	3.89	9720
C-106	2/15/94 (2)	8-12	0.2-8.8	neg	0.4	0.04	5.83	3.36	8410
C-107	9/29/94 (3) 1/17/96 (3/4) 3/26/96 (3/4) 9/6/96 (3) 12/17/96 (3)	110-258 all data not available	45-87	<20	2.8-3.7	0.74	4.92	3.48	8700
C-108	8/5/94 (3)	14-16	2.4-3.3	0.1	0.3	0.04	4.58	3.78	9450
C-109	8/9/94 (3)	124-125	9.1-11.4	0.9	1.4	0.32	4.27	3.89	9720

Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
C-110	8/24/94 (3)	12	120-130	<61	20.5	<0.24	8.61	0.51	1270
C-111	9/13/94 (3)	10-14	4.7-6.8	0.3	1.0	0.04	5.28	3.50	8750
C-112	8/11/94 (3)	200-210	22-23	1.0	3.0	0.54	4.32	3.88	9670
C-201	6/19/96 (4)	<17	<1.4	<25	2.6-2.7	<0.09	4.65	1.82	4550
C-202	6/26/96 (4)	<17	<0.7	<25	1.0-1.4	<0.09	4.59	1.83	4570
C-203									
C-204	7/2/96	<17	0.7-0.8	0.16-21	76-82	<0.085	4.56	2.00	5000
S-101	6/6/96 (4)	439-444	764-777	0.2-177	8.3	1.96	7.11	2.26	5650
S-102	3/6/95 (3) 1/26/96 (3/4) 4/3/96 (3/4) 9/19/96 (3) 12/19/96 (3)	613-740 all data not available	402-642	<12	15-20	2.29	6.09	3.23	8080
S-103	6/12/96	78-81	147-153	<0.2-16	1.2-1.3	0.33	7.50	2.43	6080
S-104									
S-105	12/13/95 (3)	20-22	34-38	<4	2.6	0.088	7.31	2.51	6280
S-106	6/13/96 (4)	<17	32-39	<0.8-16	1.76-1.91	<0.10	7.22	1.71	4260
S-107	6/18/96 (4)	360-366	176-187	<25	3.52-3.57	1.09	5.32	3.37	8430
S-108	12/15/95 (3)	21-23	24-27	<4	2.9	0.083	6.51	2.77	6930
S-109	6/4/96 (4)	<17	43-48	<25	3.08-4.11	<0.12	7.29	1.38	3440
S-110	12/4/95 (3)	132-139	141-153	<4	4.2	0.45	6.51	3.06	7650
S-111	3/13/95 (3)	390-392	115-124	<23	3.7	1.11	4.87	3.54	8860
S-112	7/11/95 (3)	<25	86-90	<25	5.5	<0.17	8.21	1.47	3660

Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m³	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
SX-101	7/19/95 (3)	<25	3.4-4.2	<25	1.5	<0.12	4.70	2.17	5420
SX-102	7/21/95 (3)	<25	15-16	<25	1.6	<0.12	5.37	2.04	5090
SX-103	3/20/95 (3)	<23	71-80	<23	2.0	<0.16	8.12	1.48	3710
SX-104	7/20/95 (LOW) 7/25/95 (3)	24000 <25	450 24-26	200 <25	- 1.6	64 (LOW) <0.13	4.47 5.88	3.76 1.93	9400 4830
SX-105	7/26/95 (3)	<25	25-30	<25	1.7*	<0.13	6.07	1.90	4740
SX-106	3/27/95 (3)	<98	171-188	<12	2.4	<0.39	7.64	2.51	6280
SX-107									
SX-108									
SX-109	8/1/95 (3) (Duct)	<25	16-18	<25	1.6	<0.12	5.48	2.01	5040
SX-110									
SX-111									
SX-112									
SX-113									
SX-114									
SX-115									
T-101									
T-102									
T-103									
T-104	2/7/96 (3/4)	4-17 all data not available	102-110	<4	1.9	0.12	10.78	1.40	3500
T-105									
T-106									

Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
T-107	1/18/95 (3)	<94	122-127	<61	3.8	<0.44	6.42	2.14	5350
T-108									
T-109									
T-110	8/3/95 (3)	<25	108-109	<25	1.6	<0.18	8.70	1.37	3420
T-111	1/20/95 (3)	<94	225-227	<61	22.5	<0.50	7.59	1.87	4670
T-112									
T-201									
T-202									
T-203									
T-204									
TX-101									
TX-102									
TX-103									
TX-104									
TX-105	12/20/94 (3)	<99	19-21	<61	4.6	<0.38	4.73	2.58	6460
TX-106									
TX-107									
TX-108									
TX-109									
TX-110									
TX-111	10/11/95 (3)	107-110	588-638	<25	13.1	0.74	10.49	1.49	3730
TX-112									
TX-113									
TX-114									

Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
TX-115									
TX-116									
TX-117									
TX-118	12/16/94 (3)	96-98	31-36	<61	10.7	0.39	5.00	2.51	6280
TY-101	4/5/95 (3)	<93	15-17	<12	1.7	<0.27	4.56	3.48	8690
TY-102	4/12/96 (3)	<3.1	4.0-4.1	<4.3	3.08-4.11	<0.02	6.05	1.63	4080
TY-103	4/13/95 (3) 11/6/96 (4)	<93	47-51	<12	55.6	<0.29	5.39	3.21	8030
TY-104	4/26/95 (3)	<49	57-62	<23	2.8	<0.21	6.43	2.35	5880
TY-105									
TY-106									
U-101									
U-102									
U-103	2/15/95 (3)	552-557	720-761	<61	20.9	2.01	6.88	2.78	6940
U-104	7/16/96 (4)	no data							
U-105	2/24/95 (3)	<49	275-354	<23	7.9	<0.40	10.73	1.23	3090
U-106	2/26/95 (3)	203-214	931-1013	<61	19.1	1.31	9.83	1.63	4080
U-107	2/17/95 (3)	496-505	425-474	<12	15.4	1.59	6.22	3.17	7930
U-108	8/18/95 (3)	518-524	679-701	<25	14.5	1.81	6.90	2.89	7230
U-109	8/10/95 (3)	724-770	556-608	<25	14.4	2.37	5.93	3.25	8130
U-110									
U-111	2/20/95 (3)	244-250	671-682	<12	12.3	1.09	8.67	2.30	5740
U-112	7/9/96 (4) 12/6/96 (4)	231-233	289-326	<25	1.85-2.16	0.84	6.93	2.76	6910

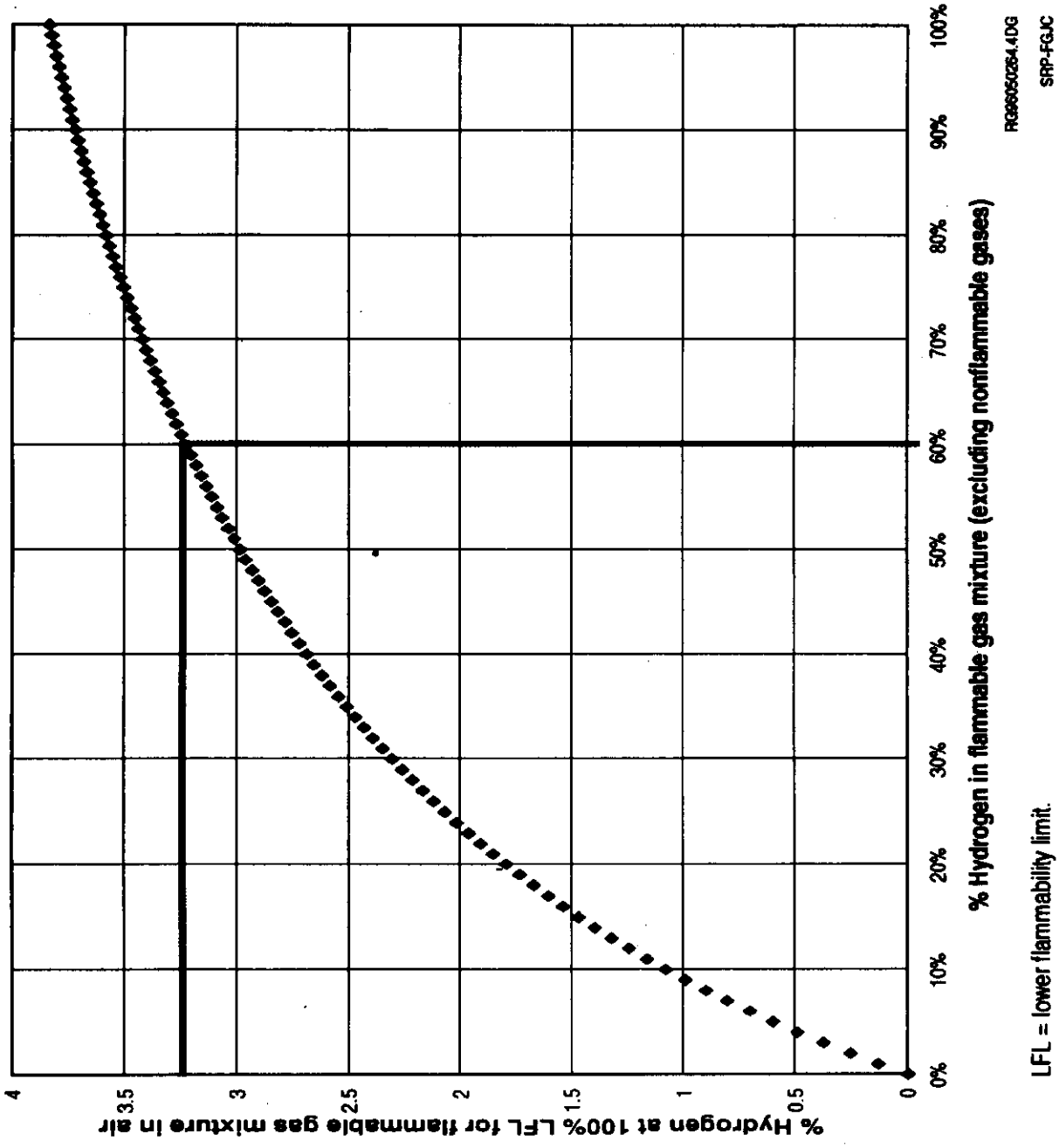
Table KA-8. Single-Shell Tank Calculated LFL Values. (8 sheets)

Tank	Date[1] Sampled () = Type	TYPE 2/3/4 Sample Results				Calculated Values			
		Hydrogen ppmv	Ammonia ppmv	Methane ppmv	Other Organics mg/m^3	% LFL for Tank Vapor Space	LFL for Flammable Gas Mixture	% Hydrogen @ 100% LFL	% Hydrogen @ 25% LFL
U-201									
U-202									
U-203	8/9/95 (3)	<25	0.8-1	.25	13.4	<0.11	4.51	2.21	5520
U-204	8/7/95 (3)	<25	0.1-0.2	<25	6.5	<0.11	4.46	2.22	5550

Notes: [1]Dates are in the mm/dd/yy format.

Figure KA-1.

Percent LFL Correlation for a Gas Mixture* Relative to Pure Hydrogen and Air.



*Note: Gas Mixture is described in Section EA 2.4.4.

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APPENDIX KB

SAMPLE FLAMMABLE GAS CONTROLS SPECIFICATION PROCESS

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LIST OF TERMS

AWF	Aging Waste Facility
DCRT	double-contained receiver tank
DST	double-shell tank
FGEAB	Flammable Gas Equipment Advisory Board
GRE	gas release event
IC	ignition source control
JCO	Justification for Continued Operation
PHMC	Project Hanford Management Contract
RL	U.S. Department of Energy, Richland Operations Office
SST	single-shell tank
TWRS	Tank Waste Remediation System
USQ	Unreviewed Safety Question

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APPENDIX KB

SAMPLE FLAMMABLE GAS CONTROLS SPECIFICATION PROCESS

This Appendix shows a sample process that can be used to specify the allowed safe conditions and control requirements to address the flammable gas hazards as described in TF-96-0433 (USQ Tracking No.), *Consolidation of Flammable Gas/Slurry Growth Unreviewed Safety Question Issues*. The process is used by the Project Hanford Management Contractor (PHMC) to establish whether proposed activities are within the allowed conditions and requirements of the flammable gas Justification for Continued Operation (JCO) for the flammable gas hazard. This process description is not an Authorization Basis document. The process uses existing Tank Waste Remediation System (TWRS) procedures and work practices, as well as certain new work practices created as part of the flammable gas JCO. This attachment must be used in concert with the TWRS USQ procedure as found in HNF-IP-0842, *TWRS Administration*, Volume IV, Section 5.4. This process is **not** a substitute for the USQ process. The process flow is summarized in Figure KB-1 and described in the following paragraphs.

Signature to release work signifies that the process described in this appendix has been completed and that required controls are implemented.

KB1.0 APPLICABILITY

The JCO and, therefore, this process applies to work packages and operating procedures that cover activities involving any of the following locations or characteristics: ex-tank intrusive, dome space intrusive, waste intrusive, local waste disturbing, or global waste disturbing.

NOTE: If the activity or operation involves only non-intrusive locations, is not waste disturbing, and applicable ventilation requirements are met, the activity or operation does not involve the flammable gas USQ and no applicable ignition source control (IC) or monitoring JCO requirements are related to the flammable gas hazard.

KB2.0 WORK AUTHORIZATION PROCESS OVERVIEW

Comparison with Flammable Gas JCO Conditions for Safe Operation

The information in the work package or operating procedure is used to answer the following questions to establish the appropriate and required JCO controls.

[a] Is this activity or operation expressly prohibited by the JCO?

Yes ____
No ____

If YES, the Authorization Basis must be amended and specific approval by the U.S. Department of Energy, Richland Operations Office (RL) must be sought.

[b] Which JCO facility groups are affected by this activity or operation?

Facility Group 1 ____
Facility Group 2 ____
Facility Group 3 ____
Non-GRE (gas release event) ____

[c] Which regions of the affected facilities are involved in this activity or operation? NOTE: Activities and equipment may involve more than one region.

Nonintrusive ____
Ex-tank Intrusive ____
Dome Space Intrusive ____
Waste Intrusive ____
Inside Waste Intruding Equipment ____

[d] What is the nature of the activity or operation in the affected facilities?

Non-Waste Disturbing ____
Local Waste Disturbing ____
Global Waste Disturbing ____
For non-GRE facilities, this does not apply ____

NOTE: If the activity or operation involves only Nonintrusive locations and is not waste disturbing, the activity or operation does not involve the flammable gas USQ and no JCO requirements apply.

[e] Determine the ventilation requirements for the affected facilities, as specified in the JCO. (Check the applicable requirements.)

Double-Shell Tank (DST) and Aging Waste Facility (AWF) Tank Ventilation ____
Single-Shell Tank (SST) Active Ventilation ____
SST Passive Ventilation ____
Double-contained receiver tank (DCRT) Ventilation ____
244-AR, TK-002 Ventilation ____
No ventilation is required ____

Can the work activity or procedure be performed without violating the applicable requirements?

Yes ____
No ____

If NO, is there a RL-approved Authorization Basis for this activity or operation that provides alternative ventilation requirements and addresses the flammable gas hazards as described USQ TF-96-0433, Rev. 1?

Specify: _____

If YES, does this approved basis clearly apply to the affected facilities?

Yes ____
No ____ ([h] below)

[f] In light of the answers to [b], [c], and [d], which ignition source requirements apply? Go to the Ignition Source Control Evaluation Worksheet before proceeding, to determine specific requirements and compliance.) Document the requirements on an IC Evaluation Worksheet.

Are the equipment and materials (1) in compliance with the ICs, or (2) do they provide equivalent safety per the Flammable Gas Equipment Advisory Board (FGEAB) or (3) or are they exempted as listed in Table K4-4?

Yes ____
No ____

If NO, is there a RL approved Authorization Basis for this activity or operation that provides alternative ignition source requirements and addresses the flammable gas hazards as described USQ TF-96-0433, Rev. 1?:

Specify: _____

If YES, does this approved basis clearly apply to the affected facilities?

Yes ____
No ____ ([h] below)

[g] In light of the answers to [b], [c], and [d], check the applicable requirements.

Entry monitoring only ____

Continuous monitoring during manned activities ____

Continuing periodic monitoring during unmanned global waste disturbing activities in passively ventilated SSTs ____

For non-GRE facilities: monitoring before energizing equipment that does not meet ICs, when ventilation has not been verified to be adequate and operable (e.g., catch tanks) ____

Monitoring as a compensatory measure to ICs. Specify applicable monitoring requirements: _____

No monitoring is required ____

Are the monitoring requirements for the affected facilities, as specified in the JCO, contained in the operating procedure or the work package?

Yes ____
No ____

If No, is there a RL-approved Authorization Basis for this activity or operation that provides alternative monitoring requirements and addresses the flammable gas hazards as described USQ TF-96-0433, Rev. 1?:

Specify: _____

Does this approved basis clearly apply to the affected facilities?

Yes ____
No ____ ([h] below)

[h] Are all of the requirements indicated in items [e], [f], or [g] satisfied?

Yes ____ The activity or operation is within the JCO and TSRs from the perspective of the flammable gas hazard only.

No ____ The activity or operation is not permitted per the approved JCO and an amendment to the TWRS Authorization Basis is required before the activity or operation may proceed as proposed.

Ignition Source Control Evaluation Worksheet (Sample)

Equipment, Materials, Work Practices (1)	Location (2)	Ignition Control Set (3)	IC* Set Met (4)	FGEAB Safety Equivalence Ruling (5)	Approved Exception (TSR AC 5.10) (6)

*IC = ignition source control

Example Entries:

(1) Drill String, Sampler System, Power Connection, Foot Clamp, Ventilation Fan, Level Detector, Bonding, Grounding, Carbon Steel Camera Support Column, Non-conductive Polymer Receiver Bag, etc.

(2) Nonintrusive, Ex-tank Intrusive, Dome Space Intrusive, Waste Intrusive

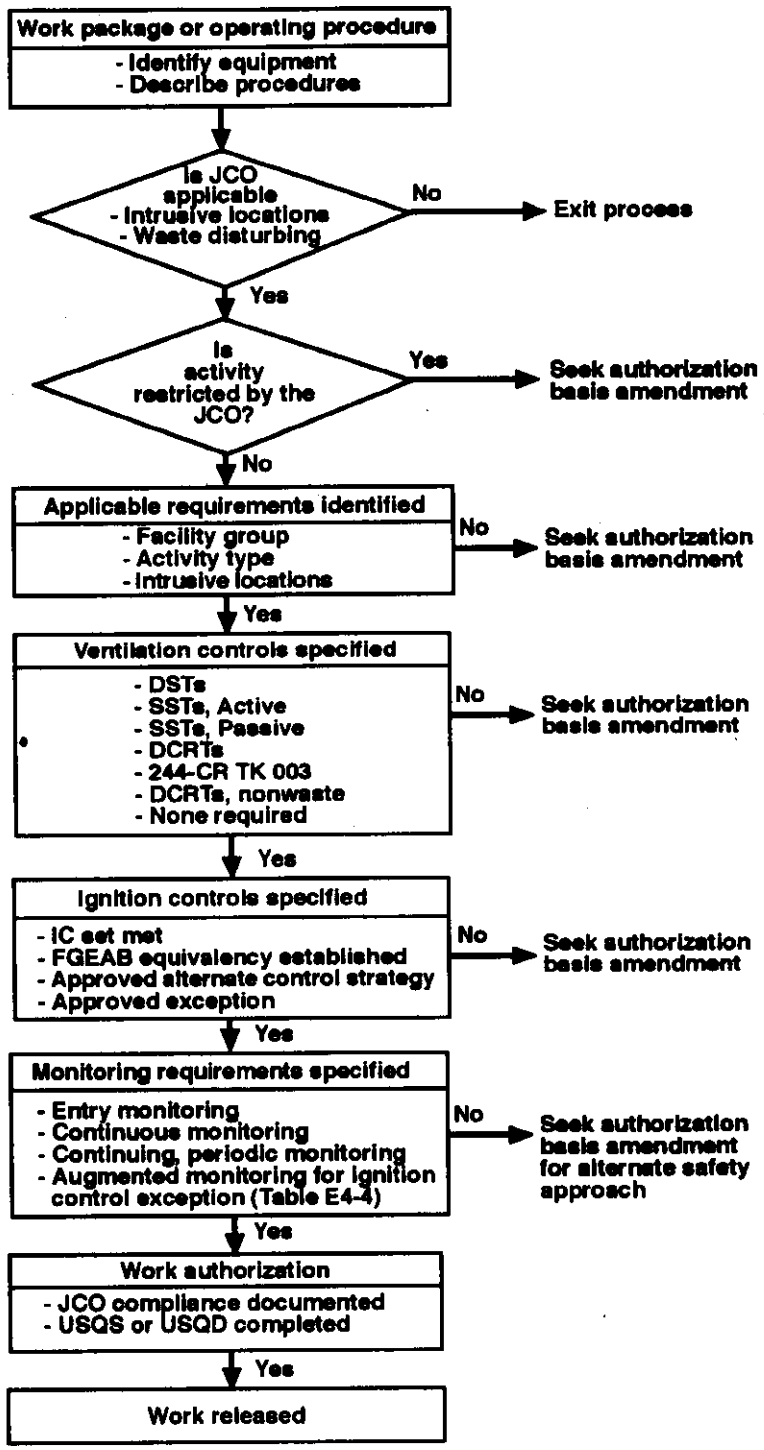
(3) IC Set No.1, IC Set No.2, None

(4) IC Set Met, IC Set Not Met

(5) Is Equivalent per Ref. "x"

(6) Reference appropriate item from exceptions list in Table K4-4

Figure KB-1. Flammable Gas Controls Specification Process



DCRT = double-contained receiver tank.
DST = double-shell tank.
FGEAB = Flammable Gas Evaluation Advisory Board
IC = Ignition control.
JCO = Justification for Continued Operation
SST = single-shell tank
USQD = Unreviewed Safety Question Determination
USQS = Unreviewed Safety Question Screening

H96110033.1b
SRP-BIO

KB3.0 REFERENCES

See Appendix K, K7.0, "REFERENCES."

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APPENDIX KC

EXCEPTIONS TO IGNITION SOURCE CONTROLS

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LIST OF TERMS

ALARA	As Low As Reasonably Achievable
CAS	Continuous Air Sampler
CGM	Combustible gas meter
FG	Facility Group
FGEAB	Flammable Gas Equipment Advisory Board
FIC	Food Instrument Corporation (level gauge)
GRE	gas release event
GWD	global waste disturbing activities
ICS	Ignition Control Set
IMUST	inactive miscellaneous underground storage tank
ISVS	in-situ vapor system
JCO	Justification for Continued Operation
LFL	Lower Flammability Limit
LOW	liquid observation wells
LWD	local waste disturbing activities
MITs	Multiple instrument trees
NFPA	National Fire Protection Association
NWD	non-waste disturbing activities
OVM	organic vapor monitor
PAM	portable alpha monitor
PMCS	push mode core sampling
PVC	polyvinyl chloride
RCT	radiological control technician
RH	relative humidity
RMCS	rotary mode core sampling
SHMS	Standard Hydrogen Monitoring System
TCR	Tank Characterization Report
VDTT	velocity-density temperature tree

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ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 1 (page 1 of 4)

EQUIPMENT: Rubber/plastic gloves, canvas gloves. Tyvek clothing, plastic clothing

CATEGORY: Static Spark Potential

USE:

Used for protecting personnel from contamination.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3 (ICS 1 #3) (ignition control set)	FG 1 ex-tank FG 2 ex-tank global waste disturbing activities (GWD) FG 1,2 dome intrusive FG 3 dome intrusive (local waste disturbing activities [LWD], GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Surgeon's gloves, or other "rubber" gloves, are worn in radiation areas for personnel protection. Canvas gloves are coated with a vinyl covering when new, most of which eventually gets removed in the laundry. Gloves are worn in ex-tank regions, but occasionally might be placed minimally inside a dome intrusive area or waste intruding equipment. Tyvek clothing or plastic clothing is worn during operations with the potential for high personnel contamination. Tyvek clothing complies with the Flammable Gas Justification for Continued Operation (JCO) when grounded. This is not done at this time. Plastic clothing does not comply with the Flammable Gas JCO. Use of either of those articles of protective clothing is a significant issue with respect to personnel contamination control. These are judged to have a negligible potential for creating sparks. Finger ring use (for radiological monitoring) meets equivalence with the Flammable Gas JCO, and so finger rings are not included in the above items.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. Gloves are used in ex-tank locations, but may be used in a minimally dome or waste intrusive location (e.g., at the entry of a riser or liquid observation well [LOW]). Tyvek and plastic clothing is only worn in an ex-tank region. The risk of personnel contamination due to not using these gloves or clothing is unacceptable. The resulting delay to all sampling work, and most other tank intrusive work, the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the gloves or clothing. The risk associated with continuing to use the gloves or clothing is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] as appropriate for the activity. See definition of monitoring methods at the end of this section.

The person performing the initial monitoring per [A] will be wearing rubber gloves, probably canvas gloves, and possible Tyvek or plastic clothing. It is an acceptable risk to have him perform the monitoring while wearing these items.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop all ex-tank and dome intrusive work

Facility Group 2 Tanks-Would stop all dome intrusive and some ex-tank work.

Facility Group 3 or other Tanks-Would stop all waste disturbing dome intrusive work.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring controls [A] for rubber gloves, canvas gloves, and Tyvek or plastic clothing in:

1) FG 1 ex-tank regions
2) FG 1,2 tanks during dome intrusive activities.
3) FG 2 ex-tank region (GWD).
4) FG 3 tanks for dome intrusive regions (LWD, or GWD).

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 1 (page 2 of 4)

EQUIPMENT: Air respirators, air fed hoods, and breathing air hoses

CATEGORY: Static Spark Potential

USE:

Used for providing adequate breathing air.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Air respirators are made from rubber and plastic. Breathing air hoses are made from rubber. These are judged to have a negligible potential for creating sparks.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. The risk of internal contamination or inhalation of potentially toxic vapors due to not using respirators or breathing air when needed is unacceptable. The resulting delay to sampling work, and most other tank intrusive work, the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the respirators or hoses. The risk associated with continuing their use is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] for the activity. See definition of monitoring methods at the end of this section.

The person performing the initial monitoring per [A] may be wearing a respirator or an air hose. It is an acceptable risk to have him perform the monitoring while wearing these items.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work.

Facility Group 2 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work during GWD.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for respirators and breathing air hoses in:

1) FG 1 ex-tank regions
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 1 (page 3 of 4)

EQUIPMENT: Rubber/plastic footwear

CATEGORY: Static Spark Potential

USE:

Used for protecting feet from contamination.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Rubber boots are worn in radiation areas for personnel protection. Rubber boots are judged to have a negligible potential for creating sparks.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. The risk of personnel contamination and loss of contamination control due to not using boots is unacceptable. The resulting delay to sampling work, and most other tank intrusive work, the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the boots. The risk associated with continuing to use the boots is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] for the activity. See definition of monitoring methods at the end of this section.

The person performing the initial monitoring per [A] will be wearing rubber boots. It is an acceptable risk to have him perform the monitoring while wearing the boots.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work.

Facility Group 2 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work during GWD.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for rubber boots in:

1) FG 1 ex-tank regions
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 1 (page 4 of 4)

EQUIPMENT: Installation, removal or use of masking tape

CATEGORY: Static Spark Potential

USE:

Used for taping up protective clothing.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Masking tape is used for taping personal protective clothing, therefore, is present in ex-tank regions. The primary spark potential is when applying or removing the tape. Applying or removing masking tape could form small static sparks under certain conditions. Taping is not normally done in an ex-tank area, but may be necessary in certain circumstances. Masking tape is judged to have a negligible potential for creating sparks.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. The risk of contamination due to not using masking tape is unacceptable. The resulting delay to sampling work, and most other tank intrusive work, the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the tape. The risk associated with continuing the tape use is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] for the activity. See definition of monitoring methods at the end of this section.

The person performing the initial monitoring per [A] will be wearing masking tape. It is an acceptable risk to have him perform the monitoring while wearing the tape.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work.

Facility Group 2 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work during GWD.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for masking tape in:

1) FG 1 ex-tank regions
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 2

EQUIPMENT: Wearing of plastic badges, badge holders, and dosimeters.

CATEGORY: Static Spark Potential

USE:

Used for security and dosimetry.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Badges and dosimeters are small, plastic items which all personnel are required to carry for security and exposure monitoring. Risk of a static spark in the above listed ex-tank regions from these items should be small, especially if they are inside another pair of protective clothing. Badges, badge holders, and dosimeters are judged to have a negligible potential for causing flammable gas ignition under the applied conditions.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. The risk of overexposure due to not using dosimetry, and the violation of security requirements is unacceptable. The resulting delay to sampling work, and most other tank intrusive work, the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the items. The risk associated with continuing their use is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] for the activity. See definition of monitoring methods at the end of this section.

The person performing the initial monitoring per [A] will be wearing a badge, badge holder, and dosimetry. It is an acceptable risk to have him perform the monitoring while wearing these items.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work.

Facility Group 2 Tanks-Would stop all ex-tank, and by default, most dome intrusive work and waste intruding equipment work during GWD.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for badges, badge holders and dosimeters in:

1) FG 1 ex-tank work
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 3

EQUIPMENT: Installation of, removal of, working on, or extended presence of nonconductive lead blankets

CATEGORY: Static Spark Potential

USE:

Used for portable shielding.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The lead blankets currently in use are constructed of a nonconductive polymer jacket surrounding a lead wool blanket. The blankets are used for shielding in the work area. This equipment may be in or outside of an ex-tank exclusion zone. There is no ignition source issue with the lead; the verbatim compliance issue is due to the plastic coating. Lead blankets are judged to have a negligible potential for creating sparks.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. Lead blankets are not arranged in a manner which could trap flammable gases. These blankets are normally installed and removed when ex-tank regions are not present (i.e., before a riser is opened or after it is closed). During limited instances it may be necessary to move these blankets in one of the above listed ex-tank areas. Removal is normally done after a riser is sealed. The risk of not using lead blankets would lead to higher personnel exposure if the items cannot be relocated. Failure to approve use of the lead blankets will result in considerable costs. This would restrict some work in the above listed ex-tank regions until suitable replacements, if available, were obtained. The resulting delay to sampling work and most other tank intrusive work, and the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the blankets. The risk associated with continuing their use is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] for the activity. See definition of monitoring methods at the end of this section. This monitoring is in full compliance with the monitoring requirements referenced by U.S. Department of Energy, Richland Operations Office (RL) letter 96-WSD-283 (Wagoner 1996).

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop some of ex-tank, and by default some dome intrusive work and waste intruding equipment work.

Facility Group 2 Tanks-Would stop some ex-tank, and by default most dome intrusive work and waste intruding equipment work during GWD.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for lead blankets in:

1) FG 1 ex-tank regions
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 4

EQUIPMENT: Installation, removal, or extended presence of nonconductive adhesive tape

CATEGORY: Static Spark Potential

USE:

Used for taping plastics and other miscellaneous items.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3, ICS 1 #3	FG 1 ex-tank FG 2 ex-tank (GWD) FG 1,2 dome intrusive FG 3 dome intrusive (LWD, GWD) FG 1,2,3 waste intruding equipment

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Nonconductive adhesive tape is used routinely in ex-tank regions. Because of the nature of its use portions of tape will occasionally be exposed to tank vapors during sleeving, bagout or other activities, and as a result it is also included as a dome intrusive and waste intruding equipment item.

RISK ACCEPTANCE:

The minimal risk is primarily associated with tape application and removal, thus the time at risk is small. Tape is used in ex-tank locations, but may be used in a minimally dome or waste intrusive location. It is used primarily for taping down plastics for contamination control. Depending upon the location, the work to be done, and the contamination level, tape may on occasion be placed around the edge of or just inside a dome intrusive region or item of waste intruding equipment. Tape is also used when "horsetailing" out contaminated equipment from a tank. The contaminated item is brought up into a plastic sleeve, the plastic twisted around under the object, and tape wrapped around the twist. The taped area is then cut through and the waste item removed. Should the taped joint come apart, the edge of the tape could be exposed to the tank vapors. Tape is also used to seal sleeves around items such as cameras which are lowered into tank vapor spaces. In such cases the tape is in the tank dome for anywhere from a few minutes to a few days. Not using tape would lead to ceasing most activities in the above areas. The resulting delay to sampling work, and most other tank intrusive work, the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the tape. The risk associated with continuing its use is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] or [B] applicable for the activity. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop all sampling related activities, and most other tank intrusive work.

Facility Group 2 Tanks-Would stop all sampling related activities, and most other tank intrusive work.

Facility Group 3 or other Tanks-Would stop all core sampling, and other tank activities with waste intruding equipment.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] or [B] as appropriate for use of green tape in:

1) FG 1 ex-tank regions
2) FG 2 tanks for ex-tank regions (GWD)
3) FG 1,2 dome intrusive regions
4) FG 3 tanks for dome intrusive regions (LWD, GWD)
5) FG 1,2,3 tank waste intruding equipment

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 5

EQUIPMENT: Portable Alpha Monitor (PAM)

CATEGORY: Electrical Spark Potential

USE:

Used for monitoring for alpha contamination

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #5 ICS 1 #5	FG 1 ex-tank FG 2 ex-tank (GWD) FG 1,2 dome intrusive FG 3 dome intrusive (LWD, GWD) FG 1,2,3 waste intruding equipment

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The portable alpha monitor (PAM) is battery powered. The unit is judged not in verbatim compliance with the Flammable Gas JCO. Per ICS #2: "As a minimum the equipment is non-sparking under normal operation...". While the PAM normally meets this requirement, the probe source is easily damaged and a postulated spark could occur if internal electronics were shorted out. The PAM is usually used for determining alpha contamination on smears rather than near a riser or in a waste intruding equipment item. However, sometimes it is necessary to use the PAM to determine contamination levels (fixed or smearable) on the equipment. PAMs are judged to have a negligible potential for causing flammable gas ignition.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. The PAM is used in ex-tank locations, but may be used in a minimally dome or waste intrusive location (e.g., at the entry of a riser or LOW). The PAM is needed for monitoring for alpha contamination. The potential problems arising from an alpha contamination spread are more severe than from a beta gamma spread. Monitoring for alpha contamination is required by the RWPs for most waste intruding or dome intrusive activities on tanks which have shown a potential for alpha contamination problems. The requirement for using alpha monitors comes in part from two letters: Caldwell, C.L., 1997, Justification for Dual Survey Exemption in 200 East Tank Farms (Interoffice Memo 771EO-97-006 to W. E. Ross, March 12), Lockheed Martin Hanford Corporation, Richland, Washington; and Dossett, S.D., 1997, Justification for Dual Survey Exemption in 200 West Tank Farms (Interoffice Memo 77B50-97-008 to J. Burton, March 17), Lockheed Martin Hanford Corporation, Richland, Washington. Per discussion with a vendor, there are no known battery powered, intrinsically safe, alternatives available for the PAMs. Furthermore, switching to a different monitor could not be made without significant delays due to required testing. PAMs are inspected frequently and checked prior to use, which minimizes the possibility of using a monitor with a failed window. The risk associated with continuing to use the PAM is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use of the PAM. This will include monitoring per method [A] or [B] as appropriate for the activity. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Restricts radiological control technician (RCT) flexibility to monitor riser area for alpha contamination and results in lowering of radiological control and contamination problems. Failure to accept the risk of continuing to use the PAM will shut down or restrict most waste intrusive work.

Facility Group 2 Tanks-Same as above.

Facility Group 3 or other Tanks-Same as above(LWD, GWD).

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring controls [A] or [B] for use of PAMs in:

1) Ex-tank regions in FG 1 tanks.
2) Dome intrusive regions in FG 1,2 tanks.
3) Waste intruding equipment in FG 1,2,3 tanks.
4) Dome intrusive regions (LWD, GWD) for FG 3 tanks
5) Ex-tank regions in FG 2 tanks (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 6

EQUIPMENT: Nonconductive poly bottle

CATEGORY: Static Spark Potential

USE:

Used for contamination control

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3, ICS 1 #3	FG 1 ex-tank FG 1,2 dome intrusive FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Nonconductive poly bottles are used in ex-tank regions, but may be used in a minimally intrusive region for washing off some equipment items by pouring the solution inside the bottle over the item and down a riser. Glass bottles could be used as a substitute, but poly bottles have been used because they are safer (non-breakable). Poly bottles are judged to have a negligible potential for creating sparks.

RISK ACCEPTANCE:

These bottles are normally used in ex-tank locations, but may be used in a minimally dome intrusive region when pouring the liquid down a riser. The amount of liquid used is small, nominally ≤ 1 liter. The velocity of the poured liquid is limited to gravity flow and the wetting action of the liquid on the bottle will minimize static buildup. The potential safety concern associated with breakage of a glass bottle is a greater concern than the small risk of a flammable gas ignition event due to a spark from the plastic bottle. The risk associated with continuing use of the poly bottle is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Small impact. Would switch to glass or other container meeting Flammable Gas JCO requirements. Will be a slight increase in the personnel risk for cuts in radiation zones.

Facility Group 2 Tanks-Small impact. Would switch to glass or other container meeting Flammable Gas JCO requirements. Will be a slight increase in the personnel risk for cuts in radiation zones.

Facility Group 3 or other Tanks-No impact, except when using around/in waste intruding equipment. Would switch to glass or other container meeting Flammable Gas JCO requirements. Will be a slight increase in the personnel risk for cuts in radiation zones.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for use of nonconductive poly bottles in:

1) FG 1 ex-tank regions
2) FG 1,2 dome intrusive regions
3) FG 2 ex-tank regions(GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 7

EQUIPMENT: Zip cords

CATEGORY: Static Spark Potential

USE:

Used for taking waste level measurements.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3, ICS 1 #3	FG 1 ex-tank FG 1,2 dome intrusive FG 1,2,3 waste intrusive

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

A zip cord is an insulated wire that is inserted into a riser and lowered down to the waste surface. Waste intruding equipment is included in this evaluation because on rare occasions it may be necessary to use a zip cord in a failed LOW or drill string. The electrical spark produced by the zip cord's contact with the waste or the metal riser is similar to that for manual tapes, which has been analyzed in WHC-SD-WM-ES-176, and is limited by the portable ohm meter used to take the reading. The current level and voltage values are orders of magnitude below the ignition curve in UL 913. Bonding of zip cords is impractical since this would interfere with their operation. Coating of the zip cords with a static reducing compound would provide little reduction in the static discharge risk, and could increase the potential for contamination or waste disposal problems. Zip cords are judged to have a negligible potential for creating sparks.

RISK ACCEPTANCE:

See risk acceptance starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would shut down most sampling activities until an alternate was available, or run the risk of errors in sampling and resulting questions with Tank Characterization Reports (TCRs).

Facility Group 2 Tanks-Would shut down most sampling activities until an alternate was available, or run the risk of errors in sampling and resulting questions with TCRs.

Facility Group 3 or other Tanks-No impact, except when needed for waste intruding equipment.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring controls [A] or [B] as applicable for use of nonconductive coated zip cords in:

1) FG 1 ex-tank regions
1) FG 1,2 dome intrusive regions
2) Waste intruding equipment (such as failed LOWs) in FG 1,2,3 tanks

Risk Acceptance for Zip Cords.

The distance between a specific riser and the waste surface is required for many waste intrusive jobs such as leak detection, sampling, level gauge installations/repairs or tank equipment installations. Zip cords have been shown to be an inexpensive and easy means of detecting the waste level in tanks. Alternate non tank intrusive measurement systems have been evaluated and determined to be cost prohibitive and substantially more complex.

The relative humidity (RH) has been measured at >50% in 95% of the non-exhausted tanks sampled. The remaining 5% of the non exhausted tanks all measured between 40 to 50% RH. The SX Farm exhausted tanks measured between 20 to 40% RH, except one tank which was 65% RH. Tank 241-C-105 measured between 40 to 60% RH, and 241-C-106 measured between 50 to 100% RH. Therefore, for non-exhausted tanks, plastic coated zip cords in dome intrusive regions are expected to be in compliance with the Flammable Gas JCO about 95% of the time. For exhausted tanks, 241-C-105 and 241-C-106 are approximately 50% RH. Most double shell tanks would be expected to be the same due to the liquid or moist solid surfaces. For waste intruding equipment, waste gases will be at 100% RH because the gases come from waste pockets surrounded by liquid waste. In such pockets the water vapor in the gas would be at equilibrium with the water in the liquid. The gas in waste intruding equipment may be partially mixed with tank vapors depending upon the work being done but, as most tank vapors have a high RH, the RH of the mixed vapors in waste intruding equipment is expected to be >50%.

Most sampling would have to be shut down without the use of zip cords. The resulting delay to sampling work, and some other tank intrusive work, the ability to double check questionable ENRAF, manual tape or Food Instrument Corporation (FIC) readings, and the ability to obtain characterization data from waste tanks that is used both for helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the zip cord. The risk associated with continuing use of the zip cords is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] or [B] as applicable. See definition of monitoring methods at the end of this section.

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 8

EQUIPMENT: Nonconductive plastic ropes

CATEGORY: Static Spark Potential

USE:

Used for tieing tools used around open risers or miscellaneous purposes.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3, ICS 1 #3	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Nonconductive plastic rope is used as lanyards for tools around open risers and other miscellaneous needs. Plastic rope is judged to have a negligible potential for causing flammable gas ignition under the applied conditions.

RISK ACCEPTANCE:

Nonconductive plastic rope is used for a variety of applications in addition to restraining tools. If nonconductive plastic rope cannot be used, manila rope can be used as an alternative. However, manila rope is not as strong and can weaken with time when exposed to the elements. Contaminated plastic rope can be wiped down easier. Plastic rope has proven to be more effective and less expensive for general use in tank farms and is used in ex-tank regions. Normal use of nonconductive plastic ropes does not involve activities that would build up a significant static charge.

The use of plastic rope is advantageous for operations. The inability to use this rope is a significant concern due to increased personnel and clothing contamination potential than the minimal risk of a flammable gas ignition event due to a spark from the plastic rope. The risk associated with continuing use of the rope is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Minor impact, would switch to manila or similar rope, would increase potential for personnel contamination.

Facility Group 2 Tanks-Minor impact, would switch to manila or similar rope, would increase potential for personnel contamination.

Facility Group 3 or other Tanks-No impact, except when using around/in waste intruding equipment, would switch to manila or similar rope, would increase potential for personnel contamination.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for use of nonconductive plastic rope in:

1) FG 1 ex-tank regions
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 9

EQUIPMENT: Nonconductive plastic tubing

CATEGORY: Static Spark Potential

USE:

Used for purge lines or miscellaneous purposes.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3, ICS 1 #3	FG 1 ex-tank FG 1,2 dome intrusive FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Nonconductive plastic tubing is used for miscellaneous needs, including temporary gas purge lines, vent and balance testing and aerosol testing of filters, temporary drain lines and temporary instrument lines during calibration or operation. Nonconductive plastic tubing is judged to have a negligible potential for causing flammable gas ignition under the applied conditions. Nonconductive plastic tubing shall not be used below the plane of a riser.

RISK ACCEPTANCE:

Nonconductive plastic tubing is used as described above in ex-tank areas. The nonconductive plastic tubing is also considered to be used in dome intrusive activities because it is connected to fittings which are in communication with the dome vapor space. During use, it is normally immobile. Static charge due to friction is minimized during insertion or removal. If nonconductive plastic tubing cannot be used, the only alternatives are rigid tubing or the wire wrapped tubing used during CGM sampling. Rigid tubing use is undesirable due to the extra cost and time for installation and waste disposal. Wire wrapped tubing is more expensive than nonconductive plastic tubing and is primarily available in a few specific lengths. The costs associated with these alternatives are a greater concern than the small risk of a flammable gas ignition event due to a spark from the plastic tubing. The risk associated with continuing to use this tubing is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] as applicable for the activity at the time the tubing is used. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Moderate impact due to occasional work delays. Would switch to alternate higher cost (in both time and money) tubing now available.

Facility Group 2 Tanks-Moderate impact due to occasional work delays. Would switch to alternate higher cost (in both time and money) tubing now available.

Facility Group 3 or other Tanks-No impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] as appropriate for nonconductive plastic tubing in:

1) FG 1 ex-tank regions
2) FG 1,2 dome intrusive regions
3) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 10

EQUIPMENT: Installation and removal of Garlock gaskets

CATEGORY: Static Spark Potential

USE:

Used for sealing riser flanges to risers.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Garlock gaskets are used for sealing riser flanges to risers. Garlock gaskets are a replacement for asbestos gaskets, which are no longer used for reasons related to worker safety and asbestos abatement. Ex-tank use for gaskets in Facility Group 1 tanks is included to avoid confusion because the gaskets are handled in an ex-tank area prior to installation. Garlock gasket installation and removal is judged to have a negligible potential for causing flammable gas ignition under the applied conditions.

RISK ACCEPTANCE:

Garlock gaskets are a replacement for asbestos gaskets, which are no longer used for reasons related to worker safety and asbestos abatement. They have been installed on hundreds of risers in recent years. The barrier provided by the gaskets is needed to seal the risers. Using other materials is undesirable from an environmental standpoint. The gaskets are sandwiched between two steel flanges during use, with only a small portion of the gasket (less than 1/8 inch) open to the vapor space. There is no process which would be expected to build up a static charge on the gaskets. The installed orientation of the gasket and flanges is such that a static charge would not be retained. Therefore, the risk associated with Garlock gaskets is strictly confined to installation and removal. Since installation and removal tasks are of a short duration, the actual time at risk is small.

The problems with using alternative gaskets are a more significant concern than the low risk of a flammable gas ignition event due to a spark from a gasket. The risk associated with continuing use of the gaskets is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during installation. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-There is no reasonably available gasket material which has equivalent performance for worker safety and contamination control.

Facility Group 2 Tanks-No Impact.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for installation and removal of Garlock gaskets in tanks without flammable gas monitoring or response actions in:

1) FG 1 ex-tank regions

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 11

EQUIPMENT: Nonconductive plastic garden type sprayer

CATEGORY: Static Spark Potential

USE:

Used for contamination control.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The garden sprayer is a commercial unit containing less than 5 gallons of liquid. It is hand pumped and is used in Tank Farms for localized wetting and contamination control. The non-sparking brass end may enter dome intrusive regions, but the container and wand are located outside, or in ex-tank regions only. The garden type sprayer is judged to have a negligible potential for causing flammable gas ignition under the applied conditions.

RISK ACCEPTANCE:

The sprayer has proven to be an inexpensive, easy to use, flexible tool for use in tank farms. Static buildup on the sprayer tip from the water spray is believed to be minimal. The nozzle velocity is limited by the air pressure that can be generated by hand pumping. The sprayer is used for less than a minute at a time. The risk associated with continued use of the sprayer is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Minor impact, would switch to stainless steel sprayer.

Facility Group 2 Tanks-Negligible impact.

Facility Group 3 or other Tanks-No impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for use of nonconductive plastic sprayer in:

1) FG 1 ex-tank regions
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 12

EQUIPMENT: Use of grab sample cap, sampling and sludge weight retrieval device, and coated steel cable.

CATEGORY: Static Spark Potential

USE:

Used for obtaining grab samples and sludge weight retrieval.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 1,2 dome intrusive FG 3 dome intrusive (LWD, GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The grab sample bottle is glass and is held in a stainless steel holder assembly. The grab sampler meets the Flammable Gas JCO and is not included in this exception request. The sample bottle cap is a small plastic item. The cable holding the stainless steel holder assembly is steel covered with a plastic coating to allow decontamination. The grab sample and sludge weight retrieval device includes a piece of PVC pipe with a PVC cap on the top and open on the bottom. This PVC enclosure has a metallic crank used to withdraw the stainless steel holder assembly up from the tank using the plastic coated steel cable. The PVC enclosure sits over the sampling riser. The retrieval device is usually outside the glove bag and therefore not in an ex-tank region. However, depending upon the riser arrangement it may be necessary to place part of the retrieval device inside the glove bag, which would then make it in an ex-tank or dome intrusive region. These grab sampling and sludge weight removal items are judged to have a minimal potential for causing flammable gas ignition under the applied conditions.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would halt grab sampling or sludge weight removal until alternate items were available, or would have to accept significant personnel exposure and contamination.

Facility Group 2 Tanks-Would halt grab sampling or sludge weight removal until alternate items were available, or would have to accept significant personnel exposure and contamination.

Facility Group 3 or other Tanks-Would halt grab sampling or sludge weight removal until alternate items were available, or would have to accept significant personnel exposure and contamination.

REQUESTED APPROVAL FROM DOE:

Continued use of the listed equipment when performing flammable gas monitoring control [A] for above items:

1) FG 1 ex-tank regions
2) FG 1,2 tanks dome intrusive regions
3) FG 3 tanks for dome intrusive regions (LWD, GWD).

Risk Acceptance for Grab Sample Items.

The cap is a negligible source of static discharge. The RH has been measured at >50% in 95% of the non-exhausted tanks sampled. The remaining 5% of the non-exhausted tanks all measured between 40 to 50% RH. The SX Farm exhausted tanks measured between 20 to 40% RH, except one tank which was 65% RH.

Tank 241-C-105 measured between 40 to 60% RH, and Tank 241-C-106 measured between 50 to 100% RH. Therefore, for non-exhausted tanks, use of the cable and enclosure in dome intrusive regions is expected to be in compliance with the Flammable Gas JCO about 95% of the time. Exhausted Tanks 241-C-105 and 241-C-106 are approximately 50% RH. Most double-shell tanks would be expected to be the same due to the liquid or moist solid surfaces.

Not using the coated cable would lead to a significant increase in personnel exposure and contamination. The static buildup resulting from the cable rubbing against the inside of the PVC riser adapter is judged to have minimal risk for causing flammable gas ignition under the applied conditions. Not only is the humidity above 50% much of the time, the cable is inserted/retrieved slowly and the whole insertion or removal step only takes a few minutes. Not using the retrieval device would result in more personnel exposure. The impact of halting waste transfers and characterization from halting grab sampling must be balanced against the low risk of a flammable gas ignition event due to a spark from these items. The risk associated with continued use of the items is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 13, 14

EQUIPMENT: Installation, removal, and presence of PVC liners for manual tapes and FICs

CATEGORY: Static Spark Potential

USE:

Used for keeping metal tapes from grounding out against the insides of risers.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1,2, dome intrusive FG 3 dome intrusive (LWD, GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The PVC liners are present on most single-shell and double-shell tanks with manual tapes or FICs, to prevent the metal tapes from making contact with the riser wall. Removal and replacement of these liners is done occasionally. Approximately four times in the past, a manual tape or FIC has been removed to permit sampling when another riser was not available. To date, this has been done to allow push mode core sampling (PMCS), which would result in a steel pipe being inserted into the riser. Grab sampling has been done at least once in the last three years through a liner.

RISK ACCEPTANCE:

The RH has been measured at >50% in 95% of the non-exhausted tanks sampled. The remaining 5% of the non-exhausted tanks all measured between 40 to 50% RH. The SX Farm exhausted tanks measured between 20 to 40% RH, except one tank which was 65% RH. Tank 241-C-105 measured between 40 to 60% RH, and Tank 241-C-106 measured between 50 to 100% RH. Therefore, for non-exhausted tanks, use of the cable and enclosure in dome intrusive regions is expected to be in compliance with the Flammable Gas JCO about 95% of the time. Exhausted Tanks 241-C-105 and 241-C-106 are approximately 50% RH. Most double-shell tanks would be expected to be the same due to the liquid or moist solid surfaces.

The PVC liners are already installed in the tanks. The cost in labor, time, waste disposal, and personnel exposure to remove them is a more significant concern than the small risk of a flammable gas ignition event due to a spark from a liner. The risk associated with continued use of the liners is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during installation. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

Core sampling is seldom performed through a riser liner, and rarely for grab sampling. During grab sampling, the plastic coated steel cable would be raised and lowered while in occasional contact with the riser liner. This does not pose a significant static buildup hazard. Flammable gas monitoring is done while taking the sample and the discussion above on the tank humidity levels applies.

No monitoring for flammable gas is done for the routine presence of the PVC liners in a tank vapor space. It is an acceptable risk to have the liners installed in the tanks without monitoring for flammable gases during their presence.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Almost all the tanks would be out of compliance, and the risk of removing the liners is far greater from cost and As Low As Reasonably Achievable (ALARA) standpoints, than the risk involved with leaving them in place.

Facility Group 2 Tanks-Same as for FG 1 tanks.

Facility Group 3 or other Tanks-Same as for FG 1 tanks.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for installation or removal of PVC riser liners, and their extended presence in tanks without flammable gas monitoring in:

1) FG 1,2,3 dome intrusive regions

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 15, 16

EQUIPMENT: Manual Tapes

CATEGORY: Static Spark Potential

USE:

Used for measuring waste level surfaces.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #2	FG 1,2 dome intrusive FG 3 dome intrusive (LWD, GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The electrical spark produced by the manual tape contact with the waste has been evaluated in WHC-SD-WM-ES-176, and is limited by the portable ohm meter used to take the reading. The current and voltage values are orders of magnitude below the ignition curve in UL 913. The manual tapes are not bonded to the tank, which could be interpreted as being required by the ICS 2 control #2 in the Flammable Gas JCO. These tapes will not function if bonded to the tank. Manual tapes are judged to have a negligible potential for causing flammable gas ignition under the applied conditions.

RISK ACCEPTANCE:

The metal tapes used for the manual tape level gauges represent a small potential static discharge source. If the manual tape acquired a static charge, it would dissipate over time. If a portable ohm meter is connected to the manual tape when it held a charge, it would be dissipated through the meter circuitry to ground. Any spark at the time of connection would be outside the controlled area. The loss of manual tapes for determining waste levels to detect leaks to the environment is greater than the small risk of a flammable gas ignition event due to a spark from a tape. The risk associated with continuing use of the tapes is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during installation and removal. This includes monitoring per method [A]. See definition of monitoring methods at the end of this section.

Monitoring is not an appropriate control for the presence of the manual tapes in a tank vapor space as no response actions are available. Per the above discussion, it is an acceptable risk to have the manual tapes installed in the tanks without monitoring for flammable gases during their presence.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-All tanks would be out of compliance and the risk of removing the tapes is far greater from cost, ALARA, and lack of level monitoring standpoints, than the risk involved with leaving them in place.

Facility Group 2 Tanks-Almost all tanks would be out of compliance and the risk of removing the tapes is far greater from cost, ALARA, and lack of level monitoring standpoints than the risk involved with leaving them in place.

Facility Group 3 or other Tanks-Same as for FG 2 tanks.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for installation or removal of manual tapes in:

1) FG 1,2 dome intrusive regions

Continued extended presence of manual tapes without flammable gas monitoring in:

2) FG 1,2,3 dome intrusive regions

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 17

EQUIPMENT: Core Sampling Equipment-Installation, use, removal, or extended presence of Pipe Wiper (Frisbee), Rainer Rubber #R2325 (Truck 1), H-2-821457 (Trucks 2 and 3)

CATEGORY: Static Spark Potential

USE:

Used for sealing around drill string during core sampling.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1,2 dome intrusive FG 3 dome intrusive (LWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The frisbee is a rubber disc approximately nine inches in diameter and is located at the top of a riser during core sampling. It is used to provide a seal around the drill string between the tank vapor space and the area outside the tank. About a two inch annular area of the frisbee is exposed to the tank vapor space. Frisbees have a negligible potential for causing a flammable gas ignition under the applied conditions. The FGEAB reviewed the use of the frisbee and determined that the frisbee met equivalence with the Flammable Gas JCO because of the lubricant used to wet it down prior to insertion of the drill string. The frisbee is still included in this exception because it cannot be guaranteed that the lubricant will remain present should the drill string be in place for an extended period of time with no sampling activity ongoing.

RISK ACCEPTANCE:

WHC-SD-WM-SAD-035 Rev 0-b for rotary mode core sampling (RMCS) in flammable gas single-shell tanks concluded the use of the frisbee was acceptable for RMCS in flammable gas tanks. The conclusion from this document cannot be directly applied to PMCS. However, the continued risk of using the frisbee is low. Not using the current frisbee would cease all PMCS and retained gas sampling.

The frisbee design cannot be readily changed. The frisbee was tested at the Bureau of Mines and must stay the same configuration for RMCS unless a new design is tested. The resulting delay to sampling work and the ability to obtain characterization data from waste tanks that is used for both helping to close safety issues and for design of privatization waste handling facilities must be balanced with the small risk of a flammable gas ignition event due to a spark from the frisbee. The risk associated with continuing its use is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] as applicable for the core sampling step being performed. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would stop all PMCS and retained gas sampling.

Facility Group 2 Tanks-Would stop all PMCS and retained gas sampling.

Facility Group 3 or other Tanks-Would stop all PMCS and retained gas sampling.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] as appropriate for use of the core sampling frisbee in:

1) FG 1,2 dome intrusive regions
2) FG 3 tanks dome intrusive regions (LWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 18

EQUIPMENT: Core Sampling Equipment-Installation, removal, and use of plastic cam-lock caps.

CATEGORY: Static Spark Potential

USE:

Used for capping the quill rod when disconnected from the drill string

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1,2 dome intrusive

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Cam-lock caps are placed on the bottom of the quill rod when it is disconnected from the drill string for contamination control. The cam-lock caps in use are constructed of nonconductive polymer material. The quill rod is not connected to the tank when the cam-lock cap is in place, but the quill rod could be vented back to the tank vapor space. Based upon the definitions in the Flammable Gas JCO, this could be interpreted as dome intrusive work. Plastic cam-lock caps are judged to have a negligible potential for causing a flammable gas ignition under the applied conditions.

RISK ACCEPTANCE:

This is an item where worker safety must be balanced with negligible ignition source risk. Not using the caps would cease all PMCS and retained gas sampling. Steel caps were previously used, but were eliminated because they were a personnel safety hazard. Installation and removal of the caps is normally done at arm's length to minimize personnel exposure or contamination. The cap is held out and slowly raised up onto the quill rod and the cam-lock handles on the adapter moved to hold the cap in place. Handling of the heavy steel caps was difficult at arm's length, so the plastic caps were implemented. This has improved operations around the truck. In use, the caps are motionless. Thus, there is no mechanism for static charge buildup. Elimination of the plastic caps is not warranted from a cost, schedule, and worker safety standpoint, and is a more significant concern than the small risk of a flammable gas ignition event due to a spark from the plastic caps. The risk associated with continuing their use is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during use. This will include monitoring per method [A] as applicable for the core sampling step being performed. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would delay PMCS and retained gas sampling until different caps were obtained; increased personnel safety hazard.

Facility Group 2 Tanks-Would delay PMCS and retained gas sampling until different caps were obtained; increased personnel safety hazard.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] as appropriate for use of plastic cam-lock caps in:

1) FG 1,2 dome intrusive regions (non-waste disturbing [NWD])

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 19

EQUIPMENT: Presence of extension cords

CATEGORY: Static Spark Potential

USE:

Used for providing power to electrical equipment.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #5	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Electrical cords are used in some ex-tank regions. The cords meet equivalence with the Flammable Gas JCO from an electrical spark potential as long as power connections or disconnections are accomplished outside the area or when the ex-tank area does not exist. There is a negligible risk of a static spark potential from the plastic or rubber coated extension cords.

RISK ACCEPTANCE:

Continued use of this equipment will permit activities to continue that require temporary service electrical power to an ex-tank region. Calibration or maintenance of Technical Safety Requirements and Operating Specification Documents required instruments, Standard Hydrogen Monitoring System (SHMS) cabinets, leak detectors or other instruments is a more significant concern than the negligible risk of a flammable gas ignition event due to a static spark from one of these items. The risk associated with continuing to use the cords is managed by performing flammable gas monitoring, with safe shutdown controls, prior to installation and during use when personnel are present. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Will shut down a moderate amount of ex-tank region work.

Facility Group 2 Tanks-Same as above, except only during GWD.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for the presence of electrical cords in:

1) FG 1 ex-tank regions
2) FG 2 ex-tank regions (GWD)

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 20

EQUIPMENT: Closed Pit Work Related Equipment-Installation, Use and Removal of Low and High Pressure Pit Spray Whirlie and Operation of Valve Handles

CATEGORY: Mechanical Spark Potential

USE:

Used for washing down pits and operating valves in pits.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #1	FG 1 ex-tank FG 2 ex-tank (GWD) FG 1 dome intrusive FG 2 dome intrusive FG 3 dome intrusive (LWD, GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The subject tools and equipment are normally made of carbon steel and were not procured to meet non-sparking criteria. The valve handle is used for operating valves in pits through holes in the cover blocks. The spray whirlie is inserted through an opening in the cover block and sprays solutions inside the pit for decontamination or temporarily fixing loose contamination. Most usage will be ex-tank related, but it may be required to use a valve handle or the whirlie in a pit during a time when it is designated as dome intrusive.

RISK ACCEPTANCE:

Valve handle operation has been evaluated to be low risk with regards to spark initiation. This is due to the low energies and small ranges of motion involved. The whirlie operation creates a high humidity environment within the pit which is not conducive to spark generation. Furthermore, these tools are either; a) not readily or economically available in a spark resistant version, or b) are only rarely used in areas requiring compliance with the Flammable Gas JCO controls, hence, the time at risk is low. The need to use these tools is a more significant concern than the small risk of a flammable gas ignition event due to a spark from one of them. The risk associated with continuing to use these tools and equipment is managed by performing flammable gas monitoring, with safe shutdown controls, prior to and/or during the work. The monitoring used is method [A] as appropriate. See definition of monitoring methods at the end of this section.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Will significantly increase contamination and exposure, and shut down all pit work and a minor amount of other ex-tank work until alternate equipment or means of isolating from the tank can be established. Will halt installation of most new equipment items into the tank.

Facility Group 2 Tanks-Will significantly restrict or shut down pit work during dome intrusive activities until alternate tools or means of isolating from the tank can be established. Will halt installation of most new equipment items into the pit. Will affect most all transfers. Will significantly increase exposure and spread of contamination.

Facility Group 3 or other Tanks-Will halt some transfers. Will significantly increase exposure and spread of contamination.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring controls [A] as appropriate for the above equipment:

1) FG 1 tank ex-tank regions.
2) FG 1 tank dome intrusive regions
3) FG 1 and 2 tanks dome intrusive regions (LWD, GWD).
4) FG 2 ex-tank regions GWD

ITEM CLASSIFICATION: DE MINIMUS

ITEM NUMBER: 21

EQUIPMENT: Fittings on openings less than or equal to 2.54 cm (1 in) inside diameter located on the boundary of intrusive locations.

CATEGORY: Static Spark Potential

USE:

Used for sealing tank ventilation system access points and fitting on instrument lines.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #2	During fitting removal during entry into intrusive locations and final installation upon exiting intrusive locations

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Electrically conductive objects are bonded as per NFPA 77 (1993) during intrusive work, except removal and installation of fittings on lines that are less than 2.54-cm (1-in) in diameter. The 2.54-cm (1-in) diameter line is chosen to exclude most instrument tubing or small piping from bonding, but to include all gasketed flanges. This is justified because bonding is done to minimize static electrical buildup and discharge. The potential for static buildup on a screwed fittings is minimal as a resistance of less than 1 megohm (required by NFPA 77 (1993) for static bonding) between the nut and the tubing is realistic for small screwed fitting in the service seen in tanks farms. Any static charge buildup that might occur while the fitting is off will be discharged by touching the fitting against a ground point prior to installation.

RISK ACCEPTANCE:

Monitoring is not an appropriate control for removal of small fittings during intrusive location entry as the monitoring activity requires the availability of an intrusive location access point, which required the removal of a fitting. Per the above discussion, it is an acceptable risk to remove and install small fittings without bonding or monitoring for flammable gases during the entry and final fitting installation portion of an activity.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

<u>All facilities within the scope of this JCO</u> - Require additional bonding, grounding, and monitoring steps in work packages and procedures that remove or install these fittings.

REQUESTED APPROVAL FROM DOE:

Continued practice of removing and installing small fitting without bonding or monitoring in:

1) Entry into intrusive locations
2) Fitting installation during exiting from intrusive locations

ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 22

EQUIPMENT: Use of Type 4 Vapor Sampling head

CATEGORY: Static Spark Potential

USE:

Used for obtaining Type 4 dome space vapor samples.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3	FG 1 ex-tank FG 1,2 dome intrusive

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Type 4 vapor sampling is the tank vapor sampling method currently used. It is a marked improvement over Type 3 sampling in both cost, schedule and sampling time. The sampling is done in situ, making the data more reliable than the Type 3 vapor sampling. Type 3 vapor sampling requires the removal of vapors from a tank through heated sampling tubes. Type 4 vapor sampling requires the insertion of a sampling head equipped with sampling media. Figure 4VS-1 is a sketch of the equipment inserted into the tank vapor space. Some of the items on the sampling head are made of different polymers. Encased within the acrylic tubing are approximately 1 foot of the plastic flexible tube bundle, the bulkhead top collar (ultra-high molecular weight plastic) and Teflon filter. The tube bundle, within the acrylic tubing, terminates with the stainless steel sample head (non-sparking) containing the exposed (to tank vapors) Teflon alignment guide. The remainder of the tube bundle above the acrylic tubing is wrapped in plastic sleeving.

The scope of this requested exception is limited to the Type 4 vapor sampling head items.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Would halt Type 4 vapor sampling until alternate items were available.

Facility Group 2 Tanks-Would halt Type 4 vapor sampling until alternate items were available.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [B] for above polymeric items during Type 4 vapor sampling in:

1) FG 1 ex-tank regions
2) FG 1,2 tanks during dome intrusive activities

Risk Acceptance for Type 4 vapor sampling head.

The Teflon and various plastic components in the Type 4 vapor sampling head were all specifically selected for use based upon their physical characteristics and because they were shown to cause minimal bias to the sampling operation from outgassing of organics. Alternate materials cannot be used for the Type 4 vapor sampling head without going through extensive testing. The sampling method is sufficiently sensitive that during early sampling with the Type 4 vapor sampler, it was found that the results were being biased by outgassing from the plasticizer used in the tape that attached the plastic sleeve to the sample head. This required revising the taping method normally used for sleeving objects inserted into tank risers to the one shown in Figure 4VS-1 which maintains a barrier between the tape and the vapor sampling head inlet. The ends of the sampling tubes are tightly pressed into the teflon end piece. There is no flow of tank vapors into the acrylic housing as there is no driving force to cause vapors to pass by the seal.

Static buildup is a function of the RH and physical factors that influence a charge such as mechanical friction. The Type 4 vapor sampling head is only in a tank vapor space for a few hours. The unit is stationary at that time while the tank vapors flow through the tubes. There is no work done to induce a static charge.

The RH has been measured at >50% in 95% of the non-exhausted tanks sampled (as of 7/96). This is to be expected since the concentration of water in air in a sealed chamber will eventually reach saturation, and be in equilibrium with the liquid phase. The remaining 5% of the non-exhausted tanks all measured approximately between 40 to 50% RH. The SX Farm exhausted tanks measured approximately between 20 to 40% RH, except one tank which was 65% RH. Tank 241-C-105 measured 40 to 60% RH, and Tank 241-C-106 measured 50 to 100% RH. Therefore, for non-exhausted tanks, plastics in dome intrusive regions are expected to be in compliance with the Flammable Gas JCO about 95% of the time. For exhausted tanks, Tanks 241-C-105 and 241-C-106 are approximately 50% RH. Most double-shell tanks would be expected to be the same due to the liquid or moist solid surfaces.

Concern is when a spark occurs coincident with a flammable gas mixture >100% lower flammability limit (LFL). Per Appendix A of this JCO, vapor space sample results for single-shell tanks indicate that 70 to 90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10 to 30% of the tanks average 1.2 to 1.5% of the LFL. The highest CGM measurement (7%) recorded to date using the organic vapor monitor (OVM) samples equated to approximately 3.5% of the LFL. The highest vapor sample results obtained via Type B/Type 4 vapor sampling correlates to 2.51% of the LFL. One inactive miscellaneous underground storage tank (IMUST) sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL combustible gas meter (CGM) reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectible levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

Trapping of gases is not a concern with the Type 4 vapor sampling head as the top end of the external sleeving is open. The following list summarizes the points to be considered when evaluating the risk associated with using the Type 4 vapor sampling head:

1) The air flow in the sampler tubing is insufficient to induce a static charge.

2) There is a low potential for static buildup and subsequent discharge with the unit. There are no moving parts and the head is in the tank vapor space for only a few hours.

3) The RH in passively ventilated tanks or waste intruding equipment is expected to be high enough so that the majority of the time nonconductive plastic use in these areas is in compliance with the Flammable Gas JCO.

4) There is no liquid or wind exposure to the head to cause a static buildup.

5) Flammable gas levels have not been seen in excess of the LFL in the tank dome space for any tank except in pre-mitigated Tank 241-SY-101 during one or more gas release event (GREs). In about 80% of the single-shell tanks that have been sampled the LFL is below detectable. In the remaining 20% of the single-shell tanks the LFL is less than 2%, except for 2-3 specific readings which have ranged up to 6.5%. The presence of flammable gases in actively ventilated single-shell and double-shell tanks would be expected to be low most of the time because of the constant dilution air. Therefore, although the presence of flammable gas concentrations in dome intrusive areas above the LFL cannot be positively ruled out, they can be expected to be a rare occurrence.

Based upon the following, continued use of the Type 4 vapor sampling head in Tank Farms poses a low risk of causing a flammable gas ignition event; a) consideration of the small amount of time the Type 4 vapor sampling head is exposed to the tank vapor space, b) the low percentage of the time the Type 4 vapor sampling head will be used in a dome intrusive regions when the RH will be low enough that the head use would not meet the Flammable Gas JCO, c) the lack of any significant static generating mechanisms, and d) the small percent of the time that flammable gas levels might be above the LFL.

The risk with continuing use of the Type 4 vapor sampling head is further reduced by performing flammable gas monitoring of the work area prior to and during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

When flammable gas levels reach 25% of the LFL, work ceases as required per the Flammable Gas JCO. The National Fire Protection Association (NFPA 30, 1988) recommends that processes be controlled so that flammable gas concentrations are <25 percent of the LFL, when relying upon vapor space flammability levels to preclude the possibility of an ignition. DOE Order 5480.4 requires Hanford waste tanks to be operated within NFPA guidelines. Thus, a control of <25% of the LFL has been established for performing activities in and around Tank Farm facilities. Because of the unpredictable nature of GREs, it is currently not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are thus in place to minimize the potential for a tank to exceed 25% of the LFL, and to cease work in areas common with the tank vapor space when the flammable gas concentration exceeds this value. This 25% limit is far below the actual limit at which flammability can occur, and is conservatively chosen to allow for potential measurement errors.

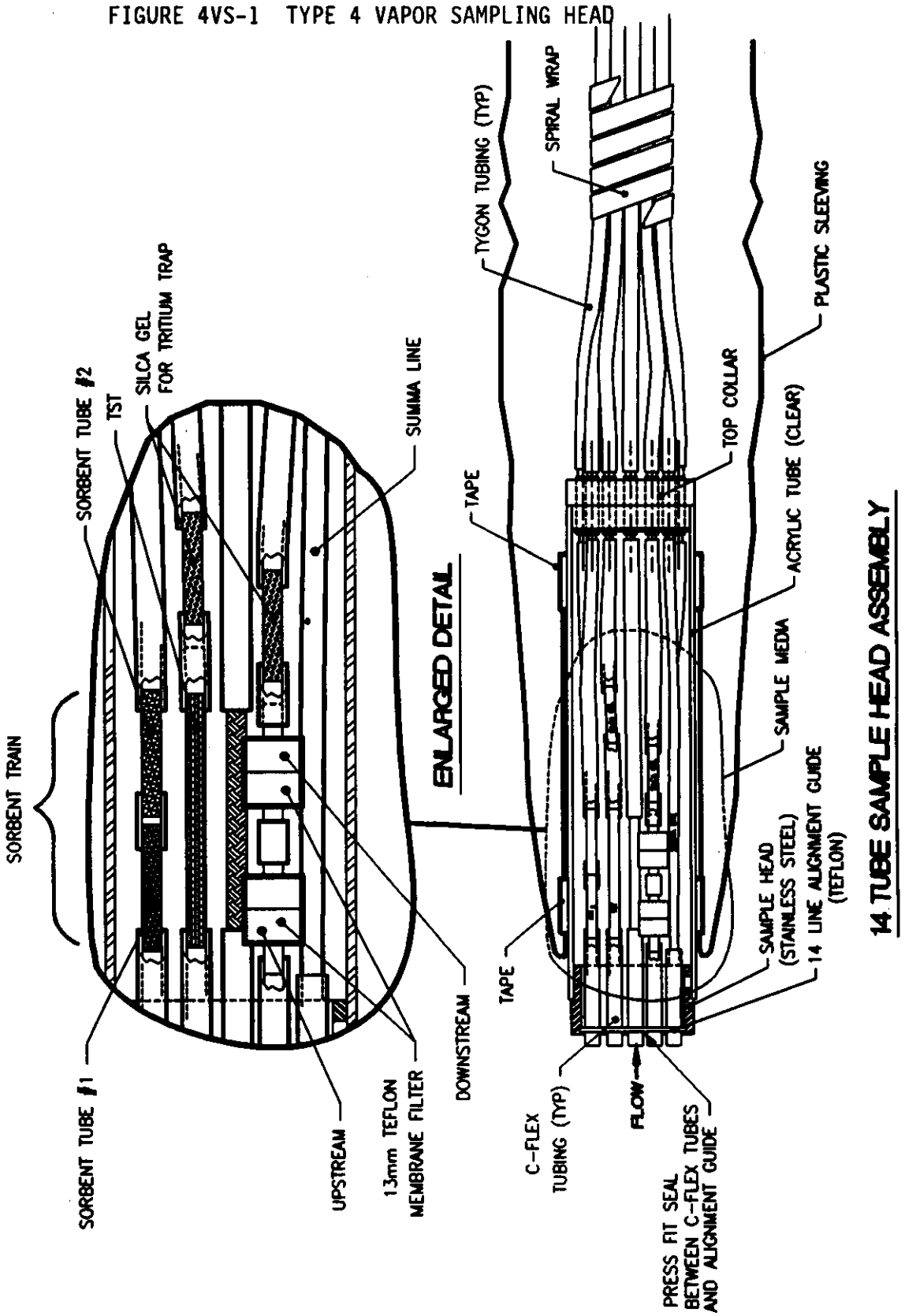
Monitoring is normally performed with a portable CGM. The CGM is calibrated with pentane and reads high by 100% when monitoring for hydrogen in air. For conservatism, no correction factor is applied in the field to the CGM reading when used for monitoring for personnel protection. Thus a 25% of the LFL reading on a CGM is actually 12.5% of the LFL for hydrogen in air, but is treated as if it were 25%. Depending upon the concentration of the flammable gas constituent and oxidants (ammonia, methane, carbon monoxide, nitrous oxide) a 25% LFL CGM reading will be indicative of 12.5% to approximately 20% of the LFL. The response time of a CGM to an increase in flammable gas concentration is not instantaneous. The CGM starts responding to an increase in flammable gas concentrations almost immediately upon the gas reaching the CGM internals. The internal response time for a CGM to reach a 10% of the LFL indication (5% LFL actual for hydrogen in air) when exposed to a 23% of the LFL pentane mixture (equivalent to a 11.5% of the LFL hydrogen in air mixture) ranged from 7-12 seconds in a number of informal tests. Time to reach the full 23% test gas indication took 20-40 seconds.

If the CGM is drawing a sample out of a tank dome space, the time for the tank vapors to reach the CGM is approximately 26 seconds, based upon the 500 cm^3/min CGM flow and the tubing currently used for flammable gas monitoring. Thus an instantaneous change from 0 to 12.5% of the LFL for hydrogen in air in a tank vapor space (an indicated 25% of the LFL) would not indicate any change at all on a CGM for about 26 seconds. At 26 seconds, the indicated LFL would begin to rise and 33-36 seconds after the step change the CGM would indicate about 10% of the LFL. The CGM would indicate 25% of the LFL approximately 45-65 seconds after the step change.

A CGM is an acceptable instrument to use for flammable gas monitoring in Dome Intrusive regions as long as work is halted upon significant increase in the indicated flammable gas levels. An instantaneous step increase in an entire tank dome vapor space concentration from 0 to 100% of the LFL is not realistic due to the large volume of gas which would be required to be released, although localized spots near the waste surface could show a quick step change to >100% of the LFL from relatively small releases of gases from below the waste surface. The risk is low that a gas stream would be released from the waste surface of a 75 foot diameter tank and enter the 2½ inch diameter sampling head directly above without the gas being partially diffused by tank vapors. The sampling head is not routinely used near the waste surface where there could be quick localized step changes in the flammable gas concentration. Were high gas concentrations present for a few seconds until noted by the CGM, there is still low risk of a static discharge as there are no moving parts to the Type 4 vapor sampling head and no major static discharge inducing activity.

The current polymeric materials used for vapor sampling were selected after a study which evaluated the effects of outgassing with a variety of compounds. Using other materials, even if they were available, would result in unnecessary expense and delays to the vapor sampling program. The impact on resolution of tank safety issues by halting Type 4 vapor sampling is a more significant concern than the low risk of a flammable gas ignition event due to a spark from these items.

FIGURE 4VS-1 TYPE 4 VAPOR SAMPLING HEAD



ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 23

EQUIPMENT: Electric Impact Wrench

CATEGORY: Electrical Spark Potential, Mechanical Spark Potential

USE:

Used for loosening and tightening jumper heads in pits.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #1, #5	FG 1 ex-tank

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The impact wrench is a large, 480 VAC electrical induction motor and socket. It is not designed to meet the ICS controls. The unit is used in tank farms for making jumper changes.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Will shut down most pit work until an alternate wrench, administrative controls or means of isolating the pit from the tank vapor space can be derived.

Facility Group 2 Tanks-No impact.

Facility Group 3 or other Tanks-No impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for the electric impact wrench:

1) FG 1 ex-tank regions (NWD, LWD)

Risk Acceptance for Electric Impact Wrench.

The electrical impact wrench is both an electrical spark source and a mechanical spark source. It is used for tightening and loosening horizontal and vertical jumper heads in pump pits, diversion boxes, valve pits and any location where the old design Hanford or newer PUREX jumper heads are present. No equipment is known to exist which can meet the Flammable Gas JCO controls from both electrical and mechanical spark source standpoints. Manual wrenches are not practical for the majority of the high torques required and would result in high personnel exposures.

Concern is when a spark occurs coincident with a flammable gas mixture >100% LFL. Per Appendix A of this Flammable Gas JCO, vapor space sample results for single-shell tanks indicate that approximately 70-90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10-30% of the tanks average 1.2-1.5% of the LFL. The highest CGM measurement (7%) recorded to date using the OVM samples equated to approximately 3.5% of the LFL. The highest vapor sample results obtained via Type B/Type 4 vapor sampling correlates to 2.51% of the LFL. One IMUST tank sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL CGM reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectible levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

The following can be summarized concerning the risk associated with using the impact wrench:

1) Its use is required to make jumper changes or repairs.

2) Flammable gas levels have not been seen in excess of the LFL in the tank dome space for any tank except in pre-mitigated Tank 241-SY-101 during one or more GREs. In about 80% of the single-shell tanks that have been sampled the LFL is below detectable. In the remaining 20% of the single-shell tanks the LFL is less than 2%, except for 2-3 specific readings which have ranged up to 6.5%. The presence of flammable gases in actively ventilated single-shell and double-shell tanks would be expected to be low most of the time because of the constant dilution air. Therefore, although the presence of flammable gas concentrations in Dome Intrusive areas above the LFL cannot be positively ruled out, they can be expected to be a rare occurrence. The presence of flammable gases at concentrations >25% of the LFL in an Ex Tank area is expected to be even less likely.

Based upon the following, continued use of the impact wrench in Tank Farms poses a low risk of causing a flammable gas ignition event; a) the requirement to use the wrench if some transfers are to continue and b) the small percent of the time that flammable gas levels might be above the LFL in the Ex Tank pit area.

The risk associated with continuing use of the impact wrench is further reduced by performing flammable gas monitoring of the work area prior to and during use. This will include monitoring per method [A], which will require continuous monitoring of the tank dome space or the pit. See definition of monitoring methods at the end of this section.

When flammable gas levels reach 25% of the LFL, work ceases as required per the monitoring requirements of this Flammable Gas JCO. The National Fire Protection Association (NFPA 30, 1988) recommends that processes be controlled so that flammable gas concentrations are <25 percent of the LFL, when relying upon vapor space flammability levels to preclude the possibility of an ignition. DOE 5480.4 requires Hanford waste tanks to be operated within NFPA guidelines. Thus, a control of <25% of the LFL has been established for performing activities in and around Tank Farm facilities. Because of the unpredictable nature of GREs, it is currently not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are thus in place to minimize the potential for a tank to exceed 25% of the LFL, and to cease work in areas common with the tank vapor space when the flammable gas concentration exceeds this value. This 25% limit is far below the actual limit at which flammability can occur, and is conservatively chosen to allow for potential measurement errors.

Monitoring is normally performed with a portable CGM. The CGM is calibrated with pentane and reads high by 100% when monitoring for hydrogen in air. For conservatism, no correction factor is applied in the field to the CGM reading when used for monitoring for personnel protection. Thus a 25% of the LFL reading on a CGM is actually 12.5% of the LFL for hydrogen in air, but is treated as if it were 25%. Depending upon the concentration of the flammable gas constituent and oxidants (ammonia, methane, carbon monoxide, nitrous oxide) a 25% LFL CGM reading will be indicative of 12.5% to approximately 20% of the LFL. The response time of a CGM to an increase in flammable gas concentration is not instantaneous. The CGM starts responding to an increase in flammable gas concentrations almost immediately upon the gas reaching the CGM internals. The internal response time for a CGM to reach a 10% of the LFL indication (5% LFL actual for hydrogen in air) when exposed to a 23% of the LFL pentane mixture (equivalent to a 11.5% of the LFL hydrogen in air mixture) ranged from 7 to 12 seconds in a number of informal tests. Time to reach the full 23% test gas indication took 20 to 40 seconds.

If the CGM is drawing a sample out of a tank dome space, the time for the tank vapors to reach the CGM is approximately 26 seconds, based upon the 500 cm^3/min CGM flow and the tubing currently used for flammable gas monitoring. Thus an instantaneous change from 0 to 12.5% of the LFL for hydrogen in air in a tank vapor space (an indicated 25% of the LFL) would not indicate any change at all on a CGM for about 26 seconds. At 26 seconds, the indicated LFL would begin to rise and 33-36 seconds after the step change the CGM would indicate about 10% of the LFL. The CGM would indicate 25% of the LFL approximately 45 to 65 seconds after the step change.

If the CGM was being used to sample the immediate work area where an impact wrench was used the 26 second delay would not apply, the CGM would start to rise immediately and a reading of 10% of the LFL would be noted 7 to 12 seconds after sensing a 25% step increase in the LFL.

A CGM is an acceptable instrument to use for flammable gas monitoring in dome intrusive or ex-tank regions as long as work is halted upon significant increase in the indicated flammable gas levels. An instantaneous step increase in an entire tank dome vapor space concentration from 0 to 100% of the LFL is not realistic due to the large volume of gas which would be required to be released, although localized spots near the waste surface could show a quick step change to >100% of the LFL from relatively small releases of gases from below the waste surface. The risk is very low that a gas stream would be released from the waste surface of a 75 foot diameter tank and enter a 4 inch diameter pit drain directly above without the gas being partially diffused by tank vapors. Since monitoring for flammable gases is done both in the tank dome space and the pit while using the wrench, the current response time for CGMs is not a significant concern.

There does not appear to be a suitable substitute for an electric impact wrench which could adequately tighten and loosen jumper heads and, at the same time, create no potential for mechanical sparking. In its tank farm applications, the impact wrench is judged to present a low risk for ignition of flammable gas due to the combination of the location of its use and the relatively short duration of its use. Therefore, the benefits derived from the use of the impact wrench (e.g., enabling waste transfers and repairing jumper leaks) must be balanced with the low risk introduced by its potential for mechanical sparking.

ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 24

EQUIPMENT: Type 4 Vapor Sampling Cart

CATEGORY: Electrical Spark Potential

USE:

Used for monitoring flows and providing suction for gas drawn through sampling tubes inserted in the tank.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #5	FG 1,2 dome intrusive

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The electronic equipment on the Type 4 sampling cart consists of four mass flowmeters, four electronic totalizers, and a vacuum pump. The Type 4 vapor sampling cart establishes the vacuum, and monitors the flow of tank vapors from the Type 4 vapor sampling head. The information is not yet available to show whether the items on the cart meet the controls for dome intrusive electrical equipment for Facility Group 1 and 2 tanks. Although the definitions in the Flammable Gas JCO would imply the equipment is not required to meet Dome Intrusive criteria, a conservative assumption is that it should meet the requirements as filtered tank gases pass through the equipment and any flammable mixtures would be exposed to the electrical equipment internals. Type 4 vapor sampling is currently only performed on FG 2 and FG 3 tanks, plans are to sample at least one FG 1 tank in the future.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-No impact unless sample FG 1 tanks. If FG 1 tanks are sampled, the impact would be the same as for FG 2 tanks.

Facility Group 2 Tanks-If the risk of continuing to use the current equipment is not accepted, all in-situ vapor sampling (Type 4) vapor sampling activities will be shutdown until different equipment is available or the existing equipment can be shown to meet the Flammable Gas JCO criteria.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for the current Type 4 vapor sampling cart:

1) FG 1,2 dome intrusive regions

Risk Acceptance for Type 4 vapor sampling cart.

The scope of this discussion is limited to potential electrical spark ignition events from the Type 4 sampling cart.

The Type 4 vapor sampling cart was developed to sample tank vapors to support resolution of tank safety issues. It replaces Type 3 vapor sampling which is more expensive and time consuming, and did not provide in situ sampling.

Concern is when a spark occurs coincident with a flammable gas mixture >100% of the LFL. Per Appendix A of this Flammable gas JCO, vapor space sample results for single-shell tanks indicate that approximately 70-90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10-30% of the tanks average 1.2-1.5% of the LFL. The highest CGM measurement (7%) recorded to date using the OVM samples equated to approximately 3.5% of the LFL. The highest vapor sample results obtained via Type B/Type 4 vapor sampling correlates to 2.51% of the LFL. One INUST tank sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL CGM reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectible levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

The following can be summarized concerning the actual risk from using the Type 4 vapor sampling cart:

1) Analytical data from Type 4 vapor sampling is used to support waste tank safety issue resolution.

2) Flammable gas levels have not been seen in excess of the LFL in the tank dome space for any tank except in Tank 241-SY-101 during one or more GREs. In about 80% of the single-shell tanks that have been sampled the LFL is below detectable. In the remaining 20% of the single-shell tanks the LFL is less than 2%, except for 2-3 specific readings which have ranged up to 6.5%. The presence of flammable gases in actively ventilated single-shell and double-shell tanks would be expected to be low most of the time because of the constant dilution air. Therefore, although the presence of flammable gas concentrations in Dome Intrusive areas above the LFL cannot be positively ruled out, they can be expected to be a rare occurrence.

Based upon the need for Type 4 vapor sampling and the small percent of the time that flammable gas levels might be above the LFL, continued use of the Type 4 vapor sampling cart poses a low risk of causing a flammable gas ignition event.

The risk associated with continued use of the Type 4 vapor sampling cart is further reduced by performing flammable gas monitoring of the work area and dome space prior to and during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

When flammable gas levels reach 25% of the LFL, work ceases as required per the monitoring requirements this Flammable Gas JCO. The National Fire Protection Association (NFPA 30, 1988) recommends that processes be controlled so that flammable gas concentrations are <25 percent of the LFL, when relying upon vapor space flammability levels to preclude the possibility of an ignition. DOE Order 5480.4 requires Hanford waste tanks to be operated within NFPA guidelines. Thus, a control of <25% of the LFL has been established for performing activities in and around Tank Farm facilities. Because of the unpredictable nature of GREs, it is currently not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are thus in place to minimize the potential for a tank to exceed 25% of the LFL, and to cease work in areas common with the tank vapor space when the flammable gas concentration exceeds this value. This 25% limit is far below the actual limit at which flammability can occur, and is conservatively chosen to allow for potential measurement errors.

Monitoring is normally performed with a portable CGM. The CGM is calibrated with pentane and reads high by 100% when monitoring for hydrogen in air. For conservatism, no correction factor is applied in the field to the CGM reading when used for monitoring for personnel protection. Thus a 25% of the LFL reading on a CGM is actually 12.5% of the LFL for hydrogen in air, but is treated as if it were 25%. Depending upon the concentration of the flammable gas constituent and oxidants (ammonia, methane, carbon monoxide, nitrous oxide) a 25% LFL CGM reading will be indicative of 12.5% to approximately 20% of the LFL. The response time of a CGM to an increase in flammable gas concentration is not instantaneous. The CGM starts responding to an increase in flammable gas concentrations almost immediately upon the gas reaching the CGM internals. The internal response time for a CGM to reach a 10% of the LFL indication (5% LFL actual for hydrogen in air) when exposed to a 23% of the LFL pentane mixture (equivalent to a 11.5% of the LFL hydrogen in air mixture) ranged from 7 to 12 seconds in a number of informal tests. Time to reach the full 23% test gas indication took 20 to 40 seconds.

If the CGM is drawing a sample out of a tank dome space, the time for the tank vapors to reach the CGM is approximately 26 seconds, based upon the 500 cm^3/min CGM flow and the tubing currently used for flammable gas monitoring. Thus an instantaneous change from 0 to 12.5% of the LFL for hydrogen in air in a tank vapor space (an indicated 25% of the LFL) would not indicate any change at all on a CGM for about 26 seconds. At 26 seconds, the indicated LFL would begin to rise and 33 to 36 seconds after the step change the CGM would indicate about 10% of the LFL. The CGM would indicate 25% of the LFL approximately 45-65 seconds after the step change.

A CGM is an acceptable instrument to use for flammable gas monitoring in Dome Intrusive regions as long as work is halted upon significant increase in the indicated flammable gas levels. An instantaneous step increase in an entire tank dome vapor space concentration from 0 to 100% of the LFL is not realistic due to the large volume of gas which would be required to be released, although localized spots near the waste surface could show a quick step change to >100% of the LFL from relatively small releases of gases from below the waste surface. The risk is very low that a gas stream would be released from the waste surface of a 75 foot diameter tank and enter the 2½ inch diameter sampling head directly above without the gas being partially diffused by tank vapors. The sampling head is not routinely used near the waste surface where there could be quick localized step changes in the flammable gas concentration. Were high gas concentrations present for a few seconds until noted by the CGM, the CGM would indicate high flammable gas levels present before flammable gases approached the Type 4 vapor sampling cart, leaving adequate time for shutdown.

Continuous monitoring is performed during Type 4 vapor sampling using a CGM. Sampling is conducted through a tube within the flexible tube bundle that is lowered into the tank. Tank vapors flow faster through the tubing used for flammable gas monitoring than through the tubing used for sampling the tank gases. This is because the vapors are drawn through the flammable gas monitoring tube with the CGM while the tank vapors to be sampled are drawn through sampling tubes by the vacuum pump on the cart. The time for tank vapors to reach the CGM is approximately 26 seconds. Tank vapors being sampled by the cart take approximately 65 seconds to reach the in situ vapor sampling instrumentation on the cart. Therefore, with the current flammable gas monitoring arrangement, a significant change in the tank flammable gas concentration would be noticed within 33-38 seconds or less, assuming there were no other indications of a GRE. This still leaves approximately 30 seconds before the instrumentation on the cart would see the gas, which allows adequate time for personnel response to shut off the vacuum pump. This monitoring is continuous during Type 4 vapor sampling while the vacuum pump is running. Shutdown of the electrical equipment on the Type 4 cart is manual upon receipt of a CGM alarm or indication.

Additionally, given that vapor sampling is non waste disturbing, the activity would not induce a GRE.

ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 25

EQUIPMENT: Open Pit Work Related Equipment (e.g., T-bar, chokers, shackles, bull hooks, pike poles, sockets; installation/removal of process blanks, vapor seals, jumpers and leak detectors)

CATEGORY: Mechanical Spark Potential

USE:

Used for handling items during installation or removal inside open pits

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #1	FG 1 ex-tank

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The subject items are normally made of carbon steel and were not procured to meet non-sparking criteria.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Will shut down all pit work. Will halt installation and removal of equipment in the waste tanks.

Facility Group 2 Tanks-No Impact.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring controls [A] as appropriate for rigging equipment:

1) FG 1 during ex-tank activities.

Risk Acceptance for Open Pit Work Related Equipment.

These items are potential mechanical spark sources. They are used for moving and adjusting equipment or sealing lines in various pits. Due to their size and weight, replacement equipment which meets the Flammable Gas JCO requirements is not readily or economically available. Control is provided through the use of proper rigging controls and procedures. Tools and equipment in this exception request are either not readily or economically available in a spark resistant version or are only rarely used in areas which require the Flammable Gas JCO controls.

Concern is when a spark occurs coincident with a flammable gas mixture >100% of the LFL. Per Appendix A this Flammable Gas JCO, vapor space sample results for single-shell tanks indicate that approximately 70 to 90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10 to 30% of the tanks average 1.2 to 1.5% of the LFL. The highest CGM measurement (7%) recorded to date using the OVM samples equated to approximately 3.5% of the LFL. The highest vapor sample results obtained via Type B/Type 4 vapor sampling correlates to 2.51% of the LFL. One IMUST tank sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL CGM reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectible levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

The following can be summarized concerning the risk associated with using these tools and equipment:

1) This equipment is required to accomplish pit work and to install and remove equipment in waste tanks.

2) Flammable gas levels have not been seen in excess of the LFL in the tank dome space for any tank except in Tank 241-SY-101 during one or more GREs. In about 80% of the single-shell tanks that have been sampled the LFL is below detectable. In the remaining 20% of the single-shell tanks the LFL is less than 2%, except for 2-3 specific readings which have ranged up to 6.5%. The presence of flammable gases in actively ventilated single-shell and double-shell tanks would be expected to be low most of the time because of the constant dilution air. Therefore, although the presence of flammable gas concentrations in dome intrusive areas above the LFL cannot be positively ruled out, they can be expected to be a rare occurrence. The presence of flammable gases at concentrations >25% of the LFL in an ex-tank area is therefore expected to be even less likely.

Based upon the following, continued use of these tools and equipment in Tank Farms poses a low risk of causing a flammable gas ignition event; a) the use of the tools and equipment is required if transfers are to continue and b) the small percent of the time that flammable gas levels might be above the LFL in the ex-tank pit area.

The risk associated with continuing use of the tools and equipment is further reduced by performing flammable gas monitoring of the work area prior to and during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

When flammable gas levels reach 25% of the LFL, work ceases as required per the monitoring requirements of this Flammable Gas JCO. The National Fire Protection Association (NFPA 30, 1988) recommends that processes be controlled so that flammable gas concentrations are <25 percent of the LFL, when relying upon vapor space flammability levels to preclude the possibility of an ignition. DOE Order 5480.4 requires Hanford waste tanks to be operated within NFPA guidelines. Thus, a control of <25% of the LFL has been established for performing activities in and around Tank Farm facilities. Because of the unpredictable nature of GREs, it is currently not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are thus in place to minimize the potential for a tank to exceed 25% of the LFL, and to cease work in areas common with the tank vapor space when the flammable gas concentration exceeds this value. This 25% limit is far below the actual limit at which flammability can occur, and is conservatively chosen to allow for potential measurement errors.

Monitoring is normally performed with a portable CGM. The CGM is calibrated with pentane and reads high by 100% when monitoring for hydrogen in air. For conservatism, no correction factor is applied in the field to the CGM reading when used for monitoring for personnel protection. Thus a 25% of the LFL reading on a CGM is actually 12.5% of the LFL for hydrogen in air, but is treated as if it were 25%. Depending upon the concentration of the flammable gas constituent and oxidants (ammonia, methane, carbon monoxide, nitrous oxide) a 25% LFL CGM reading will be indicative of 12.5% to approximately 20% of the LFL. The response time of a CGM to an increase in flammable gas concentration is not instantaneous. The CGM starts responding to an increase in flammable gas concentrations almost immediately upon the gas reaching the CGM internals. The internal response time for a CGM to reach a 10% of the LFL indication (5% LFL actual for hydrogen in air) when exposed to a 23% of the LFL pentane mixture (equivalent to a 11.5% of the LFL hydrogen in air mixture) ranged from 7 to 12 seconds in a number of informal tests. Time to reach the full 23% test gas indication took 20 to 40 seconds.

If the CGM is drawing a sample out of a tank dome space, the time for the tank vapors to reach the CGM is approximately 26 seconds, based upon the 500 cm^3/min CGM flow and the tubing currently used for flammable gas monitoring. Thus an instantaneous change from 0 to 12.5% of the LFL for hydrogen in air in a tank vapor space (an indicated 25% of the LFL) would not indicate any change at all on a CGM for about 26 seconds. At 26 seconds, the indicated LFL would begin to rise and 33-36 seconds after the step change the CGM would indicate about 10% of the LFL. The CGM would indicate 25% of the LFL approximately 45-65 seconds after the step change.

If the CGM was being used to sample the ex-tank area where these tools are used the 26 second delay would not apply, the CGM would start to rise immediately and a reading of 10% of the LFL would be noted 7-12 seconds after sensing a 25% step increase in the LFL.

A CGM is an acceptable instrument to use for flammable gas monitoring in ex-tank and dome intrusive regions as long as work is halted upon significant increase in the indicated flammable gas levels. An instantaneous step increase in an entire tank dome vapor space concentration from 0 to 100% of the LFL is not realistic due to the large volume of gas which would be required to be released; although localized spots near the waste surface could show a quick step change to >100% of the LFL from relatively small releases of gases from below the waste surface. The risk is very low that a gas stream would be released from the waste surface of a 75 foot diameter tank and enter a 4 inch diameter pit drain directly above without the gas being partially diffused by tank vapors. Since monitoring for flammable gases is done in the pit while using the tools and equipment, the current response time for CGMs is not a significant concern.

ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 26

EQUIPMENT: Closed Pit Work including the Installation and Removal of Valve Handles

CATEGORY: Mechanical Spark Potential

USE:

Used for operating valves in pits.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #1	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Valve handles are made of carbon steel. They were not procured to meet non-sparking criteria. The valve handles are bulky and are a potential spark source during installation and removal. Valve operation is covered as a de minimus item.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Will shut down transfers.

Facility Group 2 Tanks- May impact transfers.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring control [A] for installation and removal of valve handles in:

1) FG 1 tank ex-tank regions.
2) FG 2 tank ex-tank regions (GWD) operations

Risk Acceptance for Closed Pit Work.

Valve handles are potential mechanical spark sources as they could be dropped during installation or removal due to their size and weight. Concern is when a spark occurs coincident with a flammable gas mixture >100% of the LFL. Per Appendix A of this Flammable Gas JCO, vapor space sample results for single-shell tanks indicate that approximately 70 to 90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10 to 30% of the tanks average 1.2 to 1.5% of the LFL. The highest CGM measurement (7%) recorded to date using the OVM samples equated to approximately 3.5% of the LFL. The highest vapor sample correlates to 2.51% of the LFL. One IMUST tank sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL CGM reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectible levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

The following can be summarized concerning the risk associated with installing and removing valve handles,

1) Valve handles are required to perform transfers.

2) Flammable gas levels have not been seen in excess of the LFL in the tank dome space for any tank except in pre-mitigated Tank 241-SY-101 during one or more GREs. In about 80% of the single-shell tanks that have been sampled the LFL is below detectable. In the remaining 20% of the single-shell tanks the LFL is less than 2%, except for 2-3 specific readings which have ranged up to 6.5%. The presence of flammable gases in actively ventilated single-shell and double-shell tanks would be expected to be low most of the time because of the constant dilution air. Therefore, although the presence of flammable gas concentrations in dome intrusive areas above the LFL cannot be positively ruled out, they can be expected to be a rare occurrence. The presence of flammable gases at concentrations >25% of the LFL in an ex-tank area is therefore expected to be even less of a probability.

Based upon the need to install and remove valve handles if some transfers are to continue and the small percent of the time that flammable gas levels might be above the LFL in the ex-tank pit area, continued installation and removal of the valve handles poses a low risk of causing a flammable gas ignition event.

The risk associated with continuing installation and removal of valve handles is further reduced by performing flammable gas monitoring of the work area prior to and during the activity. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

When flammable gas levels reach 25% of the LFL, work ceases as required per the monitoring requirements of this Flammable Gas JCO. The National Fire Protection Association (NFPA 30, 1988) recommends that processes be controlled so that flammable gas concentrations are <25 percent of the LFL, when relying upon vapor space flammability levels to preclude the possibility of an ignition. DOE Order 5480.4 requires Hanford waste tanks to be operated within NFPA guidelines. Thus, a control of <25% of the LFL has been established for performing activities in and around Tank Farm facilities. Because of the unpredictable nature of GREs, it is currently not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are thus in place to minimize the potential for a tank to exceed 25% of the LFL, and to cease work in areas common with the tank vapor space when the flammable gas concentration exceeds this value. This 25% limit is far below the actual limit at which flammability can occur, and is conservatively chosen to allow for potential measurement errors.

Monitoring is normally performed with a portable CGM. The CGM is calibrated with pentane and reads high by 100% when monitoring for hydrogen in air. For conservatism, no correction factor is applied in the field to the CGM reading when used for monitoring for personnel protection. Thus a 25% of the LFL reading on a CGM is actually 12.5% of the LFL for hydrogen in air, but is treated as if it were 25%. Depending upon the concentration of the flammable gas constituent and oxidants (ammonia, methane, carbon monoxide, nitrous oxide) a 25% LFL CGM reading will be indicative of 12.5% to approximately 20% of the LFL. The response time of a CGM to an increase in flammable gas concentration is not instantaneous. The CGM starts responding to an increase in flammable gas concentrations almost immediately upon the gas reaching the CGM internals. The internal response time for a CGM to reach a 10% of the LFL indication (5% LFL actual for hydrogen in air) when exposed to a 23% of the LFL pentane mixture (equivalent to a 11.5% of the LFL hydrogen in air mixture) ranged from 7 to 12 seconds in a number of informal tests. Time to reach the full 23% test gas indication took 20 to 40 seconds.

If the CGM is drawing a sample out of a tank dome space, the time for the tank vapors to reach the CGM is approximately 26 seconds, based upon the 500 cm^3/min CGM flow and the tubing currently used for flammable gas monitoring. Thus an instantaneous change from 0 to 12.5% of the LFL for hydrogen in air in a tank vapor space (an indicated 25% of the LFL) would not indicate any change at all on a CGM for about 26 seconds. At 26 seconds, the indicated LFL would begin to rise and 33 to 36 seconds after the step change the CGM would indicate about 10% of the LFL. The CGM would indicate 25% of the LFL approximately 45 to 65 seconds after the step change.

If the CGM were being used to sample the pit where these tools are used, the 26 second delay would be reduced to 3 to 6 seconds (due to shorter sample tube lengths and, thus, shorter transport times), and a reading of 10% of the LFL would be noted 10 to 18 seconds after sensing a 25% step increase in the LFL.

A CGM is an acceptable instrument to use for flammable gas monitoring in pits as long as work is halted upon significant increase in the indicated flammable gas levels. An instantaneous step increase in an entire tank dome vapor space concentration from 0 to 100% of the LFL is not realistic due to the large volume of gas which would be required to be released, although localized spots near the waste surface could show a quick step change to >100% of the LFL from relatively small releases of gases from below the waste surface. The risk is very low that a gas stream would be released from the waste surface of a 75 foot diameter tank and enter a 4 inch diameter pit drain directly above without the gas being partially diffused by tank vapors. Since monitoring for flammable gases is done in the pit before installation and removal of the valve handles, the current response time for CGMs is not a significant concern.

There is no readily available substitute for the valve handles. Therefore, the ability to install and remove the existing valve handles is essential for transferring of waste and other basic plant operations. The benefits of the ability to install and remove valve handles must be balanced against the small risk of igniting flammable gas via mechanical sparking.

ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 27

EQUIPMENT: Cover blocks, riser flanges, shield plugs, and tank installed waste intrusive and non waste intrusive equipment items (e.g., thermocouple trees, steel LOWs, pumps, manual tapes, FICs, ENRAFs, radar gauges, heated vapor probes, multiple instrument trees (MITs), corrosion probes, velocity-density temperature trees (VDTTs), water lances, void fraction meter, core sampling drill string, salt well screens, dip tubes, cameras, lights, viscometer, auger sampler)

CATEGORY: Mechanical Spark Potential

USE:

Items are used for various purposes in risers and pits, or are equipment installed or removed in tanks to perform various functions.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #1	FG 1 ex-tank FG 1,2 dome intrusive FG 3 dome intrusive (LWD, GWD) FG 2 ex-tank (GWD) Waste Intrusive Regions

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

These are potential mechanical spark sources during seismic events, large GREs, and during installation, removal, or movement during use of various tools and equipment. Many are made of carbon steel. These items are inserted into or attached to the top of a riser or pit opening. Where required by the Flammable Gas JCO, these items are also bonded. Installation, removal, and use of these items are considered routine operations. The risk of mechanical sparks is minimized by use of practical measures such as controlling the rate of insertion or removal. Monitoring is done during installation, removal, and movement, and these are stopped if required by flammable gas levels.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Will shut down most pit or riser installation work and halt installation of equipment into tanks.

Facility Group 2 Tanks-Will shut down most pit or riser installation work and halt installation of equipment into tanks.

Facility Group 3 or other Tanks-Will restrict or shut down all waste intrusive installations and removals.

REQUESTED APPROVAL FROM DOE:

Presence of non-spark resistent materials for installed equipment in locations and during activities as listed below. As this portion of the exception applies to the presence of installed equipment, no monitoring is required by this portion of the exception.

Installation and removal or movement during use of equipment fabricated from non-spark resistent materials when practical measures to control mechanical spark potential are applied and while performing flammable gas monitoring controls [A] as appropriate for the location and activity type in:

1) FG 1 tanks ex-tank activities
2) FG 1,2 tanks dome intrusive activities
3) FG 3 tanks dome intrusive (LWD, GWD)
4) FG 2 ex-tank regions (GWD)
5) Waste intrusive regions

Risk Acceptance for Cover Blocks, Flanges, Shield Plugs, Waste Intrusive and Non-Waste Disturbing Equipment.

These items are potential mechanical spark sources due their material. Fabrication of the items from non-sparking materials is not practical or cost effective.

Concern is when a spark occurs coincident with a flammable gas mixture >100% of the LFL. Per Appendix A of this Flammable Gas JCO, vapor space sample results for single-shell tanks indicate that approximately 70 to 90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10 to 30% of the tanks average 1.2 to 1.5% of the LFL. The highest CGM measurement (7%) recorded to date using the OVM samples equated to approximately 3.5% of the LFL. The highest vapor sample correlates to 2.51% of the LFL. One IMUST tank sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL CGM reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectable levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

The following can be summarized concerning the risk and practical controls for the tools and equipment fabricated from non-spark resistent materials:

1) The use of this equipment is required to perform much of the work in Tank Farms. This includes temperature, pressure and level monitoring, transfers, sampling, and installation of equipment.

2) Flammable gas levels have not been measured in excess of the LFL in the tank dome for any tank except in pre-mitigated Tank 241-SY-101 during one or more GREs. In approximately 80% of the single-shell tanks that have been sampled the flammable gas is below detectable levels. In the remaining 20% of the single-shell tanks the flammable gas is less than 2% of the LFL, except for 2-3 specific readings which have ranged up to 6.5% of the LFL. The presence of flammable gas would only arise in the event of a GRE as steady state releases are managed by ventilation. The coincident occurrence of a spontaneous GRE and a mechanical spark is judged to be a low likelihood event. The likelihood of an induced GRE during waste disturbing operations is not fully quantified but is judged to be more likely than a spontaneous GRE. Flammable concentrations that might result from a small GRE are expected to persist for at most a short period of time as the gases are diluted with the air in the tank dome space.

3) Mechanical sparking is limited to situations where non-spark resistent materials are in motion such that sparks can be created by mechanical impacts or significant friction. These situations are described below.

   a. Motion of installed equipment in the ex-tank or dome intrusive locations might be caused by a seismic event. Specific controls to address a seismic event induced flammable gas deflagration are not included in this JCO. The risk and appropriate additional controls (if any) for this scenario are being addressed in the TWRS FSAR effort.

   b. Motion of equipment installed in waste intrusive locations might be caused by motion of the waste caused by seismic events, large spontaneous or induced GREs, or motion due to the effects of moving waste jets as in the case of operation of a waste mixer pump.

      Significant waste motion was observed during large GREs in Tank 241-SY-101 prior to mitigation. This waste motion caused long length installed equipment (e.g., T/C trees, air lances) to move about with significant velocity causing a concern for GRE induced mechanical sparks. Video surveillance of JCO FG 1 tanks indicates that significant waste and equipment motion does not occur during GREs in these tanks. Therefore, the risk of GRE induced mechanical sparks is judged to be low.

      For unmanned operations that might induce a GRE (e.g., waste transfers, operation of air lift circulators) gas monitoring is not practical. For manned activities, gas monitoring and safe shutdown are applied during the activity as required by this JCO.

      The risk and appropriate additional controls (if any) for the seismic event scenario are being addressed in the TWRS FSAR effort.

      The risks associated with gas releases and coincident mechanical sparks that might result from the operation of a large mixer pump are not yet fully evaluated. Therefore, this exception does not cover the presence of non-spark resistent materials in long length installed equipment that might be moved by the operation of a large mixer pump such that mechanical sparks might result.

c. Motion occurs during the installation of equipment (e.g., as it is lowered into the tank through a riser). Practical measures to reduce the likelihood of a mechanical spark during equipment installation shall be included in equipment design, work packages, or installation procedures when such movement has significant potential to cause mechanical sparks. This can include: limiting insertion speeds, water bathing of equipment, prevention of contact with other non-spark resistent materials by use of collars or bumpers, use of critical lift procedures where appropriate. Gas monitoring during these manned activities is performed as required by this JCO.

d. Motion occurs during the removal of equipment (e.g., as it is raised through a riser). Practical measures to reduce the likelihood of a mechanical spark during equipment removal shall be included in equipment design, work packages, or removal procedures when such movement has significant potential to cause mechanical sparks. This can include: limiting removal speeds, water bathing of equipment, prevention of contact with other non-spark resistent materials by use of collars or bumpers, use of critical lift procedures where appropriate. Gas monitoring during these manned activities is performed as required by this JCO.

e. Motion can occur as part of the operation of equipment (e.g., pushing a drill string/core barrel into the waste, [and through a riser], movement of waste characterization sampling devices such as retained gas samplers, void fraction meters, viscometer, auger sampler as they are moved through the waste). These operations are generally performed manually and are limited to low velocities by the nature of the operation. Practical measures to reduce the likelihood of a mechanical spark during equipment movement shall be included in the work packages and installation procedures when such movement has significant potential to cause mechanical sparks. This can include: limiting speeds, water bathing of equipment, prevention of contact with other non-spark resistent materials by use of collars or bumpers, use of critical lift procedures where appropriate. Gas monitoring during these manned activities is performed as required by this JCO.

The risk associated with continuing use of the tools and equipment is further reduced by performing flammable gas monitoring of the work area prior to and during use. This will include monitoring per method [A]. See definition of monitoring methods at the end of this section.

When flammable gas levels reach 25% of the LFL, work ceases as required per the monitoring requirements of this Flammable Gas JCO. The National Fire Protection Association (NFPA 30, 1988) recommends that processes be controlled so that flammable gas concentrations are <25% of the LFL, when relying upon vapor space flammability levels to preclude the possibility of an ignition. DOE 5480.4 requires Hanford waste tanks to be operated within NFPA guidelines. Thus, a control of <25% of the LFL has been established for performing activities in and around Tank Farm facilities. Because of the unpredictable nature of GREs, it is not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are thus in place to minimize the potential for a tank to exceed 25% of the LFL, and to cease work in areas common with the tank vapor space when the flammable gas concentration exceeds this value. This 25% limit is far below the actual limit at which flammability can occur, and is conservatively chosen to allow for potential measurement.

Monitoring is normally performed with a portable CGM. The CGM is calibrated with pentane and reads high by 100% when monitoring for hydrogen in air. For conservatism, no correction factor is applied in the field to the CGM reading when used for monitoring for personnel protection. Thus a 25% of the LFL reading on a CGM is actually 12.5% of the LFL for hydrogen in air, but is treated as if it were 25%. Depending upon the concentration of the flammable gas constituent and oxidants (ammonia, methane, carbon monoxide, nitrous oxide) a 25% LFL CGM reading will be indicative of 12.5% to approximately 20% flammable gas mixture. The response time of a CGM to an increase in flammable gas concentration is not instantaneous. The CGM starts responding to an increase in flammable gas concentrations almost immediately upon the gas reaching the CGM internals. The internal response time for a CGM to reach a 10% of the LFL indication (5% LFL actual for hydrogen in air) when exposed to a 23% of the LFL pentane mixture (equivalent to a 11.5% of the LFL hydrogen in air mixture) ranged from 7-12 seconds in a number of informal tests. Time to reach the full 23% test gas indication took 20-40 seconds.

If the CGM is drawing a sample out of a tank dome space, the time for the tank vapors to reach the CGM is approximately 26 seconds, based upon the 500 cm^3/min CGM flow and the tubing currently used for flammable gas monitoring. Thus an instantaneous change from 0 to 12.5% of the LFL for hydrogen in air in a tank vapor space (an indicated 25% of the LFL) would not indicate any change at all on a CGM for about 26 seconds. At 26 seconds, the indicated LFL would begin to rise and 33 to 36 seconds after the step change the CGM would indicate about 10% of the LFL. The CGM would indicate 25% of the LFL approximately 45 to 65 seconds after the step change.

If the CGM was being used to sample the immediate work area, the 26 second delay would not apply, the CGM would start to rise immediately and a reading of 10% of the LFL would be noted 7 to 12 seconds after sensing a 25% step increase in the LFL.

It is not realistic to have an instantaneous step change from 0% of the LFL to 100% of the LFL in an ex-tank area. Therefore, a CGM is an acceptable instrument to use for flammable gas monitoring in these areas as long as work is halted upon significant increase in the indicated flammable gas levels. An instantaneous step increase in an entire tank dome vapor space concentration from 0 to 100% of the LFL also is not realistic due to the large volume of gas which would be required to be released. However, localized spots near the waste surface could show a quick step change to >100% of the LFL from relatively small releases of gases from below the waste surface. The risk is very low that a gas stream would be released from the waste surface of a 75 foot diameter tank and enter a 4 inch diameter riser directly above without the gas being partially diffused by tank vapors. The response time for CGMs is not a concern when monitoring prior to or during use of this equipment.

It is necessary to balance the minimal time at risk and the risk of a mechanical sparking with the environmental and nuclear safety compliance enabled by the use of this equipment.

ITEM CLASSIFICATION: NON DE MINIMIS

ITEM NUMBER: 28, 29

EQUIPMENT: Pressure switches, limit switches and leak detector for salt well pumping Tanks 241-T-104 and 241-BY-109

CATEGORY: Electrical Spark Potential

USE:

Used to detect leaks, ensure proper valve positioning and provide pump pressure detection during salt well pumping.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #2	FG 3 dome intrusive (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The above equipment are items that are currently installed for salt well pumping Tanks 241-T-104 and 241-BY-109. These items are located in the salt well pump pit and although potential spark sources, they would only do so under the following conditions; 1) if the pump or jumper were to develop a leak, 2) a valve were to leak through or not seat properly, 3) high or low pressures were detected in the pump assembly, and 4) if valving were realigned during pumping. The exercising of these instruments results in a low time at risk for sparking. The Flammable Gas JCO ICS #2 requirements are only applicable for these pieces of equipment during salt well pumping or any global waste disturbing activity.

Tank 241-BY-109 is listed as a Facility Group 3 tank in this Flammable Gas JCO.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-N/A

Facility Group 2 Tanks-N/A

Facility Group 3 or other Tanks-Will delay interim stabilization of Tank 241-T-104, potential impact to Tri-Party Agreement milestones and increased radiological exposure to personnel.

REQUESTED APPROVAL FROM DOE:

Continued use of the above equipment with pit monitoring with installed flammable gas monitor and monitoring per method [A] in:

1) Tank 241-T-104 (GWD).
2) Tank 241-BY-109, following approval of Facility Group 3 categorization (GWD).

Risk Acceptance for Tanks 241-T-104 and 241-BY-109 Salt Well Pumping Equipment.

The scope of this discussion is limited to potential electrical spark ignition events from the listed equipment in the Tanks 241-T-104 and 241-BY-109 pump pits. The pressure switches, limit switches and leak detector are installed.

Tank 241-T-104 has been pumped for 7 months prior to its shutdown. Continuous flammable gas monitoring of the pump pit has consistently indicated less than detectible levels of flammable gases (<3% LFL). It is estimated that pumping of this tank will be completed within three months of restart.

Tank 241-BY-109 has been pumped intermittently over the past several years. The highest flammable gas levels seen in the pump pit during the six weeks of pumping commencing September 10, 1996 was <10% of the LFL. During the previous pumping campaign in September 1995 the highest concentration shown in the tank dome space on the installed SHMS cabinet was 12% of the LFL for a two-hour period. The pump pit flammable gas monitor was installed after September 1995. The pump pit flammable gas monitor in Tank 241-BY-109 deenergizes equipment in the pit at 10% of the LFL. It is estimated that pumping of this tank will be completed within three months of restart.

Concern is when a spark occurs coincident with a flammable gas mixture >100% of the LFL. Per Appendix A of this Flammable Gas JCO, vapor space sample results for single-shell tanks indicate that approximately 70-90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10-30% of the tanks average 1.2-1.5% of the LFL. The highest CGM measurement (7%) recorded using the OVM samples equated to approximately 3.5% of the LFL. The highest vapor sample results obtained via Type 8/Type 4 vapor sampling correlates to 2.51% of the LFL. One IMUST tank sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL CGM reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectible levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

The following can be summarized concerning the risk with using the listed equipment:

1) The equipment is essential to the most cost effective and expeditious interim stabilization of Tanks 241-T-104 and 241-BY-109.

2) No flammable gas has been detected in the pump pit throughout the Tank 241-T-104 salt well pumping campaign.

3) Tank 241-T-104 has pumped for 7 months already, with three-months pumping estimated to remain. Flammable gas has been detected at 12% of the LFL in the Tank 241-BY-109 vapor space for a very short period in September 1995.

4) Flammable gas has not been detected above the 10% deenergizing setpoint in the pump pit. Since the pump pit flammable gas monitor was installed.

5) Tank 241-BY-109 has been pumped intermittently for several years, with one month pumping estimated to remain.

The risk associated with continuing use of the equipment is further reduced by continuous flammable gas monitoring of the pit area with the installed pit flammable gas monitor during pumping. In addition, this includes monitoring per method [A]. See definition of monitoring methods at the end of this section.

The design and configuration of the salt well pumping equipment in Tanks 241-T-104 and 241-BY-109 measures flammable gas levels in the pit area and deenergizes all electrical equipment in the pit upon detection of 10% LFL.

Stabilization of Tanks 241-T-104 and 241-BY-109 reduces the chance of an environmental release and is an M-41 Tri-Party Agreement milestone. These benefits must be balanced against the minimal risks of a flammable gas ignition event due to a spark from the pit equipment. The increased risk of using this existing equipment is judged to be minimal if not equivalent due to the short pumping time remaining (approximately three months for Tank 241-T-104 and one month for Tank 241-BY-109) and the use of the continuous flammable gas monitor with automatic deenergization of equipment on detection of 10% LFL. Additionally, modification of this equipment would increase the potential for radiological exposure to the maintenance and operation crews and the potential for a spread of contamination to the environment. It will take an estimated 20 man REM to modify equipment in the Tank 241-BY-109 pump pit to meet the Flammable Gas JCO if this exception is not approved.

ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 30

EQUIPMENT: Fiberglass and Tefzel LOWs

CATEGORY: Static Spark Potential

USE:

Used for determining interstitial liquid levels.

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #3, ICS 1 #3	FG 2 dome intrusive FG 3 dome intrusive (LWD, GWD) FG 2,3 waste intruding equipment (failed LOWs only)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

Liquid observation wells (LOWs) are hollow pipes sealed at the bottom that are inserted into many single-shell tanks for measuring the interstitial liquid level. Measurement is done by lowering a neutron source to the bottom of the LOW and measuring the observed neutron level as the probe is withdrawn. Fiberglass LOWs and Tefzel LOWs are judged to have a negligible potential for causing flammable gas ignition under the applied conditions.

Failed LOWs are waste intruding equipment because of the potential to trap waste gases. A failed LOW is one that has broken or cracked inside the tank and can let waste enter the pipe. Any work inside a known failed LOW requires flammable gas monitoring prior to the start.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-No Impact.

Facility Group 2 Tanks-Removal of the LOWs would result in loss of leak detection capability and therefore cause environmental non-compliance. The risk of removing the LOWs is far greater from cost, ALARA, and lack of level monitoring standpoints, than the risk involved with leaving them in place.

Facility Group 3 or other Tanks-Same as for FG 2 tanks.

REQUESTED APPROVAL FROM DOE:

Continued presence and use of fiberglass and Tefzel LOWs in tanks without flammable gas monitoring:

1) FG 2,3 dome intrusive regions

Continued presence of failed fiberglass and Tefzel LOWs without flammable gas monitoring, or work in a failed fiberglass or Tefzel LOW following flammable gas monitoring control [B] for:

2) FG 2,3 tanks waste intruding equipment

Risk Acceptance for Fiberglass and Tefzel LOWs.

This is an item where environmental compliance must be balanced against the minimal risk associated with flammable gas ignition due to the presence and use of fiberglass or Tefzel LOWs. The LOWs are already installed in the tanks. The cost in personnel, time, waste disposal, and personnel exposure to remove the LOWs must be balanced with the low risk of a flammable gas ignition event due to a spark from a LOW. Steel LOWs can be installed as new ones are needed, but these are not compatible for all proposed LOW monitoring methods.

The RH has been measured to be >50% in 95% of the non-exhausted tanks sampled. This is to be expected since the concentration of water in air in a sealed chamber will eventually reach saturation, and be in equilibrium with the liquid phase. The remaining 5% of the non-exhausted tanks measured between 40-50% RH. The SX Farm exhausted tanks measured between 20-40% RH, except one tank which was 65% RH. Tank 241-C-105 measured between 40-60% RH, and Tank 241-C-106 measured between 50-100% RH. Therefore, for non-exhausted tanks, plastics in dome intrusive regions are expected to be in compliance with the Flammable Gas JCO about 95% of the time. Exhausted Tanks 241-C-105 and 241-C-106 are approximately 50% RH. For the inside of failed LOWs, any concentrated (i.e., non diluted by tank air) waste gases will be at 100% RH because the gases come from waste pockets surrounded by liquid waste. In such pockets the water vapor in the gas would be at equilibrium with the water in the liquid. The gas in failed LOWs will likely be partially mixed with tank vapors, but as most tank vapors have a high RH, the RH in the failed LOWs should be expected to be >50%. There is negligible air flow across LOWs in service to build up a static charge on them.

For use of intact LOWs, a swab is taken of each LOW prior to work inside the pipe; swabbing and monitoring is currently performed weekly. This is done by running a swab up and down the inside of the LOW and monitoring the swab for radioactivity. This is a much more accurate means of detecting a leaking LOW than using flammable gas monitoring. Work is rarely performed inside failed LOWs. The only activity in recent years was in confirming a failed LOW in Tank 241-SX-104. When required, monitoring is conducted per method [B].

The presence and use of fiberglass and Tefzel LOWs is of concern when the LOW has failed such that flammable gas may accumulate and be ignited due to static discharge upon removal of the nonconductive LOW cap. The time at risk is reduced to that time which is required to remove a cap. This time is on the order of seconds. Flammable gas monitoring is not an appropriate control for the routine presence of the LOWs in a tank vapor space as no response actions are available. It is an acceptable risk based upon experience for the LOWs to remain installed in the tanks without monitoring for flammable gases.

ITEM CLASSIFICATION: NON DE MINIMUS

ITEM NUMBER: 31

EQUIPMENT: Continuous Air Sampler (CAS) (SAIC Model #H-810 and H-809V1)

CATEGORY: Electrical Spark Potential

USE:

Used for monitoring for airborne radioactivity

APPLICABLE CONTROL NOT MET:	WHEN CONTROL NOT MET:
ICS 2 #5	FG 1 ex-tank FG 2 ex-tank (GWD)

DISCUSSION OF FLAMMABLE GAS JCO APPLICABILITY:

The CAS uses a 110v sparking motor to drive the vacuum pump which draws the air sample. The unit is not in compliance with the Flammable Gas JCO, as it does not meet the requirements of ICS 2 #2. In most applications, the sampler draws air from areas requiring ICS 2 controls. The unit will be located 18 opening diameters or 15 feet from the tank opening, whichever is less. Plastic hoses will be used to connect the sampler pump to the sampler head located in the worker's breathing space. Use of the plastic hoses is addressed in Item 1. Additionally, continuous monitoring for flammable gas while the unit is operating will be employed. If flammable gas concentration in excess of 10% of the LFL is detected, the unit will be immediately shut off.

RISK ACCEPTANCE:

See risk acceptance writeup starting on next page.

IMPACT OF NOT ACCEPTING RISK OF CONTINUED USE:

Facility Group 1 Tanks-Failure to accept the risk of continued use will shut down all tank intrusive work. All manned activity in ex-tank areas will be cancelled until qualified air samplers which meet requirements can be identified and procured. Essential ex-tank work may be performed only if workers are on breathing air.

Facility Group 2 Tanks-Failure to accept the risk of continued use will shut down all tank intrusive work during global waste disturbing operations. All manned activity in Ex Tank areas during GWD activities will be cancelled until qualified air samplers can be identified and procured. During GWD, essential ex-tank work may be performed only if workers are on breathing air.

Facility Group 3 or other Tanks-No Impact.

REQUESTED APPROVAL FROM DOE:

Continued use when performing flammable gas monitoring controls [A] for CASs in:

1) Ex-tank regions in FG 1 tanks.
2) Ex-tank regions in FG 2 tanks (GWD)

If flammable gas concentrations in excess of 10% of the LFL is detected, the unit will be immediately shut off.

Risk Acceptance for Continuous Air Sampler.

Use of CAS for personnel safety is standard in the nuclear industry. At Hanford, the HANFORD SITE RADIOLOGICAL CONTROL MANUAL, HSRC-1, requires air monitoring when appropriate as one of its basic tenets. Sections 125 and 136 both require evaluation of air spaces. Sections 551 and 555 give more specific requirements for this monitoring.

Concern is when a spark occurs coincident with a flammable gas mixture >100% of the LFL. Per Appendix A of this Flammable Gas JCO, vapor space sample results for single-shell tanks indicate that approximately 70-90% of the tanks show negligible or nondetectable flammable gas levels during non waste intrusive work. The remaining 10-30% of the tanks average 1.2-1.5% of the LFL. The highest CGM measurement (7%) recorded to date using OVM samples equated to approximately 3.5% of the LFL. The highest vapor sample results obtained via Type B/Type 4 vapor sampling correlates to 2.51% of the LFL. One IMUST tank sampled showed no flammable gas present. The highest recorded organic concentration, 3.8% of the LFL, was found in Tank 241-C-103. Tank 241-C-103 is the only waste tank known to have a significant floating organic layer. Since July 1996, one tank has shown a 10% of the LFL CGM reading (5% of the LFL), and one showed a 13% LFL CGM reading (6.5% LFL) prior to intrusive activities. Actively ventilated tanks would be expected to have low flammable gas levels because of the constant dilution air passing through the tanks. No actively ventilated single-shell tanks have shown flammable gas levels above minimum detectible levels in either the Type 3 or 4 vapors samples or in the special OVM samples taken in these tanks.

The following can be summarized concerning the actual risk with using the CAS:

1) Hanford Site radiological controls require use of a CAS for many of the operations in tank farms.

2) Flammable gas levels have not been seen in excess of the LFL in the tank dome space for any tank except in pre-mitigated Tank 241-SY-101 during one or more GREs. In about 80% of the single-shell tanks that have been sampled the LFL is below detectable. In the remaining 20% of the single-shell tanks the LFL is less than 2%, except for 2-3 specific readings which have ranged up to 6.5%. The presence of flammable gases in actively ventilated single-shell and double-shell tanks would be expected to be low most of the time because of the constant dilution air. Therefore, although the presence of flammable gas concentrations in Dome Intrusive areas above the LFL cannot be positively ruled out, they can be expected to be a rare occurrence. The presence of flammable gases at concentrations >25% of the LFL in an ex-tank area is therefore expected to be even less likely.

Based upon the requirement for remote placement of the CAS instrument during work in ex-tank areas, continuous monitoring and shutdown if flammable gas concentration exceeds 10% of the LFL, and the minimal potential for flammable gas concentrations above the LFL in the ex-tank area, the use of the CAS, with the compensatory measures prescribed poses an acceptable risk. This is especially relevant when balanced with the competing safety requirements for the protection of workers during these activities.

When flammable gas levels reach 25% of the LFL, work ceases as required per the monitoring requirements of this Flammable Gas JCO. The National Fire Protection Association (NFPA 30, 1988) recommends that processes be controlled so that flammable gas concentrations are <25 percent of the LFL, when relying upon vapor space flammability levels to preclude the possibility of an ignition. DOE 5480.4 requires Hanford waste tanks to be operated within NFPA guidelines. Thus, a control of <25% of the LFL has been established for performing activities in and around Tank Farm facilities. Because of the unpredictable nature of GREs, it is currently not possible to ensure that 25% of the LFL is never exceeded. Procedures and controls are thus in place to minimize the potential for a tank to exceed 25% of the LFL, and to cease work in areas common with the tank vapor space when the flammable gas concentration exceeds this value. This 25% limit is far below the actual limit at which flammability can occur, and is conservatively chosen to allow for potential measurement errors. For the CAS, the equipment shutdown limit is set more conservatively at 10% of the LFL.

Monitoring is normally performed with a portable CGM. The CGM is calibrated with pentane and reads high by 100% when monitoring for hydrogen in air. For conservatism, no correction factor is applied in the field to the CGM reading when used for monitoring for personnel protection. Thus a 25% of the LFL reading on a CGM is actually 12.5% of the LFL for hydrogen in air, but is treated as if it were 25%. Depending upon the concentration of the flammable gas constituent and oxidants (ammonia, methane, carbon monoxide, nitrous oxide) a 25% LFL CGM reading will be indicative of 12.5% to approximately 20% of the LFL. The response time of a CGM to an increase in flammable gas concentration is not instantaneous. The CGM starts responding to an increase in flammable gas concentrations almost immediately upon the gas reaching the CGM internals. The internal response time for a CGM to reach a 10% of the LFL indication (5% LFL actual for hydrogen in air) when exposed to a 23% of the LFL pentane mixture (equivalent to a 11.5% of the LFL hydrogen in air mixture) ranged from 7 to 12 seconds in a number of informal tests. Time to reach the full 23% test gas indication took 20 to 40 seconds.

If the CGM is drawing a sample out of a tank dome space, the time for the tank vapors to reach the CGM is approximately 26 seconds, based upon the 500 cm^3/min CGM flow and the tubing currently used for flammable gas monitoring. Thus an instantaneous change from 0 to 12.5% of the LFL for hydrogen in air in a tank vapor space (an indicated 25% of the LFL) would not indicate any change at all on a CGM for about 26 seconds. At 26 seconds, the indicated LFL would begin to rise and 33 to 36 seconds after the step change the CGM would indicate about 10% of the LFL. The CGM would indicate 25% of the LFL approximately 45 to 65 seconds after the step change.

If the CGM was being used to sample the immediate work area where a CAS is being used the 26 second delay would not apply, the CGM would start to rise immediately and a reading of 10% of the LFL would be noted 7 to 12 seconds after sensing a 25% step increase in the LFL.

A CGM is an acceptable instrument to use for flammable gas monitoring in dome intrusive or ex-tank regions as long as work is halted upon significant increase in the indicated flammable gas levels. An instantaneous step increase in an entire tank dome vapor space concentration from 0 to 100% of the LFL is not realistic due to the large volume of gas which would be required to be released, although localized spots near the waste surface could show a quick step change to >100% of the LFL from relatively small releases of gases from below the waste surface. The risk is very low that a gas stream would be released from the waste surface of a 75 foot diameter tank and enter a 4 inch diameter riser directly above without the gas being partially diffused by tank vapors. Since monitoring for flammable gases is done in the immediate area when using the CAS, the current response time for CGMs is not a significant concern.

The risk to personnel of internal exposure due to unmonitored airborne radioactivity is a more significant risk than that of a flammable gas ignition event due to a spark from the CAS motor. This competing safety concern requires the monitoring to be performed or the job will be shut down. No Site-approved CASs are currently available that meet the requirements of the Flammable Gas JCO, and initial attempts to identify an intrinsically safe air particulate sampler have failed to identify a substitute.

Monitoring definitions used in the previous sheets are:

[A] Standard monitoring requirements as described in Section 4.4 of this JCO are applicable. The monitoring requirements are graded based on when and where flammable conditions are postulated consistent with the Facility Group assignment, equipment or work locations, and activity or operation type.

[B] For waste intruding equipment activities, perform [A] above. Sampling during waste intrusive activities associated with handling waste intruding equipment is also as specified in [A] above. Monitoring associated with the waste intruding equipment shall include monitoring before any equipment item in the waste intruding equipment vapor space is energized, prior to (or during if necessary) connecting/disconnecting equipment, or prior to working with nonconductive plastic materials.

REFERENCES

See Appendix K, K7.0, "REFERENCES."

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Volume V

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Addendum 1

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Richland, Washington

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TANK 241-C-106 SLUICING SAFETY ANALYSIS
ADDENDUM 1

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EXECUTIVE SUMMARY

ES.1 FACILITY BACKGROUND AND MISSION

Public Law 101-510, *National Defense Authorization Act for Fiscal Year 1991*, Section 3137, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation" (known as the Wyden Amendment), mandates that the U.S. Department of Energy develop plans to respond to safety issues associated with the underground waste storage tanks on the Hanford Site. Tank 241-C-106 has been identified as having serious potential for release of high-level waste because of an uncontrolled temperature increase if active cooling is not maintained in the tank.

Ecology, EPA, and DOE, *Hanford Federal Facility Agreement and Consent Order*, is commonly referred to as the Tri-Party Agreement. Milestone M-45-03A of the agreement, "Initiate Sluicing Retrieval of 241-C-106," states "initiate sluicing retrieval of Tank 241-C-106 to resolve the high heat issue and demonstrate waste retrieval." The U.S Department of Energy is taking action to eliminate the safety concern regarding storage of the radiogenic high heat waste in Tank 241-C-106 and to demonstrate a single-shell tank waste retrieval technology.

The proposed action for eliminating the Tank 241-C-106 safety concern, designated as Project W-320, Tank 241-C-106 Sluicing, is the retrieval and transfer of waste from Tank 241-C-106 to double-shell Tank 241-AY-102. Tank 241-AY-102 is designed to safely store high heat wastes.

Project W-320, and related upgrades, subsequently referred to as the Waste Retrieval Sluicing System (WRSS), provides the design, procurement, installation, and testing of equipment as well as the preparation of documentation required to implement the proposed action. The scope of activities covered by this addendum includes presluicing waste transfers, startup support of the Project W-320, sluicing operations, activities through completion of the transfer of the wastes from Tank 241-C-106 to Tank 241-AY-102, and subsequent storage and monitoring of the waste in Tanks 241-AY-102 and 241-C-106.

Per requirements of DOE 5480.21, *Unreviewed Safety Questions*, an Unreviewed Safety Question evaluation (TF-95-0105, *Project W-320, C-106 Sluicing and Waste Retrieval for Storage in AY-102*) has been performed. The Unreviewed Safety Question evaluation determined that U.S. Department of Energy approval of this proposed action is required.

A safety analysis is required to demonstrate conclusively that a safety problem does not exist and to serve as the technical basis for a change to the Authorization Basis. The Waste Retrieval Sluicing System is an operation of limited complexity, limited scope (involving only two tanks), and of limited duration (six months to two years). To satisfy the requirements of documenting a safety analysis in accordance with DOE 5480.23, *Nuclear Safety Analysis Reports*, this safety analysis is prepared per DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, and is added as an addendum to the main text of Final

Safety Analysis Report (FSAR) HNF-SD-WM-SAR-067. It is important to note that this addendum was previously attached to the Basis for Interim Operation (BIO) and has been modified where necessary to assure compatibility with the FSAR. It is important to note that the hazards information presented in Appendices B, C, and D has been updated as necessary and incorporated into the FSAR hazards analysis database. Appendices B, C, and D are retained in this Addendum for information only and should not be used in the Unreviewed Safety Question process.

ES.2 FACILITY OVERVIEW

Tank 241-C-106, constructed during 1943 and 1944, is a 2.0 million L (530,000 gal) capacity single-shell tank, a high heat tank (greater than 11.7 kW [40,000 Btu/h]), and a watchlist tank that requires the addition of approximately 22,600 L (6000 gal) of cooling water per month to maintain safe storage temperatures.

Tank 241-AY-102, constructed in the late 1960's, has a rated capacity of 3.7 million L (980,000 gal), and is composed of a primary and secondary steel tank. The life-limiting conditions for Tank 241-AY-102, identified through life prediction models, suggest that Tank 241-AY-102 should not fail by through-wall pitting well beyond 2028. The primary tank wall is not expected to be breached until the year 2033 and the tank is not listed as a watchlist tank.

The major items of equipment provided by the WRSS are two nearly identical pump systems, one for delivery of the sluice stream or supernate to Tank 241-C-106 and the other for delivery of slurry to Tank 241-AY-102; a sluicer system; a slurry distributor; interfarm piping to complete a dedicated, closed-loop sluicing system; Tank 241-C-106 heating, ventilating, and air-conditioning system; and modifications to the Tank 241-AY-102 annulus ventilation system.

The WRSS uses the existing tank farm support systems, modified as required to support Project W-320 requirements. Backup for instrument air is not provided. Backup power is provided for the AY Farm and C Farm tank ventilation systems. Backup power for other systems will be provided as determined by the engineering analysis discussed in Section 4.2, "Requirements." Support services in the form of raw water, sanitary water, electrical power, telecommunications, and hoisting hardware are provided. The use of existing septic systems or portable facilities for sanitary sewage will be considered for the personnel using the control trailer.

ES.3 FACILITY HAZARD CLASSIFICATION

An evaluation to determine the WRSS hazard classification was performed. The WRSS is designated Hazard Category 2 as discussed in Section 3.3.2.1, "Hazard Classification."

ES.4 SAFETY ANALYSIS OVERVIEW

The types of events considered for the WRSS hazard analysis were internal events, external events, and natural phenomena events that can cause the uncontrolled release of radioactive or hazardous materials and affect the public, workers, or the environment. Single and multiple failures (i.e., as a result of equipment and human errors) and common-cause failures were considered to be accident initiators. Sabotage and terrorism events were not considered. The results of the hazard evaluations and accident analyses were then used to identify a subset of hazardous conditions that bound the consequences and provide a quantitative basis for the identification of controls (e.g., structures, systems, and components and Technical Safety Requirements) required to protect the public, workers, and the environment. The list of bounding, representative hazardous conditions becomes the basis for the list of candidate accidents. As a check of the selection process, each hazardous condition is grouped under a candidate accident. If hazardous conditions that cannot be represented by existing candidate accidents remain, additional candidate accidents are identified. Results of the hazard analysis activities were recorded in a hazard analysis database.

The principal bases used for identifying safety structures, systems, and components and Technical Safety Requirements are risk guidelines. The objective is to identify safety structures, systems, and components and Technical Safety Requirements that result in satisfying the risk guidelines and providing Defense-in-Depth.

The results of an assessment of beyond evaluation basis accidents analyzed to provide a perspective of the residual risk associated with tank farm operations is provided in the FSAR main text.

ES.5 ORGANIZATIONS

The Hanford Nuclear Facility near Richland, Washington, is managed by the Department of Energy and its contractors. The main text of the FSAR contains the description of key Hanford and Tank Waste Remediation organizations and their responsibilities.

ES.6 SAFETY ANALYSIS CONCLUSIONS

The accident analysis reviewed the safety of new structures, systems, and components to ensure the protection of the public, onsite workers, facility workers, and the environment by preventing or mitigating the consequences of representative accidents. The accident analysis established the additional controls required to operate the Tank Waste Remediation System facility modification through preventive and mitigative requirements.

The hazards associated with normal and abnormal operation of the WRSS have been identified and examined in the preliminary hazard analysis. The preliminary hazards analysis provided a comprehensive list of the hazards related to this activity and its related systems and operations, which is contained in Appendix C, "Hazard Evaluation Results." The hazards analysis

was performed in accordance with the methodology described in Section 3.3.1, "Methodology", of the FSAR main text. Bounding accidents have been analyzed and equipment has been classified as necessary to protect the public, the onsite worker, facility worker, and the environment.

The safety analysis demonstrates that the Waste Retrieval Sluicing System design provides an adequate safety margin that is appropriate to proceed with operation. The correct design requirements have been established through the safety classification process based on the accident analyses. This addendum addresses the risk of WRSS operation and shows the risk to be acceptable.

ES.7 SAFETY ANALYSIS REPORT ORGANIZATION

This addendum is organized in accordance with current U.S. Department of Energy standards. For those chapters where information would be provided about site-wide programmatic controls, the chapters are abbreviated to reference only documents impacted by this modification. Because the details of existing site-wide programs can be found in the FSAR main text, descriptions of those programs are omitted in this addendum.

Chapter 3.0, "Hazard Evaluations and Accident Analyses," describes the methodology and presents the results of the hazard and accident analyses performed for the Waste Retrieval Sluicing System components and operations described in Chapter 2.0, "Facility Description." Chapter 3.0 also includes information pertaining to the designation of the facility hazard classification.

Based on the results of the hazard and accident analyses, Safety-Class and Safety-Significant structures, systems, and components; Technical Safety Requirements; and additional Defense-in-Depth controls are identified for protection of the public, onsite workers, and facility workers. Chapter 4.0, "Safety Structures, Systems, and Components," provides details of the safety structures, systems, and components identified and Chapter 5.0, "Derivation of Technical Safety Requirements," provides the derivation basis of Technical Safety Requirements. Design and operational features required specifically to protect the environment from uncontrolled releases of radioactive and hazardous material are also identified in Chapter 5.0.

ES.8 REFERENCES

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1.0 SITE CHARACTERISTICS

1.1 INTRODUCTION

The objective of this chapter is to describe the Hanford Site characteristics as applicable to the Project W-320, Tank 241-C-106 Sluicing activities at the Tank Waste Remediation System facilities. The Waste Retrieval Sluicing System (WRSS) is located in the 200 East Area of the Hanford Site.

1.2 REQUIREMENTS

The site characterization requirements for support of safety analysis and design applicable to WRSS are provided in DOE 4700.1, *Project Management System*, and Hanford Plant Standard HPS-SDC-4.1, *Standard Architectural-Civil Design Criteria: Design Loads for Facilities*.

1.3 SITE DESCRIPTION

This section addresses the site boundary and site location with respect to the WRSS. For site geography, general site description, and demography see Section 1.3, "Site Description," of the TWRS Final Safety Analysis Report (FSAR).

The WRSS calculation of radiological and toxicological consequences to the maximum offsite individual assumes the maximum Site boundary at the near bank of the Columbia River at a distance of either 8,760 m (28,740 ft) to the north or 8,690 m (28,510 ft) to the north-northwest depending on the duration of the release.

1.4 ENVIRONMENTAL DESCRIPTION

The meteorological data used to calculate atmospheric dispersion coefficients for postulated WRSS accidents is nine-year averaged data (1983-1991) from the Hanford meteorology tower in the 200 Area. Calculation of atmospheric dispersion coefficients is detailed in WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*. Meteorological data was not examined explicitly by the project.

1.5 NATURAL PHENOMENA THREATS

A natural phenomena threat is an act of nature that poses a threat to workers, the public, or the environment by having the potential to cause damage to systems, structures, or components. Evaluation of natural phenomena

effects to WRSS activities is based on work documented in Section 3.4.2.18, "Natural Phenomena" of this addendum. Natural phenomena threats considered potential WRSS accident initiators include the following:

- Earthquake
- High wind
- Dust storm
- Flooding
- Rain
- Snow
- Volcanic activity
- Lightning
- Range fire
- Extreme cold temperatures.

Natural phenomena were considered to initiate a sequence of events that could result in the release of hazardous materials from a tank ventilation system during WRSS operations.

1.6 EXTERNAL MAN-MADE THREATS

There are no unique external man-made threats for the WRSS. For a full discussion of this subject see Section 1.6, "External Manmade Threats," in the main text of the FSAR.

1.7 NEARBY FACILITIES

Accidents attributed to nearby facilities are discussed in Section 1.7, "Nearby Facilities," in the main text of the FSAR. There are no unique accidents from nearby facilities identified for the WRSS. The WRSS accidents with the potential to affect the maximum onsite individual are specifically limited to those discussed in Section 3.4.2, "Evaluation Basis Accident," of this addendum.

Tank 241-AY-102 is connected to other nearby tanks in the AY/AZ tank farm through a common connection to the ventilation system (either 241-A-702 or 241-AZ-702). The configuration of the ventilation system was considered in the analysis of accidents unique to the WRSS operations. Tank 241-AY-102 is also connected to other tanks through a common, existing transfer system. There were no accidents unique to WRSS identified with regard to this system.

Tank 241-C-106 is currently shares a ventilation system (296-P-16) with Tank 241-C-105 and an overflow cascade line also connects the two tanks. The new Tank 241-C-106 ventilation system (296-C-006) has no connection to other tanks. Existing configurations were considered in the analysis of accidents unique to WRSS operations.

1.8 VALIDITY OF EXISTING ENVIRONMENTAL ANALYSES

The existing environmental analyses for the WRSS is evaluated in DOE/EA-0933, *Environmental Assessment, Tank 241-C-106 Past-Practice Sluicing Waste Retrieval, Hanford Site, Richland, Washington*. No significant discrepancies have been identified between the WRSS assumptions herein and DOE/EA-0933.

1.9 REFERENCES

DOE 4700.1, 1992, *Project Management System*, U.S. Department of Energy, Washington, D.C.

DOE/EA-0933, 1995, *Environmental Assessment, Tank 241-C-106 Past-Practice Sluicing Waste Retrieval, Hanford Site, Richland, Washington*, U.S. Department of Energy, Washington, D.C.

HPS-SDC-4.1, 1989, *Standard Architectural-Civil Design Criteria: Design Loads for Facilities*, Rev. 12, Hanford Plant Standards, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC-SD-WM-SARR-016, 1996, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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2.0 FACILITY DESCRIPTION

2.1 INTRODUCTION

The purpose of this chapter is to provide a description of the Project W-320, Tank 241-C-106 Sluicing system facilities, equipment, instrumentation, operations and any changes to the description of the Tank Waste Remediation System (TWRS) facility provided in Chapter 2.0 "Facility Description," of the Final Safety Analysis Report (FSAR). The sluicing system will be referred to as the Waste Retrieval Sluicing System (WRSS) in this document. Representative accidents unique to the WRSS and its operation as described in this chapter are analyzed in Chapter 3.0, "Hazard Evaluations and Accident Analysis." Defense-In-Depth and Safety-Class or Safety-Significant structures, systems, and components are addressed in Chapter 4.0, "Safety Structures, Systems and Components."

Tank 241-C-106, a 2.0 million-L (530,000-gal) capacity single-shell tank (SST), is a high heat tank [greater than 11.7 kW (40,000 Btu/h)] and a watchlist tank (HNF-EP-0182-120, *Waste Tank Summary Report for Month Ending March 31, 1998*) requiring the addition of up to approximately 22,600 L (6000 gal) of cooling water per month to maintain safe storage temperatures. A significant safety issue has been generated by the need to continue water additions until about the year 2045 when the radiogenic heat of decay will be less than 11.7 kW (40,000 Btu/h), the high heat tank criteria. If a tank leak occurs, it would be desirable to stop water additions to the tank to limit the leakage to the environment. However, if cooling water additions were interrupted, the sludge temperatures would exceed established limits and could cause structural damage to the tank concrete that would allow high-level waste (HLW) to be released from the tank. Should water additions continue into a leaking tank, the leakage would further contaminate the soil column.

Public Law 101-510, *National Defense Authorization Act for Fiscal Year 1991*, Section 3137, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation" (known as the Wyden Amendment), mandates that the U.S. Department of Energy (DOE) develop plans to respond to safety issues associated with the underground waste storage tanks on the Hanford Site and to report progress on implementing those plans to Congress. Tank 241-C-106 has been identified (in accordance with the Wyden Amendment) as having serious potential for release of HLW because of an uncontrolled high-temperature increase if active cooling is not maintained in the tank. According to WHC-SP-0697, *A Plan to Implement Remediation of Waste Tank Safety Issues at the Hanford Site*, Tank 241-C-106 is one of four Priority 1 waste tank safety issues.

Ecology, EPA, and DOE, *Hanford Federal Facility Agreement and Consent Order*, known as the Tri-Party Agreement, Milestone M-45-03A, "Initiate Sluicing Retrieval of 241-C-106," requires RL to "initiate sluicing retrieval of Tank 241-C-106 to resolve the high heat issue and demonstrate waste retrieval." Based on the needs and criteria detailed in WHC-EP-0586, *Tank Selection Criteria and Retrieval Recommendation for Tri-Party Agreement Milestone M-07*, Tank 241-C-106 has been identified as the retrieval demonstration tank by DOE, and the Washington State Department of Ecology, (Ecology) has concurred in this selection.

2.1.1 Safety Issues Background

DOE is taking action to eliminate the safety concern regarding storage of the radiogenic high heat waste in Tank 241-C-106 and to demonstrate a SST waste retrieval technology.

The proposed action is the retrieval and transfer of waste from Tank 241-C-106 to double-shell tank (DST) 241-AY-102. Tank 241-C-106, constructed during 1943 and 1944 is well past its design life, since the original design life of the Hanford single shell tanks was on the order of 20 years. Of the 48 tanks of this type built in this time frame (B, C, T, and U tank farms) 21 are known to be leaking. The life-limiting conditions for Tank 241-AY-102 were identified through WHC-SD-WM-ER-585, *DST Remaining Useful Life Estimates*, the development of life prediction models. The results of this model suggest that this DST should not fail by through-wall pitting until well beyond 2028. The primary tank wall is not expected to be breached until the year 2033. The waste retrieval technology to be demonstrated will employ enhanced past-practice sluicing methods which were successfully employed in retrieving roughly 7.57 million L (2.0 millon gal) of waste solids from 53 SSTs during uranium, cesium, and strontium recovery campaigns in the 1950's, 1960's, and 1970's. Past-practice methods have been enhanced by the addition of a more modern control system, improved pump designs, flow and pressure monitoring instrumentation, routine in tank imaging (CCTV), and transfer line flushing capability.

Project W-320, Tank 241-C-106 Waste Retrieval Sluicing System (WRSS), which represents the proposed action, provides for the design, procurement, installation, and testing of equipment as well as the preparation of documentation required to implement the proposed action. The equipment includes sluice and slurry pumping systems; dedicated (closed-loop) transfer lines; heating, ventilation, and air-conditioning systems; support systems; and modifications to existing tanks and their associated support systems. Documentation includes an Environmental Assessment (DOE/EA-0933, *Environmental Assessment, Tank 241-C-106 Past Practice Sluicing Waste Retrieval, Hanford Site, Richland, Washington*), functional design criteria (HNF-SD-W320-FDC-001, *Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320*), a safety equipment list (WHC-SD-WM-SEL-033, *Tank 241-C-106 Sluicing Preliminary Safety Equipment List*), a preliminary safety evaluation (WHC-SD-WM-PSE-010, *Preliminary Safety Evaluation for the 241-C-106 Waste Retrieval, Project W-320*), and the FSAR.

The scope of this proposed action includes operations activities in support of WRSS such as pre-sluicing waste transfers and startup support, sluicing operation, and storage and monitoring of the waste in Tanks 241-C-106 and 241-AY-102. The proposed action includes activities through completion of the transfer of the wastes from Tank 241-C-106 to Tank 241-AY-102 and subsequent monitoring of Tanks 241-AY-102 and 241-C-106.

2.1.2 Change to Facility Authorization Basis

The WRSS is considered a change to an existing facility Authorization Basis requiring an Unreviewed Safety Question (USQ) evaluation per the

requirements of DOE 5480.21, *Unreviewed Safety Questions*. A USQ evaluation, TF-95-0105, *Project W-320, C-106 Sluicing and Waste Retrieval for Storage in AY-102*, has been performed. The USQ evaluation determined that DOE approval of this proposed action is required.

A safety analysis is required before operations can proceed, in accordance with DOE 5480.21, to determine conclusively what controls and engineered features are required and serves as the technical basis for a change to the Authorization Basis which specifically authorizes WRSS activities. DOE 5480.23, *Nuclear Safety Analysis Reports*, requires safety analysis reports for DOE nuclear facilities. The WRSS is an operation of limited complexity, limited scope (involving only two tanks), and of limited duration (six months to two years). To satisfy the requirements to document the safety analysis of the WRSS in accordance with DOE 5480.23, the safety analysis is prepared according to DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*.

2.2 REQUIREMENTS

See Section 2.2, "Requirements," of the FSAR main text for descriptions of design codes, standards, regulations, and DOE orders relevant to TWRS. Design requirements for WRSS are presented in HNF-SD-W320-FDC-001.

2.3 FACILITY OVERVIEW

The major pieces of equipment necessary for the WRSS are summarized below. The major equipment items include: two nearly identical pump systems, one for delivery of the sluice stream or supernate to Tank 241-C-106 and a second for delivery of slurry to Tank 241-AY-102; a sluicer system; a slurry distributor; and interfarm piping to complete a dedicated, closed-loop sluicing system (Figures 2-1 and 2-2). Other major equipment items are the Tank 241-C-106 ventilation system and modifications to the Tank 241-AY-102 annulus ventilation system.

2.3.1 Sluice and Slurry Pump Systems

The sluice and slurry pump systems are each made up of two pumps in series (a submersible pump and a booster pump). The booster pump raises the transfer fluid pressure to the level necessary to move the slurry between the two tanks.

2.3.2 Sluicer System

One sluicer is provided to mobilize the Tank 241-C-106 sludge in preparation for transferring the slurry to Tank 241-AY-102. The sluicer will operate in the Tank 241-C-06C sluice pit. The sluicer is vertically articulated with its articulation point located at a fixed elevation (4.7 m [15.5 ft] above the bottom center of the tank) as high as practical in the tank.

2.3.3 Slurry Distributor (Tank 241-AY-102)

The slurry from Tank 241-C-106 is discharged into Tank 241-AY-102 through a slurry distributor. The slurry distributor is a straight 4-in. pipe with four 2-in. diameter horizontal nozzles spaced at 90° intervals that are located at a fixed 3.8 m (12.5 ft) elevation in the tank. The slurry lines, and slurry distributor will be routinely flushed during WRSS operations to ensure that solids build-up in the system does not occur. Uniformity of the distributed layer of sludge in Tank 241-AY-102 will be determined at each sluicing increment through temperature data in combination with the ENRAF densitometer measurement.

A high capacity drain is incorporated into the slurry distributor head assembly installed at Pit 241-AY-02A, Riser 6. The high capacity drain is sized to drain all liquid from within the pit in the event a transfer line break were to occur during maximum flow. Liquid accumulating within the pit which overcomes the existing pit floor drain is channeled through the high capacity drain, down the respective riser, and into the tank. A drain plug is provided to seal the high capacity drain when pit cover blocks are removed.

2.3.4 Interfarm Piping

The waste is transferred through two encased pipelines, one for delivery of sluicing media (Tank 241-AY-102 supernate) to Tank 241-C-106 and the other for transporting slurry to Tank 241-AY-102. These pipelines are approximately 0.5 km (0.3 mi) each in length. The primary lines are designed to withstand a maximum pressure of 2.2 MPa (320 psig). This provides a conservative margin to the maximum expected WRSS operations pressure range of 0.7 - 1.4 MPa (105 - 200 psig) at the nominal 1325 L/min (350 gal/min) flow rate. They are provided with leak detection, either buried or covered with an earthen berm to limit personnel dose to tank farm workers in accordance with As Low As Reasonably Achievable (ALARA) practices, and have a seismic trip switch to shut off the pumps in case of an earthquake.

2.3.5 Tank 241-C-106 Sluicing Ventilation System

The Tank 241-C-106 ventilation system (296-C-006) serves to: (1) cool the tank, (2) maintain the tank at a negative pressure relative to atmosphere, which discharges a decontaminated ventilation stream to the atmosphere and (3) dilute the flammable gasses generated in the tank. The system is a combination recirculation and exhaust system. The recirculation portion of the system is used to provide the needed cooling. The exhaust portion of the system maintains the required negative pressure in the tank and flammable gas dilution. The 296-C-006 ventilation system is the only ventilation system that will be in operation on Tank 241-C-106 during active sluicing operations. Figure 2-5 provides a diagram of the 296-C-006 system. The 296-C-006 process building inlet duct includes a flushing feature to allow the duct to be washed down internally to reduce operator exposure. This feature would be used in the event that internal contamination levels produce radiation levels in the area around the ducting which do not meet ALARA guidelines.

An older ventilation system (296-P-16), the Tank 241-C-105/106 ventilation system also serves Tank 241-C-106. It will be maintained in an operational standby status as a backup system for cooling Tank 241-C-106, but will only be used to cool the tank before sluicing and during monitoring or maintenance periods. However, the main function of the older ventilation system will be to cool the Tank 241-C-106 waste before initiation of sluicing to reduce the potential for a steam release event during the retrieval activity and to provide a high-flow exhaust system to support Tank 241-C-106 open-riser maintenance activities.

2.3.6 Tank 241-AY-102 Ventilation System

The Tank 241-AY-102 primary ventilation system, 241-A-702, (1) cools the tank, (2) maintains the tank at a negative pressure while discharging a decontaminated ventilation stream to the atmosphere and (3) dilutes the flammable gases generated in the tank. Figure 2-7 provides a diagram of the 241-A-702 system. A new ventilation system, 241-AZ-702, was installed by Project W-030 and is available for use by the WRSS.

The 241-AZ-702 ventilation system uses separate systems for cooling and/or confinement and for exhausting. However, 241-AZ-702 and the existing ventilation system, 241-A-702, both rely on evaporative cooling to maintain waste temperatures. The exhaust system contains HEPA filtration and stacks similar to the existing design. A separate recirculating system is added for cooling and confinement. This additional system greatly reduces the amount of air vented out the stack. The 241-AZ-702 system will have three operating modes available: recirculation, high heat, and by-pass. It is planned that the WRSS will utilize the 241-AZ-702 system which is currently being installed. This safety assessment bounds the filtration, flow, and cooling capacity of the 241-AZ-702 system and the 241-A-702 system (which may be used as a contingency). Figure 2-9 provides a diagram of the 241-AZ-702 system.

The annulus space in Tank 241-AY-102 is provided with a dedicated, independent ventilation system. Figure 2-8 provides a diagram of the annulus ventilation system. The cooling capacity of the annulus ventilation system has been upgraded to increase the underfloor flow rate and increase the vacuum capacity. Both conservative and best estimate calculations have been developed for the required annulus cooling parameters as a function of the incremental waste volume that is transferred from Tank 241-C-106 to Tank 241-AY-102 (HNF-SD-W320-ER-004, *Project W-320 SAR and Process Control Thermal Analysis*). The best estimate calculations show that all of the sludge in Tank 241-C-106 can be accommodated in Tank 241-AY-102 without further modification to the ventilation system. Conversely, when conservative values for waste fluffing factor, heat load, and heat distribution are selected, these calculations indicate that additional cooling capacity may be required (i.e., additional blowers and/or a chiller may need to be installed). However, even the conservative calculations show that a transfer of 2 feet (0.61 m) of sludge to Tank 241-AY-102 can be cooled with the current ventilation system. Thus, the initial sluicing campaign will be limited to 2 feet (0.61 m) (or less) of sludge. Following the transfer of the initial (and each subsequent) increment, an evaluation of the system will be performed to determine its ability to maintain the waste at 30 °F below local saturation

temperature as required by Technical Safety Requirements (TSR) controls (Administrative Control [AC] 5.12.2 and AC 5.25.2). If this evaluation (i.e., thermal monitoring and modeling) indicates that 30 °F subcooling cannot be maintained for further waste additions, then the Tank 241-AY-102 ventilation system will be modified, with the addition of blowers or a combination of blowers and chillers, before transferring additional waste. It is important to note that this safety assessment analyzes the entire 6-ft waste transfer to provide bounding accident consequences.

2.3.7 Seismic Shutdown System

Seismic shutdown systems are provided as part of the Tank 241-C-106 and the 241-AY-102 WRSS electrical systems. Each seismic shutdown system consists of two seismic triggers connected in series. Each of the triggers are housed in separate environmental enclosures which protect the triggers and provide a controlled internal temperature of approximately 50 °F to 85 °F.

Both the Tank 241-C-106 and the Tank 241-AY-102 seismic systems are essentially identical. The seismic systems serve to shutdown waste transfer operations by interrupting electrical power to the submersible pumps, the booster pumps, and other WRSS components in the event a seismic event occurs which results in a ground acceleration above the trigger set point value. The individual seismic triggers open the control circuits of a contact when a seismic event occurs. The contacts remain open during and after the seismic event.

2.4 FACILITY STRUCTURES

2.4.1 Systems Descriptions

The major equipment provided by WRSS is described in detail in this section. The transfer system that consists of the sluice pumps, slurry pumps, winch assemblies and encased transfer lines which include anti-syphon and cathodic protection systems are described. Other major pieces of equipment provided specifically for Tank 241-C-106 include the sluicer system, the sluicing ventilation system, the air inlet chiller and an in-tank imaging system. The major pieces of equipment provided for Tank 241-AY-102 are the slurry distributor and the sluicer pumps. A portable in-pit imaging system is used, as necessary, at pits over both tanks.

2.4.1.1 Tank 241-C-106.

2.4.1.1.1 Tank Configuration. Tank 241-C-106 is beyond its design life as it was constructed during 1943 and 1944. It has a rated capacity of approximately 2.0 million L (530,000 gal), at a vacuum less than 1.3 m (50 in) of water. The tank is 23 m (75 ft) in diameter, and is fabricated of reinforced concrete with a carbon steel liner on the bottom and sides. The tank has a 31 cm (12 in) deep, dished bottom and a useable waste depth of about 4.9 m (16 ft) at the sidewall. The bottom of the tank is 15 cm (6 in) thick reinforced concrete covered with a 5 cm (2 in) layer of asphalt

composition material, placed between the steel liner and the reinforced concrete during construction to seal the outer surface of the steel liner and to provide a moisture barrier, and a 1 cm (3/8 in) steel plate liner. The knuckle (the transition section from bottom to sidewall) is a 1 cm (3/8 in) thick steel plate. The tank walls are 33 cm (13 in) thick reinforced concrete; the steel liner extends 5.5 m (18 ft) up the straight side of the tank, varying in thickness from 0.6 to 1 cm (1/4 to 3/8 in). The top of the steel liner is covered with lead flashing to prevent moisture from entering any spaces between the liner and concrete wall. The dome of the tank is constructed of 38 cm (15 in) thick reinforced concrete. No liner is provided for the concrete dome. The tank is shown in plan and elevation in Figure 2-3 and in pictorial cross-section in Figure 2-4.

Tank 241-C-106 contains 746,000 L (197,000 gal) (about 1.75 m [69 in.]) of sludge with a total heat load estimated at 38.8 kW (132,400 Btu/h) as of June 1994 (HNF-SD-W320-ER-004). The total heat load and, in part, the heat load distribution determine the peak temperature in the sludge. If this peak sludge temperature exceeds the local saturation temperature, a bump can occur. Tank 241-C-106 is on the High Heat Watch List and must receive periodic water additions to maintain the waste temperatures within allowable limits. The waste temperatures are maintained with evaporative cooling by means of active ventilation.

2.4.1.1.2 **Ventilation.** The Tank 241-C-106 ventilation system (296-P-16) serves to: (1) cool the tank, (2) maintain the tank at a negative pressure relative to atmosphere while discharging a thoroughly decontaminated ventilation stream to the atmosphere and (3) dilute the flammable gases generated in the tank. The system provides a nominal flow rate of 67.9 m^3/min (2400 ft^3/min) and has multiple capabilities, combining the functions of pressure, temperature, and humidity control. It includes equipment to limit the release of hazardous aerosols and a ventilation exhaust radiation monitoring system to confirm the effectiveness of the ventilation system to maintain emissions of radionuclides ALARA in compliance with Washington Administrative Code, WAC 173-480, "Air Pollution Control Regulations."

The project has installed a ventilation system chiller in combination with an inlet filter cooling coil on the 296-P-16 ventilation system, designed to cool the tank contents. This provides a constant 4.4 °C (40 °F) inlet air flow, which is adequate on a long-term basis to preclude the existence of a steam bubble in the waste (NAI-940708-3, *GOTH Tank C-106 Thermal Hydraulics Analysis Related to the 1995 Process Test*). However, even with the chiller and inlet filter cooling system, reduced water additions will continue until an adequate volume of high heat waste is removed from the tank.

In addition to the chiller and filter cooling coil, a new ventilation system (296-C-006) for Tank 241-C-106 is installed as part of WRSS and provides a nominal exhaust flow rate of 6.5 m^3/min (230 ft^3/min) with a recirculation flow rate of up to 24 m^3/min (860 ft^3/min) (Figure 2-5). The recirculation portion of the system is used to provide the needed cooling. The exhaust portion of the system maintains the required negative pressure in the tank and flammable gas dilution. There is a cascade line between

Tanks 241-C-105 and 241-C-106 which is assumed to be open in the HVAC system design. Major pieces of ventilation equipment are mounted on transportable skids (WHC-SD-W320-TI-002, *Project W-320 Tank 241-C-106 Sluicing Process*).

The ventilation system has been designed to:

- Maintain a negative tank pressure
- Remove heat from the tank and dehumidify recirculating air
- Remove aerosols from ventilation emissions
- Monitor the exhaust ventilation emissions stream through the exhaust stack to the atmosphere
- Use the existing ventilation system for active ventilation for extended maintenance or additional tank cooling (before or during the sluicing retrieval activity)
- Reduce formation of fog in the tank vapor space by recirculating de-humidified air into the tank to improve visibility for the remote viewing cameras in accordance with WHC-SD-W320-TI-002 (fog formation is not eliminated under all anticipated conditions)
- Dilute the flammable gases generated in the tank.

To minimize releases to the atmosphere from the ventilation system on Tank 241-C-106, a high-efficiency particulate air (HEPA) filtration system is installed on Tank 241-C-106. A high-efficiency mist eliminator (HEME) and a high-efficiency metal filter (HEMF) are also included in this system.

Instrumentation to monitor the condenser (HX-1361) air stream differential pressure, air stream inlet temperature, air stream outlet temperature, heating coil (HC-1361) outlet temperature, recirculation fan (FN-1361) differential pressure, and motor current is provided. Instruments to monitor HEME (HME-1361) and HEMF (HMF-1361) differential pressures and HEME outlet temperature are also provided. Position switches indicate the HEMF flush water and/or blowdown air inlet valve and drain valve positions to the control station operator.

New exhaust ducts have been designed and installed to discharge through the new filtration system. The old ventilation system and ducts will remain in place and operational for Tank 241-C-105 and Tank 241-C-106 major maintenance operations. During these infrequent major maintenance operations, an air flow of approximately 85 m^3/min (3000 ft^3/min) would be discharged through this ventilation system.

A HEME and HEMF unit is installed upstream from the HEPA filtration units, which would catch the majority of the contaminants before they reach the HEPA filters. The HEME and HEMF are included to meet ALARA requirements, which are designed to minimize worker exposure to the greatest extent possible. Because the HEME and HEMF are flushable, little or no solid waste

is expected to be generated by the entire air filtration system. At the conclusion of the waste retrieval activities, the disposable part of these filter units would be disposed of at the Hanford Site.

To control the temperature and humidity of the Tank 241-C-106 vapor space during sluicing, a recirculation line in the ventilation system was installed. This recirculation line consists of a condenser, a mist eliminator, a heater and a recirculation fan. The condenser provides a means of removing excess heat from the tank to allow sluicing to proceed safely and efficiently. If it is determined by thermal modeling (HNF-SD-W320-ER-004) that a higher cooling rate is needed, this cooling may be accomplished by activating the original high-capacity ventilation system to allow the inlet air chiller to be used. This cooling approach can only be used during periods when sluicing is not operating.

The 296-P-16 HVAC system will be used to ventilate Tank 241-C-106 during large riser (12 and 36 inch diameter risers) opening maintenance activities to maintain inflow rates at capture velocities. It may also be used during maintenance outages of the 296-C-006 HVAC system depending on their duration. The added air flow provided by the existing ventilation system may also be required periodically during the life of the project to maintain waste temperatures (i.e., ensure a continued adequate margin below any steam void formations). Air is drawn through the headspace using the existing Tank 241-C-105/106 exhauster (296-P-16).

2.4.1.1.3 Existing Instrumentation. Table 2-1 lists the existing instrumentation, prior to WRSS, for Tank 241-C-106. The signals are used to provide alarms as well as to provide data input for logging and trend analysis.

2.4.1.2 Tank 241-AY-102.

2.4.1.2.1 Tank Configuration. Tank 241-AY-102 was constructed in the late 1960's and has a rated capacity of 3.7 million L (980,000 gal). It is an underground, carbon steel, radioactive waste tank encased in a concrete shell. Tank 241-AY-102 consists of a primary steel tank with an inner diameter of 22.9 m (75 ft) and a secondary concrete, steel-lined tank with an inner diameter of 24.4 m (80 ft). The free-standing height of the primary tank is 14.3 m (46.9 ft) to the top of the dome. The thickness of the carbon steel tank bottom varies from 1 to 2.54 cm (3/8 to 1 in). The wall thickness varies from 1 to 1.9 cm (3/8 to 3/4 in), with the thicker plates at the bottom. The maximum liquid level is about 11 m (35 ft) from the bottom. There are 22 airlift circulators located in Tank 241-AY-102: one at the tank's center axis, 8 equally spaced at a radius of about 4.4 m (14.5 ft), and the remainder equally spaced at a radius of about 8.2 m (27 ft).

The tank-in-tank concept ensures that any leakage from the primary tank will be contained in the annulus between the tank walls, allowing transfer of the contents to another tank. The second barrier meets the requirement of DOE 6430.1A, *General Design Criteria*, Sections 1300-3.3 and 1323, that a single failure not result in a loss of safety function.

The tank is connected to other tanks through a network of underground transfer piping, diversion boxes, diverter stations, and valve pits. Tank 241-AY-102 is shown in an elevation view in Figure 2-2 and in a pictorial cross section in Figure 2-6.

Tank 241-AY-102, a double-shell tank, contains 121,000 L (32,000 gal) (about 305 mm [12 in.]) of sludge and 3.1 million L (812,000 gal) of supernate for a total waste depth of about 9 m (30 ft). The estimated heat load of Tank 241-AY-102 is 13.2 kW (45,000 Btu/h) (HNF-SD-W320-ER-004).

2.4.1.2.2 Ventilation. The 241-A-702 primary, and available backup ventilation systems, (1) cools the tank, (2) maintains the tank at a negative pressure and (3) dilutes the flammable gases generated in the tank (Figure 2-7, sheets 1 and 2). The annulus ventilation system ventilates and provides filtered air to the tank annulus (Figure 2-8). The 241-A-702 primary ventilation system exhausts the Aging Waste Facility (AWF) tanks (241-AY-101, 241-AY-102, 241-AZ-101, and 241-AZ-102), two catch tanks (241-AZ-151 and 241-AZ-154), and the 241-AX-152 diverter station. Two 113 m^3/min (4000 ft^3/min) exhausters operate, one at a time, to draw the gases through an extensive particulate and condensate removal system before discharging to the atmosphere via the 296-A-17 stack. This design has a heat removal capacity of 4 million Btu/h per tank (16 million Btu/h for the AWF) assuming the heat generating materials are maintained in suspension, thus enabling convective cooling.

The 241-A-702 backup ventilation system is a skid-mounted 113 m^3/min (4000 ft^3/min) exhauster. It provides containment of radioactivity should the primary exhaust fans fail during testing and maintenance of the 241-A-702 primary system, and during chemical flushing or upper pad water flushing of the K1-5-2A deentrainer. The backup exhaust fan starts automatically upon failure of both primary exhaust fans. This system uses the deentrainers and condensers of the 241-A-702 primary system but has its own preheater, HEPA filters, and ventilation fan.

The 241-AZ-702 ventilation system replaces the 241-A-702 and uses separate systems for cooling and/or confinement and for exhausting (Figure 2-9). However, 241-AZ-702 and the existing ventilation system, 241-A-702, both rely on evaporative cooling to maintain waste temperatures. The exhaust system contains HEPA filtration and stacks similar to the existing design. A separate recirculating system is added for cooling and confinement. This additional system greatly reduces the amount of air vented out the stack. Because of this reduced flow rate, Tank 241-AY-102 inleakage pathways will be sealed to the maximum extent practical to maintain negative pressure in the tank.

The 241-AZ-702 ventilation system has three operating modes available: recirculation, high heat, and by-pass. Operation of the 241-AZ-702 system in the recirculation mode will have flow rates of 14.2 m^3/min (500 ft^3/min) with 11.3 m^3/min (400 ft^3/min) recirculated and only 2.8 m^3/min (100 ft^3/min) exhausted through the stack. In the high heat mode, the system can provide 14.2 m^3/min (500 ft^3/min), single-pass ventilating to one of the AWF tanks. The normal mode provides 2.8 m^3/min (100 ft^3/min), single-pass ventilation per AWF tank. The new design will have one recirculating system per tank while

sharing a common exhaust stack. The new design also will contain some additional components such as a high-efficiency gas absorber and a high-efficiency mist eliminator.

The annulus ventilation system provides filtered air to the annulus area on Tank 241-AY-102 to monitor for primary tank leaks; minimize moisture accumulation; remove a major portion of the heat generated in the primary tank; and ventilate the leak detection pits. The annulus ventilation system supplies air through two routes: (1) a direct supply to the annulus via eight tank drop legs, of which four 14.7 cm (6 in) lines deliver air at approximately midpoint and four 10.2 cm (4 in) lines deliver air to the underfloor distribution plenum at the center of the tank; and (2) an underfloor air distribution grid work system. The underfloor flow is approximately 4.3 m^3/min (150 ft^3/min). To direct cooling flow to the floor of the tank, the annulus system upgrade will be performed to block the flow to the four 14.7 cm (6 in) annulus supply lines and to operate at a higher vacuum and exhaust flow rate. As described in Section 2.3.6, "Tank 241-AY-102 Ventilation System," an inlet system blower, or an inlet system blower and chiller can be installed to maintain the waste at 30 °F below local saturation temperature. These upgrades will enhance the cooling capacity of the annulus ventilation system to meet the cooling capacity needs of the tank based on thermal analysis of observed waste conditions (volume, fluffing factor, and tank temperature response). This evaluation is performed following each sluicing increment according to the control (AC 5.25) specified in Section 3.4.2.11, "Tank Bump."

2.4.1.3 Pump Systems. The pump systems (located in the 241-AY-02E pit and the 241-C-06A pit, respectively) each include two pumps in series. The first is a centrifugal, 40-hp submersible pump mounted on a winch system that allows its height to be adjusted. The submersible pump feeds a 250-hp, variable speed centrifugal booster pump located in the pump pit above the submersible pump. The booster pump raises the transfer fluid pressure to the level necessary to transit the distance between the two tanks at the nominal 1325 L/min (350 gal/min) flow rate and 2.7 m/s (8.7 ft/s). The booster pump variable speed drive allows fine-flow adjustments to control the tank liquid level. The submersible in-tank pumps are equipped with winches that adjust height of the pump to control the liquid level, enhance sluicing efficiency, and allow adjustment of the pump height to meet net positive suction head requirements as the liquid level changes.

The slurried waste in Tank 241-C-106 is transferred using a submersible slurry pump (P-1361) in series with a centrifugal slurry booster pump installed in pump pit 241-C-06A. The submersible slurry pump is a direct-drive, end-suction, 40-hp submersible pump installed in the 91 cm (36 in), R-9 riser in pump pit 241-C-06A. The slurried waste pressure is then increased by the centrifugal slurry booster pump, which is a 250-hp, vertical direct drive, variable-speed pump that will deliver the slurried waste to Tank 241-AY-102. Together the submersible slurry pump and slurry booster pump are rated to deliver 1325 L/min (350 gal/min) or 2.7 m/s (8.7 ft/s) at 195 m (640 ft), operating at a temperature of 49 °C (120 °F), and have a structural design temperature of 82 °C (180 °F). The temperature of the slurry in the transfer system at the beginning of sluicing operations is anticipated to be between 80 and 90 °F. The slurry temperature will increase slowly during the

active sluicing operations as the result of the energy inputs of the pumps. The resulting heating of the pumped fluids was evaluated (TR-W-320-126, *Project W-320, Tank 241-C-106 Sluicing - An Analysis of Energy and Temperature Effects for Tank AY-102*) and after 30 days of nearly continuous pumping operations the temperature was estimated to increased to approximately 120 °F.

Because sluicing operations will be intermittent (short period of sluicing followed by longer periods of observation), it is not anticipated that the 120 °F limit will be reached during sluicing operations.

The planned manner of control of the liquid level in Tank 241-C-106 is adjustment of the Tank 241-AY-102 booster pump speed. The speed of the slurry booster pump will be adjusted to give a 1325 L/min (350 gal/min) flow rate with zero solids loading, after which the speed will remain constant for the most part. This will result in a nominal flow rate of 1174 L/min (310 gal/min) at 10% solids loading based on pump run-in curves adjusted for the specific gravity and viscosity of the 10% slurry. This information is included in the WRSS Process Control Plan (PCP). The PCP will include pump performance information for a range of pump speed settings and solids loading. The 350 gpm pump flow rate is a nominal value, not a limiting operational value. Operations accidents have been analyzed for flow rates up to 450 gpm and pumping operations may be conducted down to flow rates as low as 250 gpm. Therefore, the pump flow rate for a 10% slurry loading with the booster pump speed set to provide 350 gpm with zero percent solids is not significant from a safety standpoint.

The main purpose for having a variable-speed slurry booster pump is to help maintain an optimum liquid heel in the tank. This will allow positive control while monitoring parameters such as level, temperature, and slurry concentration.

Operating experience gained from operation of the WRSS will be applied to future sluicing campaigns in other tanks, since one of the objectives of this activity is sluicing technology demonstration.

Local controls and indications for the Tank 241-C-106 submersible slurry pump (P-1361) and the variable-speed-drive slurry booster pump (P-1362) are provided at the motor control center and the variable-speed-drive cabinet located in the C Tank Farm's electrical equipment skid. In addition, remote controls and indications for the two pumps including suction and discharge pressure and volumetric flow rate, winch position control, and pump start/stop control, are provided locally. The slurry booster pump's motor speed and voltage, as well as motor current, bearing, and stator temperatures for both pumps are furnished at the electrical equipment skid. Alarms, via the panel-mounted annunciators, alert the operator to abnormal conditions. The control of the pump will be addressed in the process control plan and WRSS operating procedures.

The submersible slurry pump suction inlet has been designed to minimize vortexing and is protected by a heavy gauge, 0.6 cm (1/4 in) mesh screen that will prevent the entrainment of large sludge conglomerations. This mesh screen can also be backflushed during shutdown periods by flushing from Tank 241-AY-102.

The base plate of each winch assembly includes a 6-inch diameter high capacity drain. The high capacity drains are sized to drain all liquid from within the pit in the event a guillotine line break were to occur during maximum flow. Liquid accumulating within the pit which overcomes the existing pit floor drain is channeled through the 6-inch drain hole, down the respective riser, and into the tank. A drain plug is provided to seal the high capacity drain when pit cover blocks are removed.

2.4.1.4 Sluicer System. One sluicer is provided to mobilize the Tank 241-C-106 sludge in preparation for transferring the slurry to Tank 241-AY-102. The sluicer operates in the Tank 241-C-06C sluice pit. The sluicer is a remotely articulated design with a fixed-elevation articulation point located as high as practical in the tank to maximize impact point control of the sluice stream. The sluicer design prevents the sluice stream from being aimed above the tank liner. A control system has been provided to control the aiming of the sluicing stream from the sluicer (S-1361). During the early stages of sluicing the sluice stream will not be aimed directly at the tank walls. The perimeter of the tank will be sluiced last to minimize the amount of material that could potentially leak through the tank wall as a result of sluicer impingement on areas weakened by corrosion. The sluicer is equipped with a 2.5 cm (1 in) nozzle that is designed for a pressure drop of 1.24 kPa (180 psig). A sluicer arrangement diagram is provided in Figure 2-10. Aiming of the sluicer nozzle is accomplished by using a self-contained hydraulic system in which hydraulic cylinders provide the azimuth and rotational control. The sluicer positioning control system has two control modes: Manual and Semi-Automatic. The selection of the mode to be used depends on the operational needs, the situation in the tank, and operational experience gained during the startup phase of the project.

Clarified supernate (Sanders 1995, *Project 93L-EWW-320, Tank 241-C-106 Sluicing-Sluicing Fluid Baseline Change to Corrosion Inhibited Water*) is delivered to the sluicer nozzle in Tank 241-C-106 via a submersible sluice pump (P-0621) in series with a sluice booster pump (P-0622) installed in sluice pit 241-AY-02E. The submersible and booster sluice pumps are identical to the counterpart slurry pumps. Only minor jumper and winch assembly differences required by the pit arrangements differentiate the two pumping systems. The submersible pump is installed in the 86 cm (34 in) R-10C riser with the booster installed in the sluice pit 241-AY-02E above. The sluice pump system has the same capacity, pressure, and temperature characteristics as the slurry pump system.

The speed control of the sluice booster pump (adjusted through a variable frequency drive) is used to control the flow rate of the pumped waste. Local controls and indicators for the submersible sluice pump (P-0621) and the variable speed drive sluice booster pump (P-0622) are provided at the 241-AY Tank Farm operator station located in the 241-AY-51 Tank Farm electrical equipment skid. Pump discharge pressure and volumetric flow, booster pump motor speed and voltage, motor current, bearing, and stator temperatures for both pumps are also provided for operator information.

The slurry concentration is controlled by a combination of sluicer aiming and slurry pump suction height adjustment. The submersible sluice pump's suction height is regulated by a remotely adjustable winch from the control

station to minimize the solids loading in the sluice stream and maintain the required net positive suction head. With the exception of the painted carbon steel motor casings and the two pump liquid level detector housings, all wetted surfaces of the pumps are constructed of 300 Series stainless steel. The suction inlet of the submersible sluice pump has been designed to minimize vortexing and is protected by a heavy gauge, 0.6 cm (1/4 in) mesh screen that prevents the entrainment of large sludge conglomerations, and is capable of being backflushed, if necessary, through the sluice line flushing connection at Tank 241-AY-102. There are no provisions for reducing particle size below the inlet screen size and that attained by vigorous agitation from the sluice stream. The schedule 40 stainless steel pipeline has sufficient wall thickness to support the anticipated erosion for the less than 1000 hours of planned slurry transfer.

A high capacity drain is incorporated into the sluicer assembly installed at Pit 241-C-06C, Riser 3. The high capacity drain is sized to drain all liquid from within the pit in the event a guillotine line break were to occur during maximum flow. Liquid accumulating within the pit which overcomes the existing pit floor drain is channeled through the high capacity drain, down the respective riser, and into the tank. A drain plug is provided to seal the high capacity drain when pit cover blocks are removed.

2.4.1.5 Existing Instrumentation. Table 2-2 lists the Tank 241-AY-102 existing instrumentation (prior to WRSS) for tank liquid-level monitoring (using ENRAF and manual tapes), temperature monitoring, pressure and vacuum monitoring, and leak detection systems. The signals are used to provide alarms as well as to provide data input for logging and trend analysis.

2.4.1.6 Leak Detection. Any leaks from primary Tank 241-AY-102 would be contained in the annulus between the primary and secondary tanks. The annulus is designed to collect and transport released waste to a common point within the annulus for detection and transfer. Leak detection is also provided in the pits located on the tank dome.

The supernate and slurry transfer piping encasements are provided with a leak detection system at pump pit 241-C-06A. The fluid that is collected in the encasement piping drains by gravity to the respective pit connected to the piping and returns to Tank 241-C-106. A manual valve, with an extended valve handle operator, is located at the low point in the encasement drain line to permit the operator to isolate the piping leakage from the pit and/or to pressure test the encasement piping.

An existing dry well monitoring system coupled with the ENRAF provides limited leak detection surveillance for Tank 241-C-106. The wells are open-bottomed, either 15 or 20 cm (6 or 8 in) diameter mild steel casings, with depths ranging from 25 to 33 m (75 to 100 ft). On a monthly to quarterly schedule radiation probes determine the radiation profile in the well.

2.4.1.7 Primary Transfer Pipes. There are two primary transfer lines, with the following major features:

Clarified supernate line

- From a functional standpoint, solids content must be less than 10 wt% per the project functional design criteria (HNF-SD-W320-FDC-001). Solids loading in the slurry line is periodically verified by performing material balance calculations during the hold periods between sluicing activities. Grab samples will be taken periodically to validate the material balance. Because of the volume of supernate in Tank 241-AY-102, 10% solids loading is not considered possible unless nearly all solids from Tank 241-C-106 remain in suspension.

  The 10% solids loading in the supernatant line is not a rapidly changing parameter due to the large volume (greater than 500,000 gallons) of supernatant liquid in Tank 241-AY-102. The combination of relatively high solids settling estimates (based on core sample particle size distributions) and intermittent sluicing operations make achieving the 10% figure virtually impossible. The solids loading in Tank 241-AY-102 is monitored by a combination of the Tank 241-AY-102 ENRAF densitometer and grab samples.

- Maximum viscosity of the supernate at a 10 wt% solids loading is 20 centipoise (cP). Viscosity is not directly measured. It is controlled indirectly by the same methods used to control solids loading.

- The line is made of 10 cm (4 in), welded, schedule 40, 304L stainless steel. Design and performance attributes of the piping system are addressed in HNF-SD-W320-TI-008, *Tank 241-C-106 Sluicing Project W-320 Integrity Assessment Report*.

- The pipeline length is 0.5 km (0.3 mi).

- The line delivers supernate from Tank 241-AY-102 to the sluicer in Tank 241-C-106.

- Flow velocity in the pipes is nominally 2.7 m/s (8.7 ft/s) and the flow is nominally 1325 L/min (350 gal/min).

Slurried waste line

- Solids content is to be limited to 30 wt% per the project functional design criteria (HNF-SD-W320-FDC-001). Solids loading is measured during sluicing by mass flow meter, and periodically verified during the hold periods between sluicing activities.

- Maximum viscosity of the slurry at 30 wt% solids loading is 100 cP. Viscosity is not directly measured. It is controlled indirectly by the same methods used to control solids loading.

- The line is made of 10 cm (4 in), welded, schedule 40, 304L stainless steel. Design and performance attributes of the piping system are addressed in HNF-SD-W320-TI-008.
- The pipeline length is 0.5 km (0.3 mi).
- The line delivers slurry from Tank 241-C-106 to Tank 241-AY-102 via the slurry distributor.
- Flow velocity in the pipes is nominally 2.7 m/s (8.7 ft/s) and the flow is nominally 1325 L/min (350 gal/min).

Both of the primary transfer lines will meet the design, fabrication, installation, and testing requirements of normal service fluid (ANSI/ASME B31.3-1993, *Chemical Plant and Petroleum Refinery Piping*). As needed, thermal expansion elbows are placed for stress reduction and to follow topography (minimum bend radius 1 m [3.3 ft]). Stainless steel was chosen for corrosion resistance and for ease of decontamination in preparation for disposal following project completion.

2.4.1.8 Secondary Transfer Pipes. The secondary (encasement or outer) transfer pipes are of welded 15.2 cm (6-in.), schedule 40, carbon steel. The primary pipe is installed within the secondary pipe. The two secondary transfer (encasement or outer) pipes provide secondary confinement for the two primary transfer pipes. Both secondary transfer lines have provisions for leak detection at their low points. Additional leak detectors are provided within pump pit 241-C-06A, and sluice pit 241-C-06C. Any leakage collected at the transfer piping encasement low points or at the pits will be returned to Tank 241-C-106. Leaks to pump pit 241-AY-02A and sluice pit 241-AY-02E are monitored by existing leak detectors that alarm locally. The 241-AY-02A pit leak detector also alarms via the Computerized-Automated Surveillance System. Any leakage collected in these pits is returned to Tank 241-AY-102 by the respective pit drains.

The two pipe-in-pipe transfer lines are buried or bermed (a minimum of 0.9 m [3 ft] of earth cover between farms and 0.6 m [2 ft] of earth cover in farms) for freeze protection and to maintain personnel radiation exposure ALARA. This berm is an earth backfill and is covered with an aggregate stabilizer to prevent wind erosion. Each transfer line will be about 0.5 km (0.3 mi) in length and has been designed to slope continuously from 0.003 ft/ft to 0.10 ft/ft from Tank 241-AY-102 to Tank 241-C-106 to facilitate self-draining. This prevents any liquid stagnation in the lines during system shutdown. All transfer piping has a design operating temperature limit of 82 °C (180 °F) (WHC-SD-W320-TI-002).

2.4.1.9 Cathodic Protection System. A cathodic protection system is provided for the transfer lines to mitigate the effects of external corrosion.

2.4.1.10 Transfer Pits. The WRSS provides for new and modified waste transfer piping, pumps, flanges, jumpers, connectors, and instruments to be in the pits. The supernate is transferred directly to sluice pit 241-C-06C from Tank 241-AY-102. The 241-C-06A pit contains the slurry pump (P-1361), the slurry booster pump (P-1362), the slurry pump winch, and the slurry header

flow and pressure-measuring instrumentation. At the C Tank Farm, the sluicing pits 241-C-06A and 241-C-06C are used as transfer pits. At the AY Tank Farm, pump pit 241-AY-02A and sluice pit 241-AY-02E are used as transfer pits.

The sluicer winch assemblies, sluicer, and slurry distributor assembly have drains that are designed to accept the additional flow rate from a failure of slurry and/or supernate transfer lines and to drain the liquid to the associated tank. Leak detection instruments are provided to detect leakage inside the pits.

2.4.1.11 Syphon Protection. Syphon protection is required on the transfer piping because of an elevation difference of about 10.7 m (35 ft) between Tanks 241-C-106 and 241-AY-102. Properly sized anti-syphon holes (W320-27-045, *Pipe Drain Flow and Anti-Siphon Sizing for Transfer Lines*) are provided on the slurry distributor and the submersible sluice pump discharge line within Tank 241-AY-102 to prevent establishing a syphon when the slurry pumps or the sluice pumps are shut down. On the slurry distributor, two 1.3 cm (1/2 in) holes are provided to prevent syphoning of the slurry line, and two 0.6 cm (1/4 in) holes are provided on the discharge from the sluice pump. The larger-size holes are necessary on the slurry line since the likelihood of solids entrainment is greater there (pump suction screens out particles larger than 0.6 cm [1/4 in]). A syphon, if established, could drain back from Tank 241-AY-102 to 241-C-106 and could result in overfilling Tank 241-C-106 or, in the event of a failure of the transfer piping, a release of radioactive waste to the soil column.

2.4.1.12 Instrumentation and Control. Additional instrumentation (over and above that existing prior to WRSS) is required in both tanks, in the transfer lines between the tanks, and on the ventilation systems associated with both tanks. Also, communications between the control rooms at Tanks 241-AY-102 and 241-C-106 are required to ensure that shutdown functions are accomplished.

Tank 241-C-106 has instrumentation that monitors tank pressure to minimize the release of hazardous airborne particulates or gaseous material. Monitoring for tank vapor hydrogen concentration is also provided.

Leak detection is provided for the new transfer lines and the pump pits. Seismic shutdown switches are provided to reduce the volume of a spill from rupture of both transfer lines that could be caused by a design-basis earthquake. Mass flow rate, slurry density, and total mass flow are measured on the Tank 241-C-106 to Tank 241-AY-102 transfer line. Volumetric flow rate and pressure are measured at the discharge of the booster pumps on both transfer lines.

Temperature monitoring for Tank 241-AY-102 includes the capability to measure temperature at multiple elevations in the waste and the operation of existing thermocouples. A level gauge and a densitometer provide the capability to determine waste depth, sludge depth, and density of the fluid portion of the waste. Flow rate, temperature, and humidity monitoring on the 241-AZ-702 primary ventilation system is provided, and flow rate and temperature monitoring is provided on the annulus ventilation system. Hydrogen monitoring is provided for the Tank 241-AY-102 dome space.

2.4.1.13 In-Pit Closed Circuit Television Imaging System. A portable in-pit closed circuit television (CCTV) imaging system is provided to periodically monitor the interior of the process pits through access holes in the pit cover blocks. The system is used for determining pit conditions before opening for maintenance, leak verification, or inspection of equipment conditions.

2.4.1.14 In-Tank Imaging System. An in-tank imaging system, composed of a CCTV camera, mast assembly, a pan and tilt unit, and a shield/mounting plug, is provided within Tank 241-C-106 to locate the tank sludge accumulations during the sluicing operations and to ensure wastes are not exposed. The imaging panel contains the controls for positioning and illuminating the field-of-view for the in-tank CCTV system, as well as the cathode ray tube (CRT) displaying the in-tank view. This system also enables operators to aim the sluicer at the remaining waste sludge while minimizing the liquid level after the initial solids-removal increments.

2.4.1.15 Chemical Additions and Tank Sampling. Tank 241-AY-102 is accessible through riser number 15-0 for chemical additions and for tank sampling. Chemicals (typically sodium hydroxide to adjust PH), are added through the riser as needed to enhance the compatibility of the waste in Tank 241-C-106 with that of the waste in Tank 241-AY-102. Chemicals added to Tank 241-AY-102 supernate are dispersed throughout the WRSS by normal operation of the pumping systems. Bulk chemical additions to Tank 241-AY-102 may be necessary to maintain tank chemistry within specified limits for corrosion control. Note that the addition of corrosion inhibitor (NaOH) is compatible with the need to maintain the alkalinity of the waste in order to avoid the potential for plutonium segregation. This is further described in Section 2.5.5.

2.4.1.16 Process Building Skid. The process building skid is located within Process Building 241-C-91. This skid consists of a condenser, a moisture separator, a heating coil, a recirculation fan, a HEME, and a HEMF. Gases from the Tank 241-C-106 headspace enter the ventilation system through a 25 cm (10 in) duct and are cooled by a propylene glycol/water mixture circulating through the condenser. Part of the flow is directed to the exhaust skid and the balance circulated through the moisture separator and heating coil before returning to Tank 241-C-106 through a 20 cm (8 in) duct to cool the tank. The exhaust gases are prefiltered through the HEME and HEMF. A 20 cm (8 in) valved connection is provided between the moisture separator and the heating coil on the recirculation line to allow a portable exhauster hookup for ventilation system outages.

Compressed air and raw water supply systems are provided to support operation of the ventilation system, such as backwashing the HEME and flushing the HEMF. A seal pot is provided to collect liquids from the condenser and from other equipment drains within the process building.

2.4.1.16.1 Condenser. The condenser (HX-1361) is a shell and tube type, designed to meet the requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1. The ventilation air stream, circulating on the shell side, normally is cooled to about 4.4 °C (40 °F) by the chilled-water cooling system, which circulates a 46% propylene glycol solution on the tube side. The condenser shell side has been designed for an air flow of 34.5 m^3/min (1220 ft^3/min), an inlet temperature range of 10 to 82 °C (50 to

180 °F), an outlet temperature range of 0.6 to 82 °C (33 to 180 °F), and an operating pressure range of -15 to -0.8 cm (-5.9 to -0.3 in) w.g. The condenser tube side has been designed for a coolant flow of 416 L/min (110 gal/min), an inlet temperature range of -0.6 to 32 °C (31 to 90 °F), and an outlet temperature range of 2 to 32 °C (36 to 90 °F).

2.4.1.16.2 Moisture Separator. The moisture separator (MS-1361) is a centrifugal mist eliminator that removes moisture droplets from the recirculation air stream by centrifugal force and gravity. Drains from the moisture separator are routed to the seal pot in the process building for return to Tank 241-C-106. Water droplet removal efficiency as a function of droplet size has been evaluated for the WRSS expected conditions and is documented in W320-H-015, *Sizing of Moisture Separator*. The moisture separator will remove 99.9% of all droplets greater than 10 microns and 60% of all droplets in the range of 2-10 microns.

2.4.1.16.3 Recirculation Heating Coil. The heating coil (HC-1361) is used to reduce the relative humidity of recirculating air and protect the recirculation fan from erosion by liquid aerosols. This equipment serves to reduce any fog formations in the tank vapor space to enhance visibility for the in-tank camera system. If fog formation does not occur, this coil would not be used, since some uncertainties exist regarding potential buildup of particulates in the tank vapor space with its use. The heating capacity is approximately 25 to 30 kW (85,303 to 102,360 Btu/h). Liquid drains from the heating coil and is routed to the process building seal pot for return to Tank 241-C-106.

2.4.1.16.4 Recirculation Fan. The recirculation fan (FN-1361) has a rated capacity of 27.6 m^3/min (996 ft^3/min) at a 40.6 cm (16 in) w.g. pressure differential. Drains from the recirculation fan are routed to the process building seal pot for return to Tank 241-C-106.

2.4.1.16.5 High-Efficiency Mist Eliminator. The HEME (HME-1361) is a cartridge-type moisture eliminator with a monofilament fiberglass filter bed designed for an air flow of 10.2 m^3/min (360 ft^3/min) at a face velocity of 9 m/min (30 ft/min), a temperature of 4.4 °C (40 °F), and a pressure of 98 kPa (14.2 psig). The removal efficiency rating of the HEME is 99.5% for particles 0.5 μm and larger, which removes any moisture carryover from the condenser. The filter housing is constructed of type 304L stainless steel and designed to meet the requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1. The HEME has provisions for periodic backwashing with filtered raw water to increase its efficiency; retained particulate material is returned to Tank 241-C-106 via the process building seal pot. The control for backwashing the HEME is designed to be either manual (controlled by an operator) or automatic (controlled by a timer). The HEME is provided with a bypass to allow for maintenance. This bypass cannot be used during operation since these valves are only accessible from inside the ventilation building.

2.4.1.16.6 High-Efficiency Metal Filter. The HEMF (HMF-1361) has several sintered metal fiber-type filters arranged cylindrically within a vessel and is designed for an airflow of 10.2 m^3/min (360 ft^3/min) at a temperature of 4.4 °C (40 °F) and a pressure of 95.8 kPa (13.9 psig). The HEMF acts as a prefilter for the HEPA filter (in the exhaust stream) and

removes at least 99.97% of 0.3 μm particles and greater. The filter housing is constructed of 304L stainless steel and is designed to meet the requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1. The HEMF has provisions for backflushing, using filtered raw water followed by a compressed air blowdown and drying of the filter media. Backflushing of the HEMF is manually initiated by the operator, as required, at a predetermined radiation level sensed by a local detector. The filtered water used for backflushing, and any particulate material removed, are returned to Tank 241-C-106 via a dedicated encased drain line through the 10 cm (4 in) R-4 riser. The HEMF is provided with a bypass to allow for maintenance. As with the HEME above, this bypass is not used for the backflushing. The liquid is returned to the tank by gravity.

2.4.1.17 Recirculation System. The 296-C-006 recirculation system removes heat from the Tank 241-C-106 vapor space, promotes visibility, and dehumidifies the recirculating air. The recirculation fan (FN-1361) provides air flow (including gases in the vapor space of the tank) in the recirculation path. The condenser (HX-1361) cools the air, condenses moisture in the airstream, and the condensate is returned to the tank. The moisture separator (MS-1361) removes moisture from the air stream. A recirculation system heating coil (HC-1361) is used to reheat the air to about 25 °C (77 °F) to decrease the relative humidity of the air stream and to provide some fog suppression before returning the recirculating air to the tank.

Air, at flow rates of 34.5 m^3/min (1220 ft^3/min), flows from Tank 241-C-106 through a 25 cm (10 in) combined recirculation and exhaust flow duct, circulates through the condenser, and returns to Tank 241-C-106 through a 20 cm (8 in) duct. The discharge of the recirculation fan splits into a 20 cm (8 in) recirculation pipe, with a flow rate of 24 m^3/min (860 ft^3/min), and a 15 cm (6 in) exhaust pipe, with a flow rate of 10.2 m^3/min (360 ft^3/min), 304L stainless steel. Ventilation system ducts are constructed from schedule 10, 304L stainless steel.

2.4.1.18 Process Building Drain and Seal Pot. A seal pot is provided on the process building drain line. It serves as a common collection point and seal for the condenser and other ventilation system equipment drains while preventing Tank 241-C-106 from venting into the process building. The overflow from the seal pot, which includes the HEME backwash waste water, is returned to Tank 241-C-106 via a dedicated encased drain line through the 10 cm (4 in), R-4 riser.

2.4.1.19 Chiller Skid. The chiller skid contains an air-cooled chiller and a chilled-water cooling system. The chilled-water cooling system consists of a makeup storage tank, an air separator, circulation pumps, an expansion tank, and instruments for monitoring the closed-loop cooling system. The circulating fluid (chilled water) is a 46% propylene glycol solution mixed with water circulated between the chiller and the recirculation system condenser. Chilled water may also be provided to the intake air cooling coil (CC-1361). The chilled water cooling system removes heat and dehumidifies the recirculating tank vapor by reducing the temperature of the vapor from about 35 to 4.4 °C (95 to 40 °F). In its alternate use with the existing ventilation system, it cools the bulk solid waste in Tank 241-C-106 to reduce

(before sluicing initiation) or maintain (during intermittent sluicing outages) waste temperatures below local saturation. The chiller skid is located outside the fenced area of the C Tank Farm.

2.4.1.19.1 Air-Cooled Chiller. An air-cooled chiller (R-1361) is used to remove heat that the chilled-water system gained from the recirculation ventilation system condenser, or with the existing ventilation system, from cooling ambient inlet air to 4.4 °C (40 °F) in the intake air cooling coil (CC-1361). The chiller is a complete factory assembled package, rated at 40 tons, with reciprocating compressors, condenser, refrigerant circuits, cooler, and controls. The chiller reduces the temperature of the chilled water returning from the recirculation condenser by about 2.7 °C (5 °F).

2.4.1.19.2 Makeup Storage Tank. The makeup storage tank (TK-1361) is pressurized by compressed air to provide the suction head required by the chilled-water circulation pumps and supplies makeup glycol solution for the chilled-water circulation system.

2.4.1.19.3 Air Separator. An air separator (TK-1363) is provided to remove air from the chilled-water circulation system. Air is automatically expelled from the air separator through a float-type air vent.

2.4.1.19.4 Circulation Pumps. Two 416 L/min (110 gal/min) centrifugal pumps are provided to circulate chilled water through the condenser or intake air-cooling coil (CC-1361) and the air-cooled chiller. One pump (P-1364) is designated the primary pump and the other (P-1365) the standby pump. Following failure of the primary pump, the standby starts. Each pump is provided with normally open isolation valves that allow pump maintenance while minimizing any effect on system operations.

2.4.1.19.5 Expansion Tank. The expansion tank (TK-1362) provides space for expansion and contraction of chilled water system fluid as the fluid temperature varies.

2.4.1.19.6 Circulation Piping. The 8 cm (3 in) circulation piping routes the chilled water to and from the condenser, located in the process building, or the intake-air cooling coil (CC-1361) on the existing ventilation system (valving change required) and the air-cooled chiller. The buried and insulated piping is Schedule 40 carbon steel with welded fittings.

2.4.1.20 Exhaust Skid. This skid directs exhaust through a heating coil, two HEPA filters with a test section for each filter, and an exhaust fan. This skid also includes an exhaust stack and exhaust-monitoring instruments. The exhaust ventilation system controls the pressure of the Tank 241-C-106 vapor space. The exhaust skid is located immediately east of the recirculation skid.

Air in-leakage, to make up for the exhausted volume, flows into Tank 241-C-106 from two pathways: (1) between pits and pit cover blocks into pits and then through pit drains into Tank 241-C-106 and (2) through the existing 8 cm (3 in) cascade line connecting Tank 241-C-105 to Tank 241-C-106.

2.4.1.20.1 Exhaust Heating Coil. A heating coil (HC-1362), located upstream of the HEPA filter train, has been designed to heat the saturated air and prevent condensation on the HEPA filters. The heating capacity is about 2 kW (6820 Btu/h). During normal operations the heating coil raises the air stream temperature from 4.4 °C to 21 °C (40 °F to 53 °F) and maintains a relative humidity of 60%.

2.4.1.20.2 High-Efficiency Particulate Air Filters. The HEPA filters are the bag-in/bag-out type, designed for a particulate removal mass efficiency basis of 99.97% of 0.3 μm particles and greater. This is achieved by using two HEPA filters (HEP-1361 and HEP-1362) in series. Each filtration stage has provisions for in-place testing while in use. A HEPA filter is required to be changed out whenever the pressure differential across the filter exceeds allowables or when the radiation measurement on the filter housing is about 2.0 mSv/h (200 mrem/h).

2.4.1.21 Exhaust Fan. The 296-C-006 exhaust fan is direct driven by a variable frequency, drive-controlled, 7.5-hp electric motor with a flow capacity of 10.2 m^3/min (360 ft^3/min) at 101.6 cm (40 in) w.g. Fan speed is modulated as required to control the vapor space pressure in Tank 241-C-106.

2.4.1.22 Exhaust Stack. The 15 cm (6 in) diameter exhaust stack extends to a height of about 5.2 m (16 ft) above the exhaust skid's concrete pad. The exhaust stack provides the point of discharge for the tank ventilation system. The primary exhaust air stream is sampled for radioactive particulate and monitored for radioactivity before discharge via the stack. The exhausted air stream is also monitored for flow.

2.4.2 Support Systems

The WRSS uses the existing tank farm support systems, modified as required to support Project W-320 requirements. Backup for the instrument air system is not provided. Backup power is provided for the AY Farm and the 241-A-702 and 4,000 cfm backup exhauster tank ventilation systems. Backup power for other systems will be provided, based on their safety function, as determined by the engineering analysis discussed in Section 4.2, "Requirements," of this addendum. Support services in the form of raw water, electrical power, telecommunications, and hoisting hardware, are provided. The use of portable facilities for sanitary sewage will be provided for the personnel using the control trailer.

2.4.2.1 Electrical Systems. Electrical power systems include AC power for Tank 241-C-106, Tank 241-AY-102, and Control Facility MO-211. All electrical equipment and components are selected, or protected, to resist the adverse effects of the environment in which they are installed. Electrical enclosures and junction boxes of the proper National Electrical Manufacturers Association rating and material are used to protect internal components from the corrosive effects of moisture and chemicals.

Power from the Hanford Site power grid is provided for Tank 241-C-106 by a 480 Vac, portable, skid-mounted substation on a concrete slab outside the fence near the 241-C Tank Farm. The existing 13.8 kV pole line (C8-L6) is

extended from the pole line on the north side of the 241-C Tank Farm to the east side of the 241-C Tank Farm. The new substation includes a transformer, switchgear, and a motor control center.

The sluice pump located in Tank 241-AY-102 is supplied with 480 Vac power from the existing 13.8 kV pole line (C8-L6). This line is tapped to supply a new 13.8 kV to 480 V transformer. The motor control center and variable speed drive are located on a skid-mounted (241-AY-51) enclosure outside the 241-AY Tank Farm.

2.4.2.2 Air Supply Systems. The existing compressed air system serving 241-C Farm will not be used by the WRSS. The compressed air system provided by WRSS distributes air at various pressures, providing a source of dry instrument-quality air to various components of WRSS. Compressed air for the WRSS is provided by a compressor and receiver unit (C-1361) rated at 0.8 m^3/min (27.5 ft^3/min) and 690 kPa (100 psig). Moisture is removed from the system by an air dryer (D-1361) that will lower the dew point to -40 °C (-40 °F). The compressor unit and dryer are located in Air and Water Service Building 241-C-73. Pneumatically operated valves are supplied with either 550 kPa or 690 kPa (80 or 100 psig) as required. Blowdown and drying air to the HEMF are provided at 690 kPa (100 psig) via a 113.6-L (30-gal) air accumulator (TK-1361) located in Process Building 241-C-91. Additionally, purge air is provided at 140 kPa (20 psig) for Tank 241-C-106 level and pressure instrumentation. Backup systems are readily available in the form of either portable or stationary compressor units.

2.4.2.3 Water Supply Systems. All water for the 200 East Area is supplied from the Hanford Site Export Water System. Water is distributed throughout the area by two separate systems: the raw water system and the sanitary water system. Raw water is untreated, unchlorinated water used primarily for cooling, flushing, and dilution systems. Sanitary water is treated (filtered, purified) and used for drinking and sanitary facilities.

The WRSS has been designed to have flushing capability using raw water for all components. Raw water is provided from an existing 30 cm (12 in) fire water line through a new 5 cm (2 in) supply line into Air and Water Service Building 241-C-73 where it passes through a 20 mesh duplex strainer (F-1363). Two backflow preventers in series minimize the potential for contamination. These backflow preventers (BP-1361 and BP-1362) are located in Air and Water Service Building 241-C-73 and Process Building 241-C-91. Raw water, used for either backwashing the HEME or flushing the HEMF, is passed through two stages of filtration to remove any particulate material. The first stage is a nominal 30 μm filter (F-1361) followed by a second stage 0.5 sum absolute filter (F-1362). Between these two filters is a line used for flushing or rinsing the intake imaging system.

Pump pits 241-AY-02E and 241-AY-02A provide for water flushing of the primary transfer piping (inner pipe). Backflow prevention is provided in the flush jumper system. This flushing water is supplied by tanker truck.

During an emergency, cooling water for the condensers in the AWF ventilation system, 241-A-702, is provided by the emergency cooling water system. This system consists of a cold water sump and a warm water sump, each

with two pumps, and an induced draft cooling tower, all located outside of the restricted area east of the 241-A-401 Condenser Building. Makeup water for the cold water sump is obtained from well 299-E25-6 located about 268 m (880 ft) north of the 241-A-CT-400 cooling tower. The deep well pump and emergency cooling water equipment has standby power from a backup diesel generator.

2.4.2.4 WRSS Control Station. The WRSS control station, located just outside the 241-C Farm fence on the North East side of the farm, is in a 3.7- by 3.7-m (12- by 12-ft) room and contains control consoles for the WRSS. One console is for the CCTV (CP02), one console is for controlling C Tank Farm pumps, winches, and the sluicer (CB-01), and one console is for annunciation and indication of process variables. The control station is designed for one operator.

2.4.2.5 241-AY-02E Pit Chiller. A pit chiller is provided at the 241-AY-02E Pit to remove the heat generated by the operation of the Booster pump and control the pit air temperature within equipment operating limits. The chiller is a split system consisting of a fan coil unit mounted within the pit (FC-0621) and a packaged outdoor air cooled water chiller (R-0621). The outdoor unit provides a chilled 46% propylene glycol/water solution to the fan coil unit and includes fan controls and other system instrumentation. A similar system is not required at the C-farm pump pit due to the larger size of the pit.

2.4.2.6 Standard Hydrogen Monitoring System. Standard Hydrogen Monitoring Systems (SHMS) are provided at both Tanks 241-C-106 and 241-AY-102. The SHMS are used to continuously monitor the gas composition of the tank vapor space. Gas samples are collected from the tank dome space at Tank 241-AY-102 and from the ventilation ducting at Tank 241-C-106.

The SHMS are provided with dual range electrochemical cells for measurement of hydrogen concentrations in the range of a few hundred ppm-volume to above the flammable limit of 4%-volume. The SHMS also include sensitive gas chromotographs to measure concentrations of hydrogen and other gases in the range of a few ppm to above the lower flammability limit. Sample ports are provided at the SHMS Cabinets to facilitate grab sampling. The SHMS provides alarms and indications at both TMACS and the W-320 control rooms.

2.4.2.7 Tank 241-C-106 Pit Sump Pumps. Sump pumps are provided at both of the Tank 241-C-106 transfer pits. Sump Pump P-1363 is located in the 241-C-06A pit and Sump Pump P-1368 is located in the 241-C-06C Pit. The sump pumps provide a means to evacuate liquid accumulated with the transfer pits following detection of a leak. When a leak is detected an operator manually energizes the sump pump. The sump pump transfers the collected liquid from the pit floor back into the tank via the high capacity drain.

2.5 PROCESS DESCRIPTION

The following section describes the WRSS operation plans and the process control plan. The text of Section 2.5 commits to a prescribed process control plan (PCP) and summarizes the content of the PCP. The PCP, in turn,

implements processes and controls that are contained in the flammable gas, thermal, and chemistry topical reports. TSRs and Defense-In-Depth controls are implemented by the PCP and are summarized in Sections 3.4.2.8 and 3.4.2.11 of this addendum for flammable gas and thermal issues. This includes controls for monitoring and for contingencies such as supernate removal.

The section contains four subsections. The first subsection, Sluicing Preparations, discusses the activities that will be accomplished in advance of the first sluicing operations to prepare the tank for sluicing and to acquire information needed for process control.

The second subsection, WRSS Operations, discusses the Sluicing Campaign Plan and the integration of all associated process monitoring instrumentation and controls. The various operating modes of the WRSS system and contingency plans are also discussed in this section.

The third subsection, Supporting Operations, discusses the non-WRSS operations activities that support the operations of the WRSS, chemical additions and sampling.

The fourth subsection, Past Practice Sluicing Lessons Learned, outlines historical problems and equipment sensitivities associated with past practice sluicing activities at Hanford's 200 Area.

2.5.1 Sluicing Preparations

The presluicing operations activities needed to acquire information necessary for process control and to prepare the tank for sluicing are discussed below.

2.5.1.1 Tank 241-C-106 Ventilation Waste Subcooling. As documented in HNF-SD-W320-ER-002, *Project W-320 Thermal Evaluation*, the sludge in Tank 241-C-106 will be subcooled (the temperature reduced to below the local saturation temperature) to prevent a steam release event from occurring. This subcooling is accomplished by operation of the existing Tank 241-C-106 exhauster (296-P-16) in combination with the inlet filter cooling coil and chiller system provided by the WRSS. The cooling coil cools the air entering C-106 to approximately 4 °C (40 °F). This cooled inlet air helps to reverse or prevent the increase of tank waste temperatures resulting from higher temperatures in summer.

2.5.1.2 WRSS Supernate Temperature Equalization. A number of small supernate liquid transfers will be required between the two tanks to equalize the temperatures in the tank liquids. The number and volume of transfers to accomplish the equalization will be dependent on the initial liquid volume in Tank 241-C-106 and its initial temperature. This equalization procedure will be performed only before start of WRSS operations or after extended delay periods between sluicing increments, if the temperature differential between the tanks would result in exceeding existing control limits. Normal WRSS operations will provide temperature equalization during sluicing.

2.5.1.3 WRSS Temperature/Thermal Data Baselines. To establish the startup thermal baseline for Tanks 241-AY-102 and 241-C-106, the temperatures in both tanks will be monitored for a period of not less than one month in advance of the start of sluicing operations. This thermal baseline will be compared to the project thermal analysis before the start of sluicing to ensure that the baseline is within the assumptions envelope of the analysis.

2.5.1.4 WRSS Flammable Gas Generation and Composition Baselines. The flammable gas concentrations will be monitored in Tanks 241-AY-102 and 241-C-106 for a period of not less than four weeks before the start of sluicing to establish the flammable gas baselines. The baseline will also include the flammable gas compositions for the tanks based on vapor space sampling results.

2.5.1.5 Tank 241-AY-102 Supernate Level Adjustment Transfer. Using the existing 241-AY-02D pit transfer pump, the waste level in Tank 241-AY-102 will be reduced before the start of sluicing to approximately 4.3 m (14 ft) by a transfer of supernate to a double shell receiver tank through the existing transfer system. This level includes the existing sludge in the tank.

2.5.2 WRSS Operations

2.5.2.1 WRSS Sluicing Campaign Plan Overview. The planned approach to remove the sludge from Tank 241-C-106 is discussed in the following section.

The following definitions are used to describe the planned sluicing operations:

- Campaign—Refers to the combination of sluicing increments. Each increment requires one or more sluicing batches which remove a given volume of sludge from Tank 241-C-106. The nominal volume of sludge transferred in each of the first and second campaigns is approximately 250 m^3 (66,000 gal). The third campaign is intended to remove all of the remaining sluicable sludge in Tank 241-C-106, but the volume of this campaign is expected to be less than 250 m^3 (66,000 gal).

- Increment—The sluicing increment refers to the 125 m^3 (33,000 gal) increments of sludge. The volume in a sluicing increment is equivalent to nominally 0.3 m (1 ft) of tank level. Therefore, two sluicing increments represent a transferred sludge volume equivalent to a nominal sluicing campaign. The increment size was selected based on estimates of the magnitude of "worst case" thermal conditions or flammable gas releases which could be accommodated in a single transfer.

- Batch—The sluicing batch is the smallest sluicing element. It is a single continuous or nearly continuous sluicing operation, the duration of which is controlled by either the accumulated volume of transferred sludge reaching the desired value, or the maximum sluicing batch time limit being reached, whichever occurs first. If the sluicing process can operate at the optimum efficiency, only one

sluicing batch is required to transfer one sluicing increment. Under less optimal conditions, two or more sluicing batches may be required to complete one sluicing increment.

2.5.2.1.1 First Sluicing Campaign. The first sluicing campaign retrieval operation is characterized by a requirement to maintain a specified liquid cover over the sludge in Tank 241-C-106 and the requirement to limit the amount of material transferred (HNF-SD-W320-ER-004). The liquid cover requirement is needed only during the first campaign to maintain saturation temperature suppression by hydraulic head (HNF-SD-W320-ER-004).

Completion of the first retrieval campaign is estimated to eliminate the need to add water to Tank 241-C-106 to maintain temperature control (HNF-SD-W320-ER-004). However, active ventilation will still be required to maintain the tank within its required temperature limits. It is, therefore, projected that completion of the first campaign will result in the removal of enough heat generating waste to resolve the Tank 241-C-106 high heat safety issue.

Sluicing Increments. The first sluicing campaign is projected to include two, approximately 124,900 L (33,000 gal) sluicing increments. The 124,900 L (33,000 gal) increment size was selected for two reasons. The first reason for establishing the 124,900 L (33,000 gal) sluicing increment is to achieve conservatism in the Tank 241-AY-102 temperature process control. HNF-SD-W320-ER-004 predicts that Tank 241-AY-102 will remain within temperature limits without the need for tank annulus ventilation, even if the heat load and waste fluffing in the initial 124,900 L (33,000 gal) of transferred sludge are greater than the range of probable values. The second reason is based on past practice sluicing experience that showed the maximum liquid cover through which sluicing could be effectively achieved was 22.9 to 30.5 cm (9 to 12 in).

After waiting the required period for analyses to show that adequate subcooling has occurred, the minimum liquid level/sludge cover control level will be reduced for each succeeding sluicing increment.

Sluicing Batches. Each of the above sluicing increments will be made up of several sluicing batches. The sluicing batch operational approach is used to provide assurance that inadvertent transfer of an excessive amount of heat-generating material (greater than the 124,900 L [33,000 gal] increment volume) into Tank 241-AY-102 does not occur.

The sluicing batch durations will be limited by two parameters: (1) the total sludge transferred as determined by the mass flow meter and (2) a maximum sluicing duration based on mass flow meter instrument uncertainty. These two values will be specified in the process control plan. The values may be subsequently modified based on WRSS operational experience.

2.5.2.1.2 Monitoring During and After the First Sluicing Campaign (Increment and Batch). Following the completion of the first sluicing campaign, a period of monitoring will be instituted prior to initiating any following sluicing operations. The monitoring period durations and requirements are discussed below. If a sluicing batch or increment completion

is concurrent with the next large-sized sluicing element, then the more extensive monitoring requirements from each will take precedence. Parameters to be monitored between sluicing batches include:

- Gas release rates (SHMS)
- Waste levels (ENRAF)
- Sludge level (ENRAF Densitometer)
- Waste temperatures (TC trees, Multifunction Instrument Tree, Air Lift Circulator TC's, and under-tank TC's)
- Annulus ventilation flow rate and inlet and outlet temperatures
- Dome space ventilation flow rate, inlet and outlet temperatures, relative humidity, and chiller performance

Specific monitoring requirements are contained in the process control plan and are summarized in the following paragraphs.

Post-Batch Monitoring. The post-batch monitoring period will extend for a minimum of three days following each batch. The batch monitoring durations are established by the solids-settling velocity reported in HNF-SD-WM-TI-756, *Chemical and Chemically Related Considerations Associated with Sluicing Tank C-106 Waste to Tank AY-102*, which is such that the initial settling period will be completed and a distinct sludge-supernate interface will have formed in Tank 241-AY-102.

During the monitoring period, the volume of Tank 241-C-106 sludge transferred to Tank 241-AY-102 will be calculated using ENRAF densitometer density profile data and Tank 241-AY-102 grab samples analysis results. This estimate will be compared with the mass flow meter totalizer readings. The monitoring period duration may also be extended until adequate confidence is established in the estimated sludge volume/heat load transferred. For example, if sludge settling takes longer than expected, a longer monitoring period will be required to establish volume and heat load values since these values are highly dependent on sludge depth.

Post-Increment Monitoring. The post increment monitoring period will extend for a minimum of seven days following the completion of each increment. The increment monitoring durations are established in the WRSS process control plan.

At the completion of each sluicing increment, an updated thermal baseline for both the tanks is established prior to proceeding with further sluicing. All of these considerations have some bearing on how subsequent retrieval actions will be performed, perhaps determining if they can be performed at all.

During the increment monitoring period, the sludge volume will be calculated as discussed above. In addition, tank thermal data will be

collected and reviewed to verify that anticipated thermal responses are occurring. Deviations from the anticipated responses will be evaluated.

Post-First Sluicing Campaign Monitoring. The post-first sluicing campaign monitoring period will extend for a minimum of two weeks following the completion of the campaign. The increment monitoring durations are established by LA-UR-97-1330. Both thermal and flammable gas process parameters will be monitored during this period.

2.5.2.1.3 Second Sluicing Campaign. This sluicing campaign will be identical to that described in Section 2.5.2.1.1, except that there is no requirement to maintain a minimum hydraulic head on Tank 241-C-106 sludge by means of a minimum liquid cover. This will permit operation of both the sluicer and slurry submersible pump in the optimum position to maximize sluicing efficiency.

Both temperatures and gas retention in Tank 241-AY-102 depend on the vertical distribution of heat generating isotopes after the waste transfers. This vertical distribution, in turn, depends on the degree of isotope stratification in Tank 241-C-106, and the degree of mixing created by the sluicing jet in Tank 241-C-106. The waste in Tank 241-C-106 may be highly stratified. For example, grab samples collected during 1996 show a fairly low and relatively uniform isotopic heat content in the upper approximate 4 ft of waste, with one interpretation being that most of the heat generating isotopes may be in the lower 2 ft (HNF-SD-WM-TI-756). However, process data from when the tank was filled show two relatively high isotopic layers, one at approximately 0-2 ft from the top and one at approximately 1-3 ft from the bottom of the tank (HNF-SD-W320-ER-004).

The sluicing strategy of the second sluicing campaign will be planned to minimize Tank 241-AY-102 waste temperatures and gas retention during subsequent waste transfers. For example, higher temperatures would occur if the heat generating isotopes were in a stratified layer at mid-depth in the sludge of Tank 241-AY-102, than if they were at the top or mixed throughout (HNF-SD-W320-ER-004).

Based on monitoring results of the quantity of heat generating materials transferred to Tank 241-AY-102 and remaining in Tank 241-C-106 after the first sluicing campaign, and model predictions, the depth of localized sluice jet penetration in Tank 241-C-106 will be adjusted to the extent practicable to optimize the subsequent waste transfers. This can be done by either excavating deeper in one area of the tank, or conversely, by removing a layer of more uniform thickness from the surface of the sludge.

2.5.2.1.4 Post-Second Sluicing Campaign Monitoring. The monitoring during this period will be identical to that discussed in Section 2.5.2.1.3, with the exception that Tank 241-C-106 will no longer require special thermal evaluation because the potential two phase zone in the tank will have been eliminated by the removal of two feet of waste.

2.5.2.1.5 Final Sluicing Campaign. This sluicing campaign will be identical to that described in Section 2.5.2.1.3.

2.5.2.1.6 Long-Term Monitoring. The waste in Tank 241-AY-102 is monitored to ensure that the waste remains within the tank's operating specifications and applicable Technical Safety Requirements (TSRs) for waste storage. Monitoring is specified through the process control plan which describes the requirements for the incremental transfer and monitoring.

The WRSS equipment has a design life of two years, although actual sluicing operations should take about one year to complete. The life of the in-tank pumping systems have been reevaluated with a preliminary result of approximately 4 years (with flushing of the transfer system). After the retrieval operation is complete, equipment installed in the tanks for WRSS operations and the waste transfer lines remain in place until decommissioning by a follow-on project, or disposal activities remove them. Other project waste would be disposed of in a properly sited landfill or hazardous waste facility in accordance with all applicable state and federal guidelines.

2.5.2.2 WRSS Sluicing Operation Control. The following discussion provides details on the sluicing operation control considerations and the associated bases that are implemented in the above discussion of the sluicing campaigns and associated monitoring.

2.5.2.2.1 Slurry Solids Loading Process Control. The solids loading in the slurry line is monitored using two real-time process control instruments discussed below.

The principal solids loading process control instrument is the 241-AY-02A pit mass flow meter. This instrument provides a direct indication of the slurry loading in the slurry line at the receiver tank end of the transfer line by measuring the density of the slurry. Knowledge of the solution density (obtained from either the ENRAF densitometer or grab samples) is required to support determining the slurry solids loading.

An additional indication of slurry solids loading is provided by the slurry flow rate measured by the mag-flow meter installed in the 241-C-06A pit. This instrument provides an indirect measure of the solids loading. The utilization of the slurry flow rate will require fixing the slurry booster pump speed setting as follows.

The slurry booster pump speed is set for a flow of 1325 L/min (350 gal/min) assuming a 0% solids loading. As the solids loading increases, the slurry flow rate is estimated to decrease approximately 4 gal/min for each 1% solids loading change. The sluicing operator will monitor this flow rate to determine the effectiveness of the sluicing operations. To assist the operator in controlling the slurry loading at a level that will not potentially allow transfer lines solids settling, the flow rate for a 20 wt% solids loading will cause an alarm to sound. The response to this alarm will be to take action to avoid a future solids loading increase or to reduce the solids loading to below 20%. The following process control actions to reduce the solids loading would be implemented incrementally in the listed order to the extent required to reduce the solids loading to below 20%:

(1) Raise the submersible slurry pump level.

(2) Direct the sluice stream to the area of the submersible slurry pump intake to dilute the solids entering the pump.

(3) Increase the pump speed to achieve a 1700 l/min (450 gal/min) flow rate until the higher solids content slurry clears the system. Note: This action would have to be reversed as soon as the higher slurry content stream cleared the transfer line to reestablish the slurry loading process control pump speed setting.

2.5.2.2.2 Sludge Volume/Heat Load Transfer Process Control. The sludge volume transferred from Tank 241-C-106 to Tank 241-AY-102 is monitored in real time using the mass flow meter located in the 241-AY-02A. The solids volume transferred is used to estimate the approximate heat load transferred between the two tanks.

After the sludge transfer, a material balance is performed using the monitoring data from both tanks (i.e., levels, temperatures, ventilation flow, temperature, and humidity data) to refine the thermal analysis baseline (HNF-SD-W320-ER-004) and verify that subsequent sluicing operations can be accomplished safely.

2.5.2.2.3 Flammable Gas Process Control. The phenomena related to flammable gas generation, retention, and release have been evaluated for transfer of the Tank 241-C-106 sludge to Tank 241-AY-102 (LA-UR-97-1330, *Discussion of Flammable Gas Issue for Project W-320*). A presluicing flammable gas baseline with a four-week monitoring period, using the Standard Hydrogen Monitoring Systems (SHMS) instrumentation installed on the tanks, will be established for Tanks 241-AY-102 and 241-C-106. The flammable gas baselines will include flammable gas release rates, flammable gas compositions, and rate projections for these rates at key points in the planned sluicing operations. Data evaluations include the following:

- Gas concentrations and ventilation rates in both tanks
- An accurate accounting of all materials introduced into or removed from the tanks
- Video monitoring of the Tank 241-AY-102 waste surface for indications of foaming or crust formation during the initial sluicing operations
- Headspace grab sampling at Tank 241-AY-102
- Liquid level monitoring in both tanks (Tank 241-C-106 monitoring is limited to nonsluicing periods)
- Tank 241-AY-102 sludge settling monitoring (densitometer and/or multi-functional instrument tree)
- Evaporation rate determined by ventilation flow rate and relative humidity.

Subsequent flammable gas monitoring will continue throughout the WRSS operations. Data from this monitoring will be compared to projections and significant deviations will be evaluated to determine if mitigative actions are warranted.

Process monitoring during the period between sluicing batches, increments, and campaigns will be the same as discussed under baseline development above. The data relating to gas retention in the Tank 241-AY-102 sludge will be carefully evaluated during the hold periods between sluicing increments and campaigns. If this evaluation identifies a potentially unacceptable flammable gas buildup, then the void fraction measurement instrument would be deployed as described in section 2.5.2.3.8. If the void fraction instrument confirms the flammable gas buildup condition, the tank excess supernate removal contingency plan would be implemented. As discussed in LA-UR-97-1330, the primary mitigation option selected is the removal of the Tank 241-AY-102 supernate. A summary of the process control for flammable gas is contained in the following discussions.

Assuming that the transfer-induced degassing stops immediately after the transfer, the gas concentrations in the headspace of Tank 241-C-106 should exhibit exponential decay. Because the gas generation in Tank 241-C-106 is reduced by sludge transfer, the headspace gas concentration in this tank will exponentially decay below the baseline concentration established before sluicing.

Waste (tank) level and flammable gas concentration are monitored in Tank 241-AY-102. The waste level and background hydrogen concentrations will equilibrate within two to four weeks. The void fraction of the sludge can be estimated by comparing the background hydrogen concentration transient with the steady state concentrations using the level rise. During this time, barometric pressure evaluation (BPE) may also be deployed to obtain additional data. Sludge density measurements using the ENRAF densitometer and the sludge thickness measurements using the same instrument along with the multi-functional instrument tree validation probe will also be required.

Using the gas inventory data from Tank 241-AY-102, a decision will be made to either transfer more waste or spend additional time evaluating the situation. Sluicing in the presence of a gas inventory indicating a buoyancy instability requires implementation of a mitigation plan to remove the excess supernate from the tank. If the gas inventory estimates contain large uncertainties (as defined in the WRSS process control plan), the void fraction instrument must be deployed to measure the gas inventory at a few locations in Tank 241-AY-102. If a level swell of more than 10 cm (4 in), corrected for evaporation, is detected and high voids are indicated by the void fraction instrument, the supernate in Tank 241-AY-102 will be removed. The decision to remove the supernate will be based on the calculated potential for a buoyancy induced rollover. Such a calculation will include the total data gathered such as gas release rates, level growth, barometric pressure evaluations, void fraction measurements. The measurements are described in reports LA-UR-97-1330 and PNNL-11627, *Monitoring Gas Retention and Slurry Transport During the Transfer of Waste from C-106 to AY-102*, and will be implemented in the PCP.

2.5.2.2.4 Liquid Level Process Control. Until the steam bump accident concern is eliminated, the liquid level in Tank 241-C-106 will have to be controlled at or above a set level to avoid affecting the subcooling provided by the hydraulic head of the liquid in the tank. The minimum liquid level is established to maintain the measured temperature of the waste at all locations below the local saturation temperature. The minimum liquid level to maintain safe operations is maintained through a TSR level control (AC 5.26).

The liquid level in 241-C-106 can not be monitored using the ENRAF liquid level instrument because this instrument will be shut down during sluicing operations to avoid damage by the sluice stream. Therefore, this measurement will be made using the lower liquid level sensor on the submersible slurry pump. As a backup to the above level control, the liquid level in Tank 241-AY-102 will also be controlled using the ENRAF liquid level instrument from that tank and the variable speed sluice booster pump.

The minimum liquid cover/hydraulic head control requirement will be eliminated after the first sluicing campaign as discussed in WHC-SD-WM-ER-588.

2.5.2.2.5 Leak Prevention/Minimization Process Control. The routine sluicing operations remove the sludge from Tank 241-C-106 while minimizing the potential for leakage during these operations. Leak potential is minimized in two ways.

The first planned leak prevention/minimization method is to limit the standing liquid volume in Tank 241-C-106 during sluicing operations to the extent possible, given thermal concerns and related process control limitations. The limiting of the standing liquid volume in Tank 241-C-106 will be accomplished using operating procedures which administratively control sluicing operations to the minimum practical liquid level consistent with 1) the minimum liquid level required to maintain subcooling (applicable during the removal of the first 0.6 m [2 ft] of sludge) and 2) protection of the pump from cavitation. Liquid level control is as specified in Section 2.5.2.2.4 above.

The second leak prevention/minimization methodology is to avoid directing the sluice stream toward the tank walls during the early stages of sluicing. The perimeter of the tank will be sluiced last to minimize the amount of material that could leak through the tank wall as a result of sluicer impingement.

2.5.2.2.6 Temperature and Thermal Process Control. The process control methodology is based on thermal considerations in both Tanks 241-C-106 and 241-AY-102. The conclusions of the WRSS Thermal Evaluations (HNF-SD-W320-ER-004) follow.

- The minimum WRSS objective of retrieving 0.6 m (2 ft) of waste from Tank 241-C-106 does not require operation of the Tank 241-AY-102 annulus ventilation system.

- Accumulation of the equivalent of 0.6 m (2 ft) of Tank 241-C-106 sludge in Tank 241-AY-102 is possible without modifications to the annulus ventilation system of Tank 241-AY-102. However, as a

Defense-In-Depth precaution, annulus blocking has been implemented. The capability to draw a high annulus vacuum along with annulus blocking will be provided, to provide margin for waste transfers beyond the first 0.6 m (2 ft) (such as could be needed if a leak were to develop in 241-C-106 during the initial sluicing increment). Additionally modifications to the secondary ventilation system (air inlet blower and/or chiller) may be implemented depending on the tank thermal behavior resulting from the first 0.6 m (2 ft) of sludge transfer. (Section 2.3.6.)

- Incremental sluicing with real-time mass control and monitoring will limit the thermal response caused by the heat-generating material added to Tank 241-AY-102.

- By evaluating the monitoring data with a transient thermal analysis, the steady state equilibrium temperatures can be predicted. Based on this prediction, sluicing can proceed without delays required to reach thermal equilibrium.

- Adequate subcooling can be maintained in Tank 241-C-106 with presluice chilling of the waste and incremental sluicing with hold periods for subsequent cooling before removing the hydrostatic head. The hold periods for cooling were established by thermal modeling.

2.5.2.2.7 Submersible Pump Elevation Process Control. Controls for the Tank 241-C-106 slurry pump system are provided at the MO-211 sluicing control room operators control panel. This panel has the controls for the pumps and pump winches, and indicates pump operational status and positions. The submersible slurry pump winch also has a lockout feature for its "lower" function which will be used in combination with pump shutdown interlock for the lower liquid level sensor mounted on the body of the submersible slurry pump to ensure that the liquid head on the sludge in the tank is not lowered during the first sluicing campaign.

2.5.2.2.8 Sluicer Aiming Process Control. A sluicer is provided for mobilizing the sludge in Tank 241-C-106 to transfer it as a slurry to Tank 241-AY-102. The sluicer will operate in sluice pit 241-C-06C through the 30 cm (12 in) riser R-3.

The sluicer has two control modes: manual and semiautomatic. The control system is based on nozzle position information obtained from magnetostrictive actuator position indicators. In the manual mode, the operator moves the joystick to position the nozzle in elevation (tilt) and azimuth (pan). In semiautomatic mode, the pan position constantly cycles between two set points on the meter relay. Tilt is set by the joystick, and then the joystick is administratively disabled. The pan cycle is limited to ±97°. The meter relay and related set point adjustments are limited to ±95° to avoid affecting the mechanical motion limits. The vertical motion is physically limited to +115° from 0° (straight down). Procedural controls avoid affecting the physical limits of tilt.

The sluicer will be used to direct waste to the suction of the slurry pump. It is anticipated that the tank wall adjacent to the submersible slurry pump will be exposed as a result of the slurry flowing into the pump intake.

The MO-211 control room features a main instrumentation control console, and consoles for the data acquisition system (DACS). The main instrumentation console is built around a sluicing panel, which contains the controls necessary to position the sluicer spray impact location within Tank 241-C-106. These controls feature a keyboard and a joystick controller for the positioning of the operating sluicer. The position of the impacting sluice stream will be indicated by a sluicer positioning device.

2.5.2.2.9 In-Tank Imaging System Monitoring. The MO-211 control room features an imaging panel containing the controls for positioning and illuminating the field-of-view for the in-tank CCTV system, as well as the CRT displaying the in-tank view from the CCTV imaging system. The in-tank CCTV imaging system that provides near real-time pictures or waste-surface-contour depictions during sluicing operations will be used to help control and direct the sluicing operations. It consists of a remotely controlled television camera and illumination source mounted in riser R-7 of Tank 241-C-106. Although it is not absolutely necessary for sluicing operations, the CCTV system is intended to locate any sludge accumulations, and allow for optimum sluicer aiming while minimizing the volume of liquid resident in Tank 241-C-106. Sluicer operation is mainly guided by azimuthal and vertical directional controls.

The in-tank CCTV system is composed of a TV camera, mast assembly, a pan and tilt unit, and a shield/mounting plug. The mast assembly includes a pressure-regulated supply of instrument air/nitrogen and associated enclosure control valves, a pressurized filtered raw water enclosure and associated enclosure control valves, and video processing electronics and associated wiring. The mast assembly is constructed of 304L Series stainless steel and includes a pan and tilt unit, a charge coupled device (CCD) camera, and high-efficiency metal halide focused-beam lamps, and will fit into a 30 cm (12 in) riser. The pan and tilt unit provides for a 360° field of view with a -90°/+30° elevation. The purge gas supply provides instrument cooling and condensation removal. The water supply provides camera lens and mast cleaning.

2.5.2.2.10 Modifications to Process Controls. The uncertainty in the characterization and dynamic behavior of the wastes contained in the WRSS is such that operational experience may show some deviation from predicted system behavior. Because of this, a performance baseline must be reestablished following every sluicing increment and the predictive models used for the WRSS must be modified to reflect the observed behavior. All anticipated conditions related to the WRSS operations have been included in this analysis.

2.5.2.3 WRSS Operating Modes and Contingency Plans. The following sections include discussions of the major operating modes of the WRSS and several contingency plans which have been developed to ensure the WRSS operations are prepared to respond to the identified off-normal operations.

2.5.2.3.1 Sluicing Startup. During the start of sluicing operations, the slurry pump is used to decant the supernate in Tank 241-C-106, to Tank 241-AY-102, so that the supernate level is 183 cm (72 in). The slurry pump is then positioned so that its low-level detector is located at 178 cm (70 in). The sluice pump is started and the sluice stream is aimed to agitate the area around the slurry pump intake. This startup mode of operation ensures that an acceptably low solids content (estimated at 10% or less) is present in the solution around the slurry pump intake when it is started.

Next, the slurry pump will be started and the associated slurry flow rate and pressure instrumentation continuously monitored until a stable slurry loading is achieved. The solids level in the slurry line is monitored using the mass flow meter installed in the AY Farm end of the slurry line. As a backup, the slurry pump discharge pressure and volumetric flow rate can be used as a gross indication of excessive solids loading in the slurry transfer line. This would be evidenced by either the flow rate decreasing towards the limiting low value, or the pump discharge pressure increasing towards the limiting high value expected for the slurry. The response would be to reposition the sluicer to impact at a less efficient location for slurry formation, and the slurry booster pump could be raised to a less efficient elevation. For follow-on sluicing campaigns where the liquid level is not constrained in Tank 241-C-106, the ENRAF level gauge in Tank 241-AY-102 can be used as a gross volumetric estimate of the sludge transferred. Nominally, a given volume of sludge transferred from Tank 241-C-106 will displace the same volume of supernate in Tank 241-AY-102. However, factors such as waste fluffing and settling rate will affect this assumption. The relationship between solids percentages and viscosity has been defined for this application by the project functional design criteria (HNF-SD-W320-FDC-001).

At a constant slurry velocity, as the solids percentage increases, the flow rate will decrease approximately 15 L/min (4 gal/min) per 1% solids loading change and the pump discharge pressure will increase. Changes in the slurry composition sufficient to effect a noticeable change in the pump parameters should also be indicated by the slurry mass flow meter and associated net flow computer (NFC). Therefore, the slurry line mass flow meter is the primary online process control tool. The mass flow meter may be backed up by the slurry line volumetric flow meters, the ENRAF level gauge in Tank 241-AY-102, and the discharge pressure and low-limit detector of the slurry pump suction, depending upon the applicable thermal-hydraulic constraints currently in effect.

These procedures do not apply to the solids level in the sluice stream, since a rapid buildup of high solids loadings cannot occur in the large volume of Tank 241-AY-102 supernate. The sluice pump flow rate is adjusted, as needed to maintain the desired liquid levels in the two tanks.

As sluicing operations proceed, most of the solids transferred into the Tank 241-AY-102 are anticipated to settle out, adding to the solids heel. Uniformity of the distributed slurry layer in Tank 241-AY-102 will be verified by monitoring the thermocouple readings. The finer solids may remain suspended in the bulk solution long enough to be recirculated back to Tank 241-C-106 in the sluice stream.

Once the tank conditions have been established to start sluicing operations, the WRSS pumps will be operated to adjust the liquid level in Tank 241-C-106. During sluicing operations, the operator will maintain the resulting liquid level in Tank 241-AY-102, taking into account the effect of the volumes required to fill the transfer lines. The sluice pumps will be started first, and to prevent the possibility that the low-level alarm on the slurry booster pump may be activated by loss of the liquid volume required to fill the slurry transfer line, the slurry pumps will not be started until sluicer flow is verified in Tank 241-C-106. The 241-C Tank Farm operator will set the slurry pump flow rate to a representative value that will ensure no solids settling occurs in the slurry transfer line. The minimum allowed flow rate is 946 L/min (250 gal/min). The nominal flow rate will, however, be 1325 L/min (350 gal/min). The AY-Farm operator strives to maintain the resulting supernate level in Tank 241-AY-102 by controlling the sluice pump speed.

2.5.2.3.2 Routine Sluicing. During the run-hold cycle, the pumps are allowed to run for a period defined by both mass transfer and time limits, which will be provided by Process Engineering. The sluice batch time limit is determined from the uncertainties in the waste characterization and the measurement accuracy of the coriolis mass flowmeter. The interpretation of the time limit is that solid particles could be transferred at a rate equal to 30.48 cm (1 ft) of Tank 241-C-106 sludge over the defined time period, even if the mass flow meter indicated no solids were being transferred. Any indication of particulate solids transfer then reduces the remaining allowed amount of pump run time proportional to the ratio of the measured particulate solids transfer to the particulate solids transfer limit.

At the end of the sluicing batch, the hold period begins to allow data collection and analysis. One primary goal of the hold period is to obtain verification of the mass of solids transferred to Tank 241-AY-102. Three days are allowed to pass so that a clean interface can be established between the settling solids and the supernate in Tank 241-AY-102. The three-day period is chosen to ensure that a clean sludge/supernate interface has formed in Tank 241-AY-102. The ENRAF densitometer in Tank 241-AY-102 is used to obtain two key pieces of information: the density of the clarified supernate and the level of the settled solids (sludge)/supernate interface. If a settled solids bed with sufficient mechanical strength or density to support the ENRAF displacer has not formed, the density of the settling slurry can be measured, and this information can also be used to help estimate the mass of sludge transferred. Thereafter, the depth of the interface, or the density of the settling slurry, can be measured at a desired frequency to see if the waste solids continue to settle. The frequency will have to balance the need for information with the concern of excavating a depression in the solids bed, thus compromising the accuracy of the interface measurement (HNF-SD-WM-RPT-293, *Repository of Not Readily Available Documents for Project W-320*).

During sluicing operations, the sluicer can be controlled either semi-automatically or manually to reduce the solids level throughout the tank as evenly as possible, except for a 1.52 m (5 ft) wide ring of solids against the tank wall. The retrieval activities are accomplished in a series of 0.3 m (1 ft) waste increments. The first two retrieval increments will be

accomplished while maintaining a constant liquid level over the Tank 241-C-106 sludge to minimize the potential for a steam release event that might occur because of any abrupt reductions in hydrostatic pressure on the hotter waste deep in the sludge. The sluicer is used to wash the solids toward the slurry pump suction.

After completion of the first sluicing campaign, when the initial two feet of sludge are removed and the hold periods are satisfied, the volume of supernate in Tank 241-C-106 is minimized for tank leakage considerations and to maximize sluicing efficiency. This is controlled by using submersible slurry pump position indication and the integral level detectors on the pump. The in-tank imaging system may also be used to monitor liquid volume present in the tank. Operation of the sluicer is based on nozzle position information obtained from the sluicer drive position indication system. If fogging does not restrict viewing, the in-tank imaging system is used to help control the sluicer, thereby enhancing sluicing efficiency. During sluicing shutdown periods after the initial two feet of solids removal, the in-tank imaging system is used to identify zones of solids that need to be sluiced.

The duration of the sluicing batch will be limited to provide assurance that excess solids are not unintentionally transferred to Tank 241-AY-102. In addition, measurements on tank temperatures and liquid levels are obtained to determine the amount of sludge transferred. Process control information needs are addressed in the process control plan.

In the event that a solids level reduction assessment can not be accomplished using the in-tank CCTV system in a real-time mode, more frequent (potentially once a shift) temporary shutdowns may be used to allow defogging of the tank to support visual progress assessments.

If pieces of solids (broken-up crust or hard pan materials) too large to pass through the slurry pump inlet screen accumulate at the slurry pump inlet partially or completely plugging the inlet screen, the slurry pump can be temporarily shut down, and the chunks can be sluiced away from the pump intake by directing the sluice stream to agitate this area. In addition, line drainage through the submersible slurry pump will also tend to flush material away from the inlet screen.

2.5.2.3.3 Sluicing Shutdown. For controlled sluicing shutdown operations, the shutdown will be controlled to produce the desired liquid level in Tank 241-C-106. In addition, the pump height or sluicer aiming will be adjusted to reduce the solids loading in the slurry line when the pump is shut down.

To shut down the WRSS, it is desired to minimize the slurry concentration in the slurry transfer line, thus minimizing the amount of solids that may settle out in the line. The sluicer and slurry booster pump will be positioned to control the slurry concentration so that when the transfer lines drain following WRSS shutdowns, only a minimal amount of solids will have settled in the pipe. Water flushing is needed only if the shutdown is known to be of significant duration, such as at the completion of the transfer of a 30.48 cm (1-ft) sluicing increment. Water flushing will not normally be required following shutdown of the system at the completion of a sluicing

batch, because a water flushing operation would take longer than a verification of the mass of sludge transferred during that batch. In this case, the small amount of sludge that settles out in the pipes should be resuspended when the system starts back up because the shutdown duration is not long enough for the settled solids to dry out or cause a significant flammable gas concentration to build up in the pipe.

Flushing water is tapped into the slurry and supernate transfer lines via jumpers in pit 241-AY-02A at Tank 241-AY-102. After flushing, the water remaining in the transfer lines drains back through the lines to 241-C-106 by gravity.

2.5.2.3.4 Tank 241-C-106 Sluicing Completion Evaluation and Post-Sluicing Operations. Determination of the end point for the sluicing operation would depend on performance of a thermal analysis to verify the amount of heat generating material remaining in Tank 241-C-106. An evaluation of whether enough heat generating material has been removed from Tank 241-C-106 is performed in either of the following cases.

CASE 1: The maximum feasible waste recovery has been achieved.

CASE 2: Sluicing operations are stopped for an extended period after the material balance procedure indicates that an adequate volume of heat-generating solids have been removed from the tank to allow it to be stabilized (i.e., less than 18,900 L [5000 gal] supernate and less than 189,000 L [50,000 gal] interstitial liquid).

The evaluation involves maintaining the remaining waste in a wet condition while monitoring the in-tank temperature trends. The temperature data thus generated would then be used to develop an estimate of the remaining heat load in the tank.

This project is designed to lower the heat output of the remaining waste to less than 11.7 kW (40,000 Btu/h), and if required to meet temperature limits to remove as much waste as possible beyond that to demonstrate a waste retrieval technology. The volume of waste removed from the tank may have to be limited for either thermal or flammable gas considerations applicable to the receiving tank. At the end of sluicing operations, however, a 0.3 to 0.6 m (1 to 2 ft) layer of hardened waste may remain. This hardened layer, if not removed during the sluicing operation, would be removed by a different technology which is under development as part of a separate project. In the interim, between the conclusion of the proposed action and the initiation of this future retrieval action, the hardened layer would be monitored and treated (removing any potential excess heat by using air chillers and sprinkler systems), if necessary depending on the heat load, to prevent overheating the tank or keep the waste from drying out.

2.5.2.3.5 Tank AY-102 Supernate Removal Contingency Plan. If implemented, the supernate removal contingency pumping plan uses the existing Tank 241-AY-102 sluice pump system and Tank 241-C-106 slurry pump system in combination to transfer excess Tank 241-AY-102 supernate first into Tank 241-C-106 and subsequently on to the selected receiver tank. Tanks 241-AP-104, 241-AP-106 or 241-AP-107 have been identified as candidate

receivers. A jumper connecting the U11 nozzle (SL100) slurry line to the U3 (SL-503) transfer line in the 02A pit will be available for installation, if required, to support this contingency transfer plan (LA-UR-97-1330).

2.5.2.3.6 Tank 241-C-106 Tank Leak Contingency Plan. In the event of a leak (confirmed through verification of material balance calculations) in Tank 241-C-106 at or above the minimum detectable level of 30,000 L (8000 gal), the following actions would be taken to place the tank in the safest possible condition while follow-on actions are determined in consultation with the U.S. Department of Energy, Richland Operations Office (DOE-RL) and Ecology.

- Stop sluicing retrieval, pending consultation with DOE-RL and Ecology.
- Minimize liquid level within liquid level limitations.
- Maintain evaporative cooling by wetting the waste surface, pending a thermal determination of the need to continue this practice.
- Determine if leak has stopped (by liquid level monitoring).

If the leak has stopped, estimate the amount of leakage from the tank, evaluate consequences of the leaked volume, make appropriate reports, consult with DOE-RL and Ecology to make recommendations to continue the retrieval, and maintain the liquid level below that of the leak site if possible.

If the leak has not stopped, perform periodic wetting of the sludge using the sluicer or other means deemed as appropriate (maintaining minimum liquid inventory in Tank 241-C-106 to keep the sludge wet), evaluate consequences of the leaked volume, make appropriate reports, and perform a thermal analysis to support a decision to continue or stop sluicing retrieval in consultation with DOE-RL and Ecology. It is desirable from an overall risk perspective to remove as much material as possible from Tank 241-C-106 to maintain the post-sluicing temperatures below saturation. Depending on the temperature conditions in the tank, the 296-P-16 exhauster and inlet chiller (subcooling system) may also be reactivated.

2.5.2.3.7 Transfer Line Unplugging Contingency Plan. In the unlikely event that the design features and operating process controls do not prevent a line plug, the following graded approach will be used until the plug is relieved. Design features which minimize the potential for plugging have been incorporated and include 1) a robust pumping system able to maintain turbulent flow, 2) use of long-radius elbows in the buried transfer lines, 3) a transfer line flushing system, and 4) free draining process piping.

1. At the Tank 241-AY-102 end the cover block plug over the flush connection nozzle will be removed and the flush adapter installed. Pressurized hot water (within the lines, allowable pressure is 2206 kPa [320 psig]) is used to remove the plug.

2. If Step 1 is unsuccessful, the Tank 241-C-106 end pit is opened and the associated jumper is removed. A pressure test jumper is connected to the

plugged transfer line and pressurized hot water (transfer line pressure limit: 2206 kPa [320 psig]) is used to remove the plug. Operational experience with the cross site transfer line has shown this method to be effective in plug removal.

3. If Step 2 is unsuccessful, a commercially available hydrolase system is employed to remove the plug. The hydrolase systems are special, moderate- to high-pressure spray heads attached to a flexible hose. These systems are inserted into the pipeline until the spray head is in contact with the plug material. Water is then forced through the spray head to dislodge and flush the plug solids from the transfer line. Because of the free-draining nature of the hydrolasing process, hydrostatic pressure is built up to the allowable pressure of 2206 kPa (320 psig). The transfer line plugging experience at Hanford has been that plugging develops over time and adequate time is available to take corrective measures to stop the buildup of solids before the line completely plugs.

4. In the event Steps 1 through 3 fail to unplug the line and the line must be replaced, ALARA considerations are assessed. The obstruction is located by performing a gamma assay of the pipeline, and confinement barriers are placed around the area. ALARA and waste containment considerations are assessed again before excavating the berm, cutting and removing the pipeline, and replacing and welding the new pipe section.

To maintain a conservative design basis the project has incorporated features to provide a robust pumping system, monitoring capabilities, and operating plans that can be used to ensure that any solids buildup potentially leading to the plugging of either the slurry or sluice transfer lines is detected in time to allow for corrective action such as process solution flushing. These features are discussed in the following paragraphs.

Transfer Pumps. The first such feature provided by the project is a robust transfer pump having the capability to transfer up to 50 wt% solids and maintain turbulent/transition flow (which minimizes solids settling.

Monitoring Instrumentation. The second plugging-prevention design feature is instrumentation to monitor the pump discharge pressure, flow rate, mass transfer rate, and speed setting (the tandem pump system booster pump has a variable speed drive to support flexibility in responding to varying sluicing operating conditions).

The past slurry transfer operations have shown that the combination of pump discharge pressure and flow rate are the best indicators of impending plugging problems. Monitoring these two parameters during sluicing operations is the primary means of detecting changes that indicate a solids plug is beginning to develop. If these two parameters indicate a solids plug is beginning to develop, proactive corrective actions (such as flushing or increased pump flow rates) may be initiated.

Operating Procedures. The third plugging prevention element consists of the operating procedures for the Tank 241-C-106 tandem slurry pump system which avoid excessive solids loading in the slurry pipeline. This element is

not considered necessary for the Tank 241-AY-102 sluice pump because of the lower solids loading in the sluicing stream. During the startup of the Tank 241-C-106 slurry pump, the following three steps are used to ensure excessive solids are not pumped into the slurry transfer line.

1. The submersible pump is raised so that it pumps from the upper layer of liquid in the tank.

2. The sluice stream entering the tank from Tank 241-AY-102 is directed to stir the area around the submersible pump's intake, thereby diluting the solids entering the pump's intake and ensuring that a high (above 30%) solids level solution is not present at the pump intake.

3. When the tandem pumping system is started or the running submersible pump is lowered (after the first sluicing campaign) to improve solids recovery, the pump discharge pressure and flow rate is continuously monitored until steady conditions have been established. Monitoring is continued periodically after this point throughout the WRSS operation.

Transfer Line Flushing. Process supernate flushing of the slurry line is used on a routine basis to prevent the buildup of solids in the slurry line. In addition, should process monitoring identify the beginning of a solids-buildup problem, one of the two following flushing operations would be undertaken to correct the problem.

Routine Process Solution Flushing. During sluicing operations, whenever a slurry pump shutdown is planned, the submersible slurry pump is raised and the sluicer is aimed to minimize the solids entering the pump intake. Approximately 1325 L/min (350 gal/min) of relatively solids free supernate will then be used to flush out the slurry transfer line. After at least one and a half line volumes of relatively solids-free solution have been transferred, the pumps are shut down.

If the transfer pump shuts down unexpectedly, disallowing the use of process solution flushing, the system is flushed by this same process as soon as the pump can be restarted, generally within the next one to eight hours.

Water Flushing. This flushing option would be used when process data indicate the need for flushing and the routine process solution flush is not possible. It would also be used when jumper change operations are planned and it is necessary to decontaminate the process jumpers to the maximum extent practicable for ALARA reasons.

Both the sluice and slurry transfer lines can be water-flushed from the Tank 241-AY-102 end using flush connections in the sluicing system jumpers located in the 02A (slurry distributor) pit and 02E (sluice pump) pit. A cover block shielding plug is removed from the AY pit cover block using a crane. This allows access to the flushing port blank. The blank is removed and a flushing adapter jumper is attached in its place. Water from a tank

truck is then pumped through the transfer line to achieve the required flush. This nonroutine flushing operation can generally be accomplished within one to two weeks of the identification of the need.

2.5.2.3.8 Tank 241-AY-102 Void Fraction Monitoring Contingency Plan. LA-UR-97-1330 identifies the need for a contingency plan to add void fraction monitoring to Tank 241-AY-102 within two weeks of the identification of the flammable gas buildup that would warrant this monitoring enhancement.

2.5.3 Supporting Operations

2.5.3.1 Sampling. Liquid grab sampling is planned during sluicing operations to provide necessary process control characterization data. This sampling will generally be accomplished through an existing above grade riser at Tank 241-AY-102 using existing sampling procedures.

After every batch sluicing transfer, a liquid grab sample will be taken from Tank 241-AY-102. The following items will be analyzed and reported: bulk density, gravity settled solids density, liquid density, gravity settled solids volume percent, plutonium, hydroxide, nitrates, and nitrites. Thermo-gravimetric analysis, inductively coupled plasma analysis, and radioisotope analysis for Sr-90 and CS-137 results may also be performed. (It should be noted that C-106 solids dissolution by dilute Tank 241-AY-102 supernate may affect the source term. The samples that will be collected and assessed will indicate any such effects. This should have no impact on accident consequences, because a ratio of 33% solids and 67% liquids is used in the spray leak accident analysis.)

Additional sampling requirements may be specified by East Tank Farms Engineering, Environmental Permit/Policy, and Process Engineering.

2.5.3.2 Chemical Additions. The addition of nitrates and/or nitrites maintains tank corrosion specifications. This can be accomplished via additions from a tank truck to either tank or by routing the chemicals into Tank 241-AY-102 through waste transfer lines from the 204-AR Waste Unloading Facility. The supernate in Tank 241-AY-102 will be adjusted to meet double shell tank corrosion specifications before starting sluicing operations (HNF-SD-WM-TI-756).

2.5.3.3 Maintenance and Replacement of Long Length Equipment. The WRSS has been designed and arranged for efficient, cost-effective operation and maintenance, with personnel radiation exposure meeting ALARA principles. Remote maintenance capabilities are provided where required and justified. System designs provide for the safety of maintenance personnel.

2.5.4 Past Practice Sluicing Lessons Learned

Because sluicing was conducted in two distinct phases at separate times in Hanford's history, this discussion of lessons learned is broken down into

1950's and 1970's sections. Lessons learned in the 1950's were incorporated in sluicing operations in the 1970's. The lessons learned during the 1970's have been addressed by design features added to the WRSS.

WHC-SD-WM-TI-302, *Hanford Waste Tank Sluicing History*, discusses the past practice sluicing operations conducted in the 1950's and 1970's. It is the source document for the following summary of lessons learned.

2.5.4.1 1950's Past Practice Sluicing Lessons Learned. As discussed in WHC-SD-WM-TI-302, the problem areas encountered during the 1950's phase of past practice sluicing fell in three areas: 1) multiple pump failures, 2) multiple sluicer hose failures, and 3) a plugged transfer line. Each of these is discussed below.

2.5.4.1.1 Pump Failures. Failures of Nagel sludge pumps occurred frequently during the 1950's campaigns, including C Farm sluicing operations. Fifteen Nagel sludge pumps failed during the sluicing of Tanks 241-C-101 through 241-C-106. Twelve of these failures, however, occurred during the sluicing of the first tank, 241-C-101, indicating that a significant learning curve was achieved on the subsequent sluicing operations.

No specifics were provided on the cause of these pump failures in WHC-SD-WM-TI-302. However, possible causes include the inadequacy of the basic cantilevered pump design employed by the Nagel pumps for slurry service, and operations of the pumps at a too low net positive suction head, potentially causing cavitation and short pump life. Operation of the pumps at low submergence levels would have been used to maximize the sludge recovery.

The fact that the sludge pump design was changed for 1970's sluicing operations and a lack of similar problems during those operations infers that the problem was corrected, though a specific reference is not available. The 1970's slurry pumps were either straight-stick centrifugal or vertical-turbine pumps incorporating long drive shafts between the pump motor located in the process pits on top of the tanks and the impellers located down in the waste in the tanks. The drive shafts were supported by multiple intermediate bearings. This design approach provided a much more robust slurry pump, but did complicate the task of adjusting the height of the pumps. The Nagel pumps had been suspended inside the tank vapor space from chains or flat cables which allowed the height of the intake to be adjusted remotely.

The WRSS slurry and sluice pump systems were specified to ensure a robust design that would withstand the rigors of challenging slurry service conditions. The pump specification, HWS-9090, for the most successful of the 1970's slurry pumps, the P-200 Barrett, Haentjens & Co. slurry pump, was used as a starting point for the project WRSS slurry and sluice pump specification. Most of the applicable design requirements of the 1970's sluice and slurry pumps have been retained for the new sluice/slurry pump systems.
A submersible pump was specified to allow use of the remote height adjustment feature used in the 1950's. The new pump systems are more complex than either the 1950's or 1970's systems because of the need for a higher pump pressure caused by the longer transfer routes, necessitating the need for a booster pump in each system.

2.5.4.1.2 Sluicer Failures. A single sluicer hose failure was reported during the 1950's C Farm sluicing operations. A number of similar failures were also reported for sluicing in other farms during the 1950's. WHC-SD-WM-TI-302 indicates that this was corrected by installing a hose rated for a higher operating pressure.

2.5.4.1.3 Line Plugging. Transfer line plugging has been identified as a potential operational concern. Slurry pumping experience over the years at the Hanford Site indicates that a transfer line plug during sluicing operations is very unlikely. This experience includes the sluicing of 53 SSTs using past practice sluicing technology. Only a single line-plugging event was recorded during these operations, and the line involved was a sluice line, not the higher-solids slurry line.

However, to provide a robust sluicing system, design features have been incorporated into the WRSS to minimize the potential for line plugging and to allow for flushing of both the transfer lines. Design features which minimize the potential for plugging include 1) a robust pumping system able to maintain turbulent flow, 2) use of long-radius elbows in the buried transfer lines, 3) a transfer line flushing system, and 4) free draining process piping.

2.5.4.2 1970's Past Practice Sluicing Lessons Learned. WHC-SD-WM-TI-302 also discusses the sluicing operations conducted in the late 1960's and 1970's (referred to here collectively as 1970's sluicing). The problem areas encountered during these sluicing operations included: (1) sluicer hose failures, (2) extended sluicing status evaluation times, and (3) slurry pump height adjustment delays. Each of these problem areas is discussed below.

2.5.4.2.1 Sluicer Hose Failures. Sluicer hose failures were again encountered during the early parts of the 1970's sluicing operations. One or more alternative hoses were tested in operations and the final selection, Gates 18MB air drill (wire braid) hose, proved satisfactory in overcoming these problems. The new sluicer is an improved stainless steel version of the 1970's sluicers. It also uses a high-pressure rated hose 5515.81 kPa (800 psi).

The hose selected for use in the WRSS is the Gates Food Master (Specification 3132C). This hose is made of radiation-tolerant materials capable of handling radiation doses far above those anticipated during the operational life of the WRSS. The working pressure rating for this hose is well above the sluicing system operating pressure and its bend radius characteristics are superior to those of the Gates 18MB hose used in the successful 1970's sluicers.

2.5.4.2.2 Extended Sluicing Status Evaluation Time. Evaluation of the progress and completion status of sluicing operations took much too long to effectively support the operations of processing programs that depended on the sluicing program for feed stock (i.e., B Plant Strontium recovery operations).

The evaluation of sluicing progress status was accomplished by pumping the sluice tank to minimum liquid level and assuming the liquid level rise in

the receiver tank was the result of transferred solids. This technique provided no information useful in determining where next to direct the sluice stream in the tank.

Two additional techniques were available to process engineering to help provide information to direct subsequent sluicing operations. The first was gamma monitoring instrumentation installed on the slurry transfer line. Higher gamma reading from this instrumentation was used to indicate that sludge recovery was occurring. This technique had two drawbacks. The first and most obvious was that it provided only after-the-fact information, i.e., it couldn't be used to determine in advance where to sluice to achieve effective solids recovery. The second drawback was that no correlation between the radiation reading and the actual volumes of sludge being recovered existed.

The second and most informative of the sluicing progress assessment techniques was in-tank photographs. Use of this technique was, however, minimized because of its impact on the sluicing schedule and increased cost.

The process of taking photographs in the tank began by increasing the air flow through the tank by opening a riser on the tank to be photographed. This was necessary to remove fog and sluicing-generated vapors that would have otherwise obscured details in any photos taken inside the tank. The duration of the venting of the tank varied greatly depending on the time of year. In hot or warm weather, fog could be cleared in a day or two. In cold weather, as much as a week or more was required.

The photographs were then taken and developed overnight. The resulting group of 24 photographs was then hand assembled into a mosaic of the tank's interior to support interpretation of the sluicing progress status. This normally took approximately one half day.

The overall process, therefore, took between three days and a week and a half. This duration was frequently affected by unacceptably hazy photographic results, i.e., it was sometimes difficult to determine by looking down a tank riser if the tank had adequately defogged.

Because some of these sluicing operations supported and were closely coupled to the much more costly strontium recovery operations at B Plant, the duration uncertainties associated with these progress evaluations received a great deal of management attention and were considered an area in which the sluicing program needed to improve its performance. The CCTV system is designed to operate successfully in the misty, dirty tank vapor environment anticipated to be present in Tank 241-C-106 during sluicing operations. It includes provision for gas purging of the CCTV viewing lens and water flushing of both the viewing and light element lenses. The water-flushing feature was added to the system based on the results of one-quarter scale simulant testing conducted for project WRSS by the Pacific Northwest National Laboratory. The Tank 241-C-106 HVAC system also includes a provision to support in-tank viewing CCTV system. This feature is an air-recirculation loop heater designed to reheat the air being returned to the tank to avoid fogging that would obscure the tank interior.

The addition of the in-tank imaging capability to Tank 241-C-106 by the WRSS is intended to resolve this shortcoming in past practice sluicing. The design also resolved the pump height adjustment delays experienced in the 1970's sluicing program by allowing remote pump intake level height adjustments. The adjustable height design draws heavily from the successful 1950's sluicing adjustable height pump design.

2.5.4.2.3 Slurry Pump Height Adjustment Delays. The use of straight-stick pumps rather than adjustable-length pumps resulted in the need to occasionally adjust the height of the pump intake. To accomplish this adjustment, sluicing had to be stopped, thereby affecting the duration of sluicing operations.

During the initial installation of the slurry pumps, the pumps were backflushed into the waste solids in the tank until the downward movement of the pumps stopped. This usually occurred before the pump mounting flange had mated with the associated riser flange. The distance between the flanges was measured and a two-part spool piece, slightly taller than this measurement, was fabricated on a priority basis. The pump was then raised with a crane, the halves of the spool piece were slipped into place, the pump was set on the spool, and the pump discharge jumper installed. This process required a minimum of two days and up to a week or more depending on the wind conditions present (open pit operations could not be conducted with wind speeds above 12 mph at that time). Because the wind was the major contributor to the duration uncertainty, the duration could not be accurately predicted in advance.

Because some of these sluicing operations supported and were close-coupled to the much more costly strontium recovery operations at B Plant, the duration uncertainties associated with pump height adjustments received a great deal of attention and were considered a point where the sluicing program needed to improve its performance. The sluice/slurry pump system resolved the pump height adjustment delays experienced in the 1970's sluicing program by allowing remote pump intake level height adjustments. The adjustable height design draws heavily from the successful 1950's sluicing adjustable height pump design.

2.5.5 Chemical Compatibility

In addition to completing the compatibility evaluations required by TWRS operating procedures, additional laboratory work was performed. In the experimental procedure described in HNF-SD-WM-TI-756, a sample of Tank 241-AY-102 supernate was mixed with a sample of Tank 241-C-106 sludge. No unusual behaviors were noted; and most importantly no exotherm was noted for the combined solution, indicating that the energetics of the mixture are not reactive. This result is consistent with the expectations based on the chemical composition of the sludge in Tank 241-C-106 and the supernate in Tank 241-AY-102. The major chemical species in the solid phase of the Tank 241-C-106 sludge are sodium aluminum silicates, iron hydroxide, sodium bicarbonate and carbonate, sodium oxalate and aluminum hydroxide (HNF-SD-WM-TI-756, Table 8-1). Of these species, only the sodium bicarbonate/carbonate is anticipated to dissolve in the Tank 241-AY-102

supernate and the dissolution releases a small amount of energy in comparison to the heat capacity of the water present (HNF-SD-WM-TI-756, Appendix A.10). In another experimental procedure described in PNNL-11381, *Washing and Caustic Leaching of Hanford Tank C-106 Sludge*, a sludge sample from Tank 241-C-106 was subjected to washing and caustic leaching. During the washing tests, approximately 25% by weight of the solid was dissolved, while in the more aggressive leaching tests 38% by weight of the solid dissolved. The strontium showed no tendency to dissolve in either test while cesium dissolution ranged from 40 to 60%. The transuranic elements showed no tendency to dissolve in either the 0.01 M NaOH wash or the 3 M NaOH leach. These experiments confirmed the chemical behavior described in the criticality safety evaluation for the project (HNF-SD-W320-CSA-001, *Criticality Safety Assessment for Tank 241-C-106 Remediation*), which concluded that plutonium will remain bound with the neutron absorbers in a predominantly agglomerated form, provided the pH remains alkaline.

2.6 SAFETY SUPPORT SYSTEMS

This section provides detailed descriptions of the relevant Tank 241-C-106 and Tank 241-AY-102 safety support systems and equipment in their respective tank farms. These safety support systems consist of indicators, controls/control systems and interlocks.

2.6.1 Fire Protection Systems

A fire protection system includes detection, alarm, and suppression elements. Most of the hydrants are fed from raw water systems. Portable fire extinguishers are in each of the tank farm control stations located at the edge of each tank farm.

2.6.2 Ventilation Exhaust Radiation Monitoring System

The ventilation exhaust radiation monitoring system consists of a continuous air monitor and a record sampler that provides continuous radiation monitoring of the ventilation exhaust. The ventilation exhaust radiation monitoring systems are able to detect and limit a radioactive aerosol leak, resulting from an unfiltered release of the exhaust gases to the environment, by initiating a shutdown of the exhaust system.

Continuous stack air monitors sample and monitor air for the presence of radionuclides in areas of potential airborne radioactivity. The continuous air monitors are located on the exhaust stacks of the primary and alternate/backup ventilation systems for both Tanks 241-AY-102 and 241-C-106.

2.6.3 WRSS System Interlocks

The interlocks utilized by the WRSS are listed in Tables 2-3 through 2-7.

2.6.4 System Controller and Interlocks

The ventilation system controller provides and performs the following functions:

- Differential pressure indication and alarm for process-related HEPA filtration units
- Tank vacuum monitoring and control system capable of fan speed adjustments and/or ventilation system shutdown upon tank ventilation system failure
- Isokinetic monitoring station at ventilation exhaust stack to monitor radiation emissions
- Emissions monitoring at ventilation exhaust stack to meet the requirements of 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities."

Interlocks shut down the exhaust fan or prevent its operation when an exhaust high-radiation condition is detected by the ventilation exhaust radiation monitoring system (Table 2-4).

2.7 UTILITY DISTRIBUTION SYSTEMS

Tank 241-AY-102 is supported by buildings, systems, and components located in the AY Tank Farm, and served by utility systems that provide electrical power, process and instrument air, and cooling water.

Tank 241-C-106 is supported by trailers, systems, and components located in the C Tank Farm and served by utility systems that provide electrical power, 241-raw water, compressed air, and sanitary facilities.

2.7.1 Process and Instrument Air

The Tank 241-AY-102 compressed air system supplies instrument air to the primary tank and annulus ventilation systems and to the ALCs, which will not be operated during the retrieval activities. There are 22 independently controlled ALCs installed in Tank 241-AY-102.

2.7.2 Electrical Power

Power from the Hanford Site power grid is provided from existing 13.8 kV pole line C8-L6 (See Section 2.4.2.1 for a more complete discussion).

2.7.3 Water Supply

All water for the 200 East Area is supplied from the Hanford Site export water system and is distributed throughout the area in the raw water system and the sanitary water system. This treated water is supplied from the 200 Area power plants and is transported by tanker truck.

2.7.4 Compressed Air System

The compressed air system installed as part of the Project W-320 WRSS at the 241-C Tank Farm will be used. A dedicated compressed air system is provided (see Section 2.4.2.2 for a more complete discussion).

2.8 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

No systems or facilities other than those described in the previous sections were identified as requiring descriptions in this document.

2.9 REFERENCES

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Table 2-1. Tank 241-C-106 Existing Instrumentation Signals.

Instrument tag number	Description	Indication and/or alarm (CASS, TMAC)
TE-106-14-1 through TE-106-14-6, and TE-106-14-8	Riser "R-14" temperature sensors	X
TE-106-8-1 through TE-106-8-6	Riser "R-8" temperature sensors	X
WST-LIT-1306	ENRAF level detector	X

X = Indicates application or use.
NOTE: ENRAF is a trademark of the ENRAF Corporation.

Table 2-2. Tank 241-AY-102 Existing Instrumentation Signals.

Instrument tag number	Description	Indication and/or alarm (CASS, TMAC)	Control station alarm
WFT-102-1	Leak detection pit 102A weight factor sensor	X	
TE-102-28	Leak detection pit 102A temperature sensor	X	
RE-102	Leak detector pit 102A radiation sensor	X	
PAS-102-1	AY-102 high pressure (low vacuum) alarm switch	X	X
PAS-102-2	AY-102 low pressure (high vacuum) alarm switch	X	X
TE-102-38 through TE-102-59	R-2 riser temperature sensors	X	
TE-102-60 through TE-102-71	R-13 riser temperature sensors	X	
TE-102-72 through TE-102-74	R-15 riser temperature sensors	X	
LLAS-102-1	241-AY-102 liquid level high alarm switch	X	X
LDS-102-32	Sluice pit 241-AY-02E leak detector switch	X	X
LDS-102-22A	Pump pit 241-AY-02A leak detector switch	X	X
LIT-102-AY	241-AY-102 level transmitter	X	
TE-102-82 through TE-102-93	241-AY-102 dome temperature sensors	X	
TE-102-26 and TE-102-27	241-AY-102 primary tank wall temperature sensors	X	
TE-102-1 through TE-102-25	241-AY-102 primary tank floor temperature sensors	X	
TE-102-29 through TE-102-37	241-AY-102 secondary tank concrete temperature sensors	X	

X = Indicates application or use.
DACS = Digital Alarm Control System.

Table 2-3. C-Farm Ventilation System Interlocks.

Event	Sensing device	Interlock action
High differential pressure across both exhaust HEPA filters, HEP-1361 and HEP-1362	1) PDISH-13620 & KY-13620 (30 second timer)	1) High Differential Pressure (-5 W.C.) Across HEPAs HEP-1361 & HEP-1362 starts timer KY-13620, 30 seconds later Exhaust Fan (FN-1362) is shut down.
High Radiation	2) RSH-1363 (KY-13531A), High Radiation	2) High radiation in the exhaust stack Air Monitor system shuts down Exhaust Fan (FN-1362).
Excess Tank Dome space Vacuum	3) PSH-1361, Excess Vacuum	3) Excess vacuum shuts down Exhaust Fan (FN-1362).
Exhaust Fan (FN-1362) not operating	4) Fan Motor Contactor Auxiliary Contact	4) Exhaust Fan (FN-1362) is interlocked with Stack Air Monitor Vacuum Pumps. An auxiliary contact on the Fan contactor interlocks the fan with the vacuum pumps. The Exhaust Fan must be operating before Air Monitor Vacuum pumps can be turned on.
Exhaust Fan (FN-1362) not operating	5) Fan Motor Contactor Auxiliary Contact	5) Exhaust Fan (FN-1362) is interlocked with Exhaust Heater (HC-1362). An auxiliary contact on the Fan contactor interlocks the fan with the heater.
Recirculating Fan (FN-1361)	1) Fan Motor Contactor Auxiliary Contact	1) Recirculating Fan (FN-1361) is interlocked with Recirculating Heater (HC-1361). An auxiliary contact on the Fan contactor interlocks the fan with the heater.
Primary Chilled Water Circulation Pump (P-1364)	Pressure Switch PSL-13610	Low pressure shuts down primary pump (P-1364) and starts stand by pump (P-1365).
Chiller System	Flow Switch FSLL-1364	Chiller system shuts down on low flow.

HEPA = high-efficiency particulate air (filter).
HVAC = heating, ventilating, and air conditioning.
VERMS = Ventilation Exhaust Radiation Monitoring System

Table 2-4. C-Farm Submersible Pump Shutdown Interlocks.

Event	Sensing device	Interlock action
Submersible Slurry Pump Stator Winding Temperature High	TISHH-13615	Shuts down Submersible Slurry pump.
Submersible Slurry Pump Bearing Temperature #1 High	TISH-13614A	Shuts down Submersible Slurry pump.
Submersible Slurry Pump Bearing Temperature #2 High	TISH-13614B	Shuts down Submersible Slurry pump.
Submersible Slurry Pump Level Detection (Low), 1 Minute Time delay	KY-13645	Shuts down Submersible Slurry pump.
Seismic Sensor Contactor Cabinet, Unit 1361, Temperature High	TSHH-13636	High Temperature opens the contactor supplying power to the Submersible Slurry pump.
Seismic Sensor Contactor Cabinet, Unit 1362, Temperature High	TSHH-13637	High Temperature opens the contactor supplying power to the Submersible Slurry pump.
Seismic Event Sensor (Unit 1361)	ASH-1361A (Transverse) ASH-1361B (Horz.Long.) ASH-1361C (Vertical)	Seismic event opens the contactor supplying power to the Submersible Slurry pump.
Seismic Event Sensor (Unit 1362)	ASH-1362A (Transverse) ASH-1362B (Horz.Long.) ASH-1362C (Vertical)	Seismic event opens the contactor supplying power to the Submersible Slurry pump.

Table 2-5. C-Farm Booster Pump Shutdown Interlocks.

Event	Sensing device	Interlock action
Pump Bearing #1 Temperature High	TSH-1363A	Shuts down Slurry Booster pump.
Pump Bearing #2 Temperature High	TSH-1363B	Shuts down Slurry Booster pump.
Stator Winding Temperature High	TSHH-1364	Shuts down Slurry Booster pump.
Pump Suction Pressure Low	PISL-1363/KY-13632	Low pressure starts timing relay KY-13632, after a time delay, (1-60 seconds) the Slurry Booster Pump shuts down.
Seismic Sensor Contactor Cabinet, Unit 1361, Temperature High	TSHH-13636	High Temperature opens the contactor supplying power to the Slurry Booster pump.
Seismic Sensor Contactor Cabinet, Unit 1362, Temperature High	TSHH-13637	High Temperature opens the contactor supplying power to the Slurry Booster pump.
Seismic Event Sensor (Unit 1361)	ASH-1361A (Transverse) ASH-1361B (Horz.Long.) ASH-1361C (Vertical)	Seismic event opens the contactor supplying power to the Slurry Booster pump.
Seismic Event Sensor (Unit 1362)	ASH-1362A (Transverse) ASH-1362B (Horz.Long.) ASH-1362C (Vertical)	Seismic event opens the contactor supplying power to the Slurry Booster pump.

Table 2-6. AY-Farm Submersible Pump Shutdown Interlocks.

Event	Sensing device	Interlock action
Submersible Sluice Pump Stator Winding Temperature High	TISHH-0621	Shuts down Submersible Sluice pump.
Submersible Sluice Pump Bearing Temperature #1 High	TISH-0622A	Shuts down Submersible Sluice pump.
Seismic Sensor Contactor Cabinet, Unit 0621, Temperature High	TSHH-06211	High Temperature opens the contactor supplying power to the Submersible Sluice pump.
Seismic Sensor Contactor Cabinet, Unit 0622, Temperature High	TSHH-06212	High Temperature opens the contactor supplying power to the Submersible Sluice pump.
Seismic Event Sensor (Unit 0621)	ASH-0621A (Transverse) ASH-0621B (Horz.Long.) ASH-0621C (Vertical)	Seismic event opens the contactor supplying power to the Submersible Sluice pump.
Seismic Event Sensor (Unit 0622)	ASH-0622A (Transverse) ASH-0622B (Horz.Long.) ASH-0622C (Vertical)	Seismic event opens the contactor supplying power to the Submersible Sluice pump.

Table 2-7. AY-Farm Booster Pump Shutdown Interlocks.

Event	Sensing device	Interlock action
Pump Bearing Temperature #1 High	TSH-06210A	Shuts down Sluice Booster pump.
Pump Bearing Temperature #2 High	TSH-06210B	Shuts down Sluice Booster pump.
Stator Winding Temperature High	TSHH-0629	Shuts down Sluice Booster pump.
Pump Suction Pressure Low	PISL-0621/KY-0621	Low pressure starts timing relay KY-0621, after a time delay, (1-60 seconds) the Sluice Booster Pump shuts down.
Seismic Sensor Contactor Cabinet, Unit 0621, Temperature High	TSHH-06211	High Temperature opens the contactor supplying power to the Sluice Booster pump.
Seismic Sensor Contactor Cabinet, Unit 0622, Temperature High	TSHH-06212	High Temperature opens the contactor supplying power to the Sluice Booster pump.
Seismic Event Sensor (Unit 0621)	ASH-0621A (Transverse) ASH-0621B (Horz.Long.) ASH-0621C (Vertical)	Seismic event opens the contactor supplying power to the Sluice Booster pump.
Seismic Event Sensor (Unit 0622)	ASH-0622A (Transverse) ASH-0622B (Horz.Long.) ASH-0622C (Vertical)	Seismic event opens the contactor supplying power to the Sluice Booster pump.

Figure 2-1. Tank 241-C-106 Waste Retrieval Sluicing System Tank and Transfer Line Arrangement Diagram.

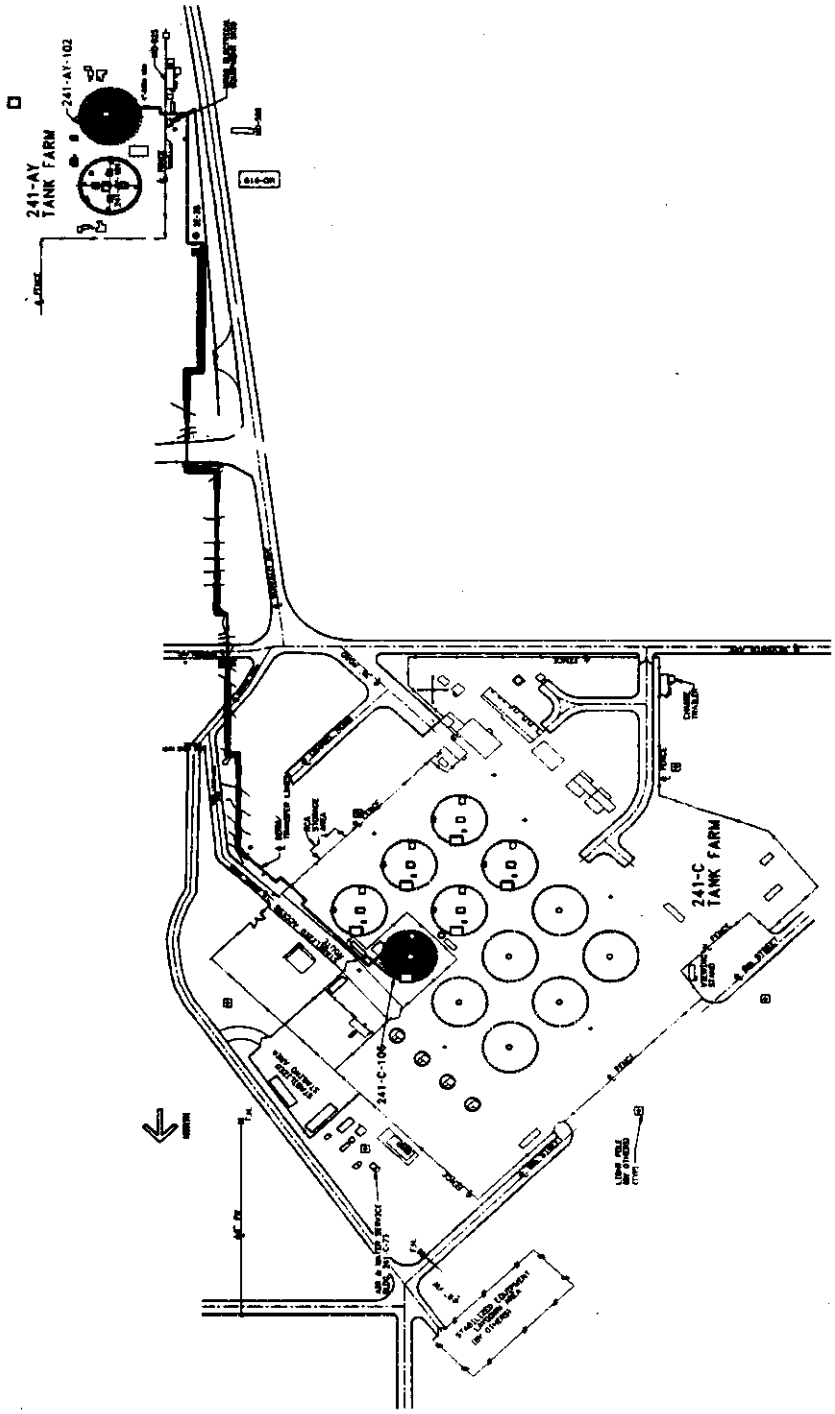


Figure 2-2. Tank 241-C-106 Waste Retrieval Sluicing System Equipment Arrangement.

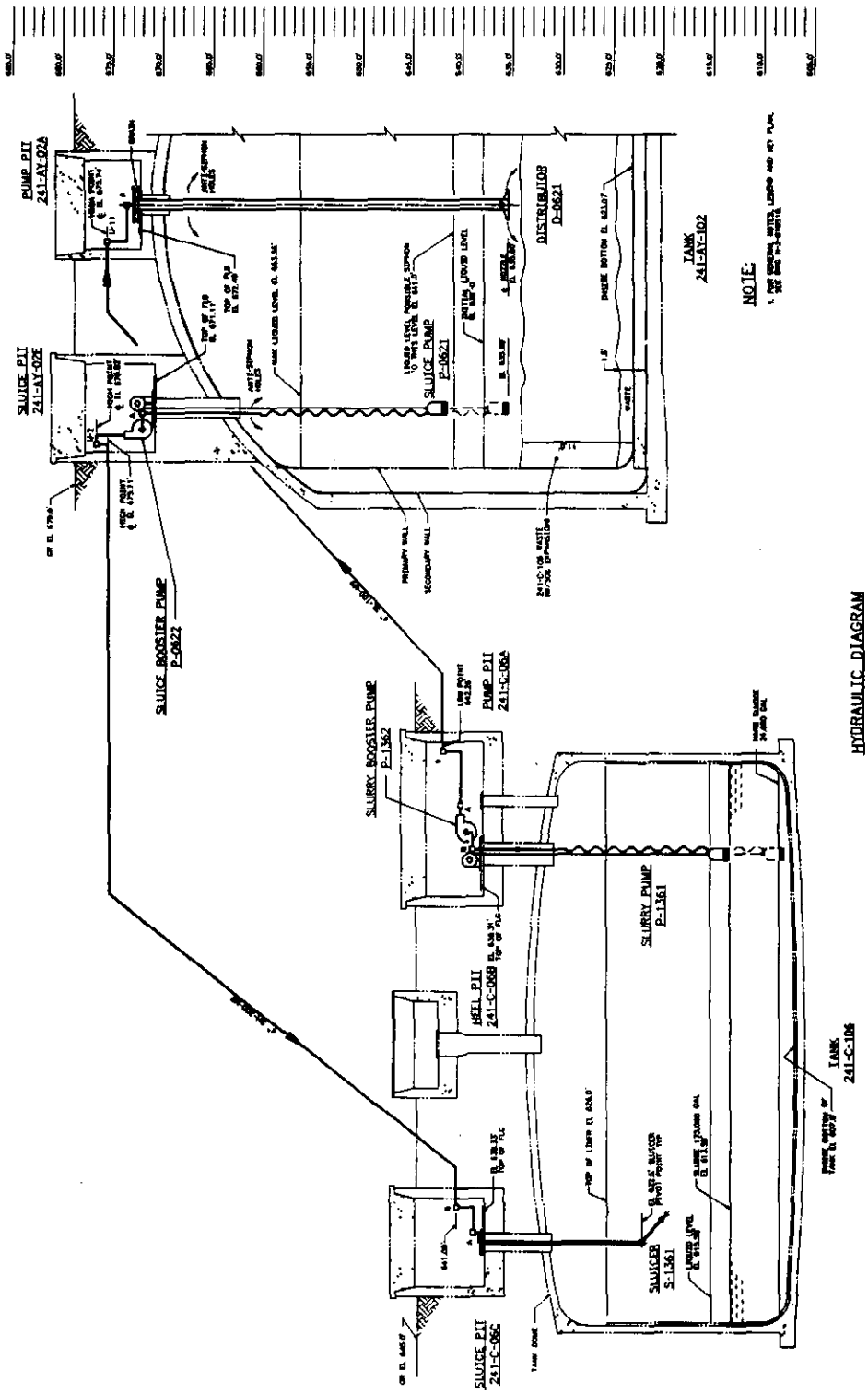
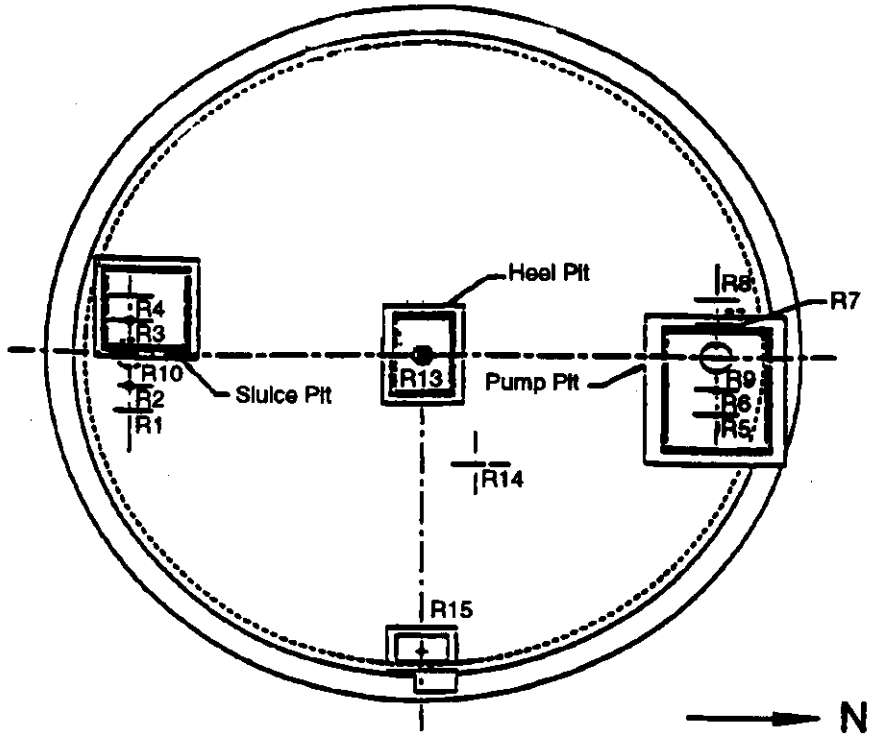


Figure 2-3. Design of Single-shell Tank 241-C-106 (530,000 gal).

Riser	Size
R1	4 in.
R2	12 in.
R3	12 in.
R4	4 in.
R5	4 in.
R6	12 in.
R7	12 in.
R8	4 in.
R9	36 in.
R13	12 in.
R14	4 in.
R15	12 in.



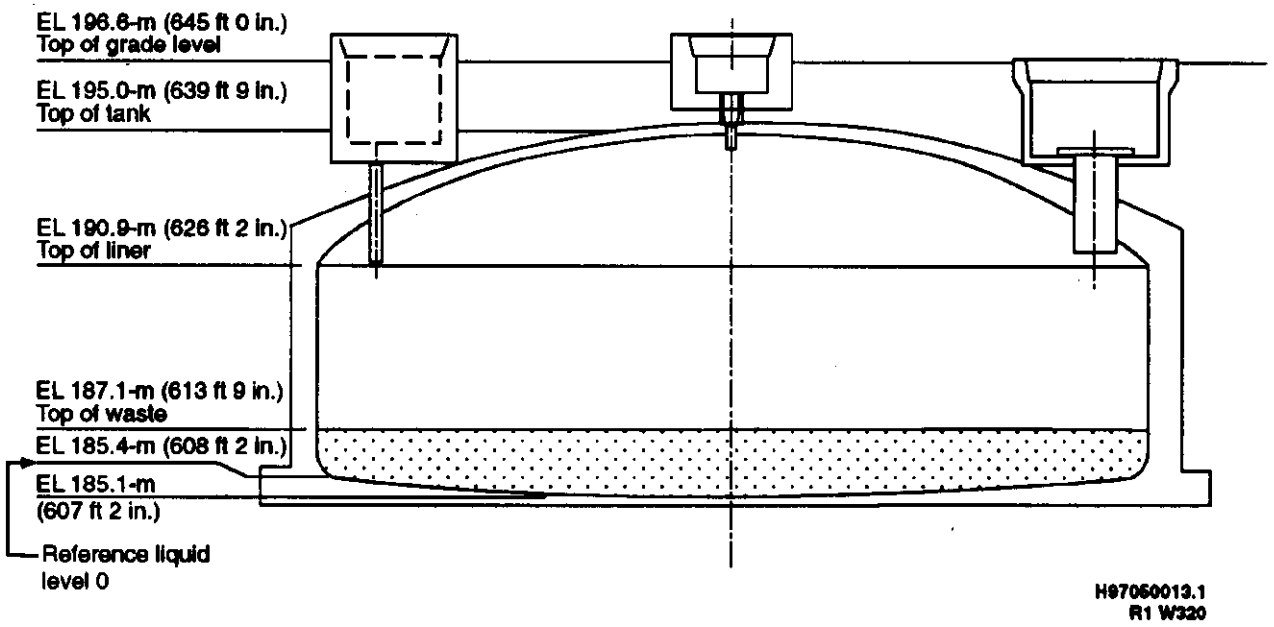


Figure 2-4. Tank 241-C-106 Cross-Sectional View.

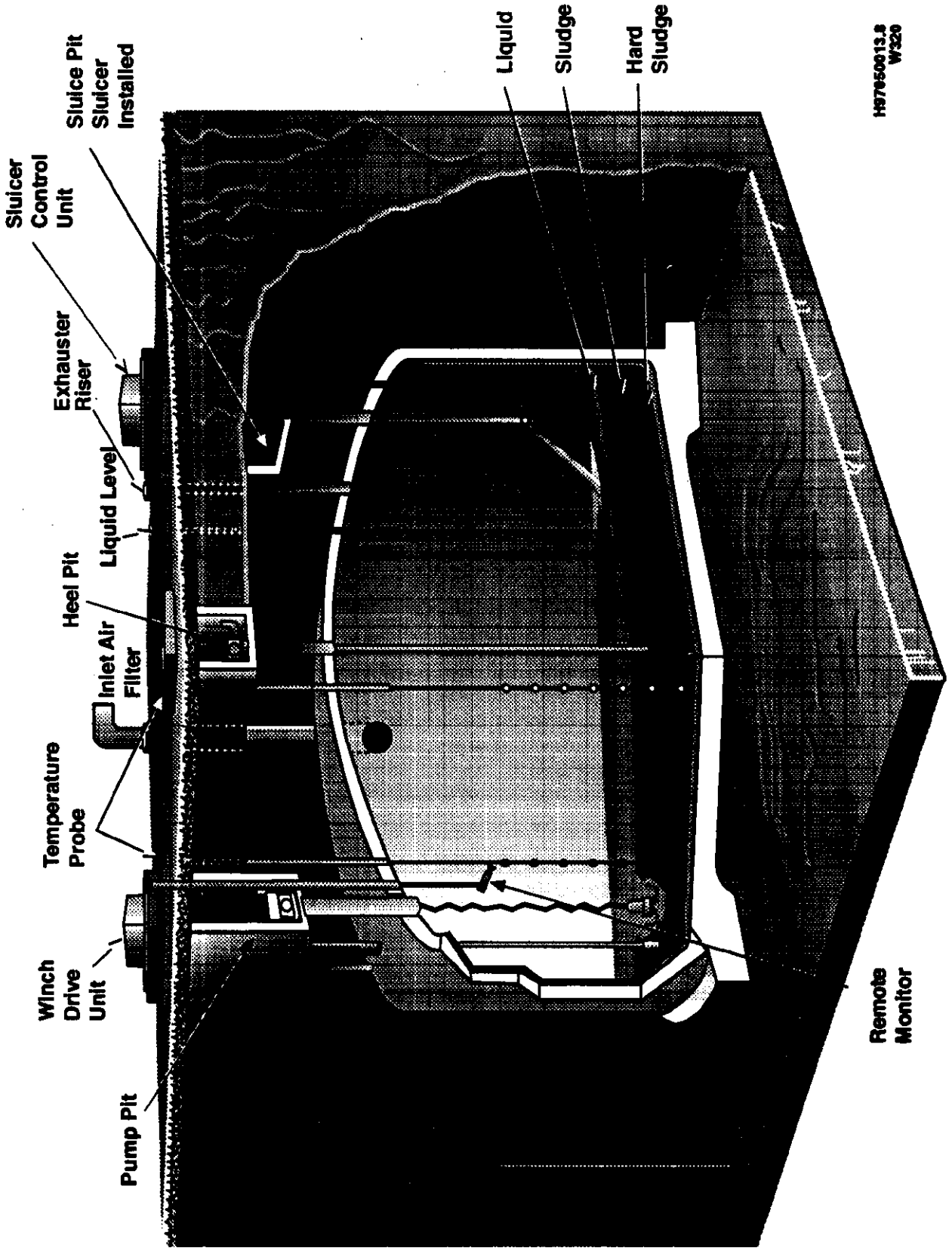


Figure 2-5. Tank 241-C-106 Waste Retrieval Sluicing System Ventilation Flow Diagram.

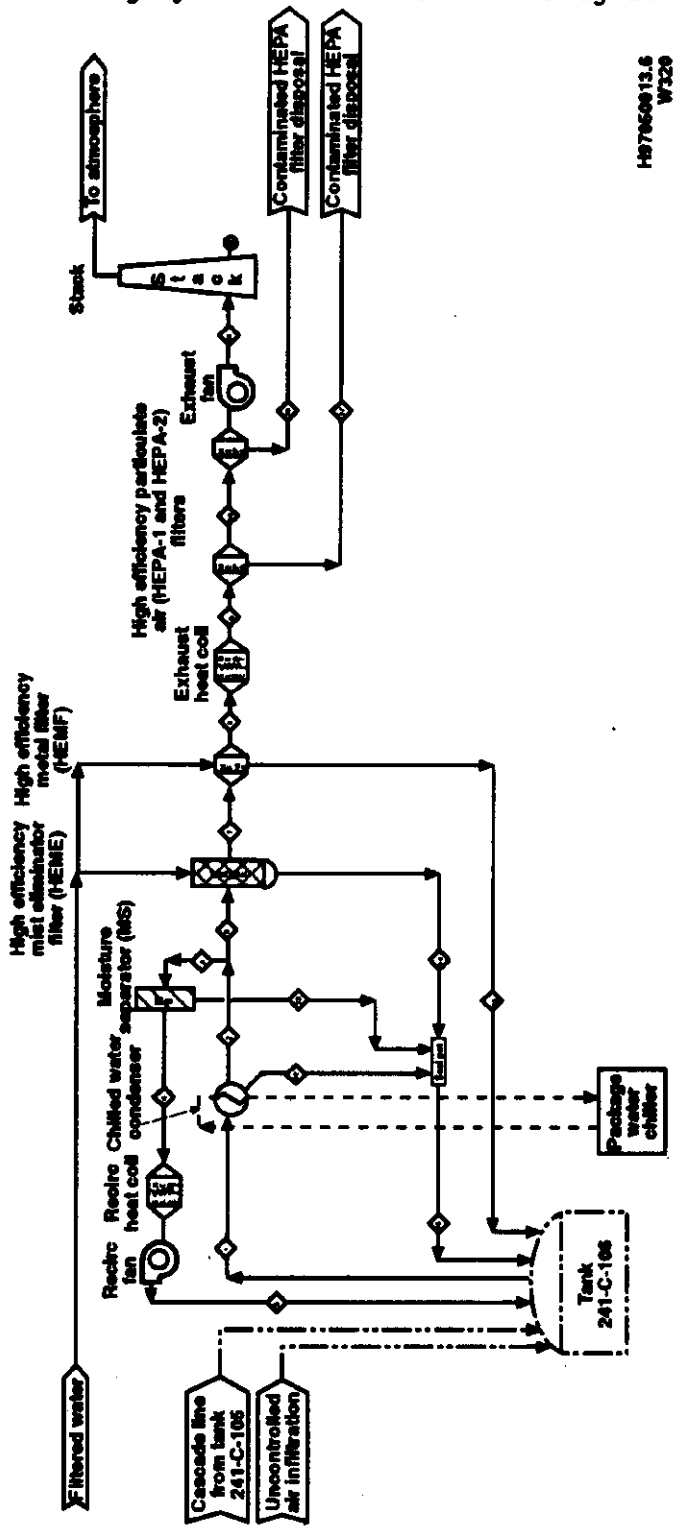


Figure 2-6. Tank 241-AY-102 Cross-Sectional View.

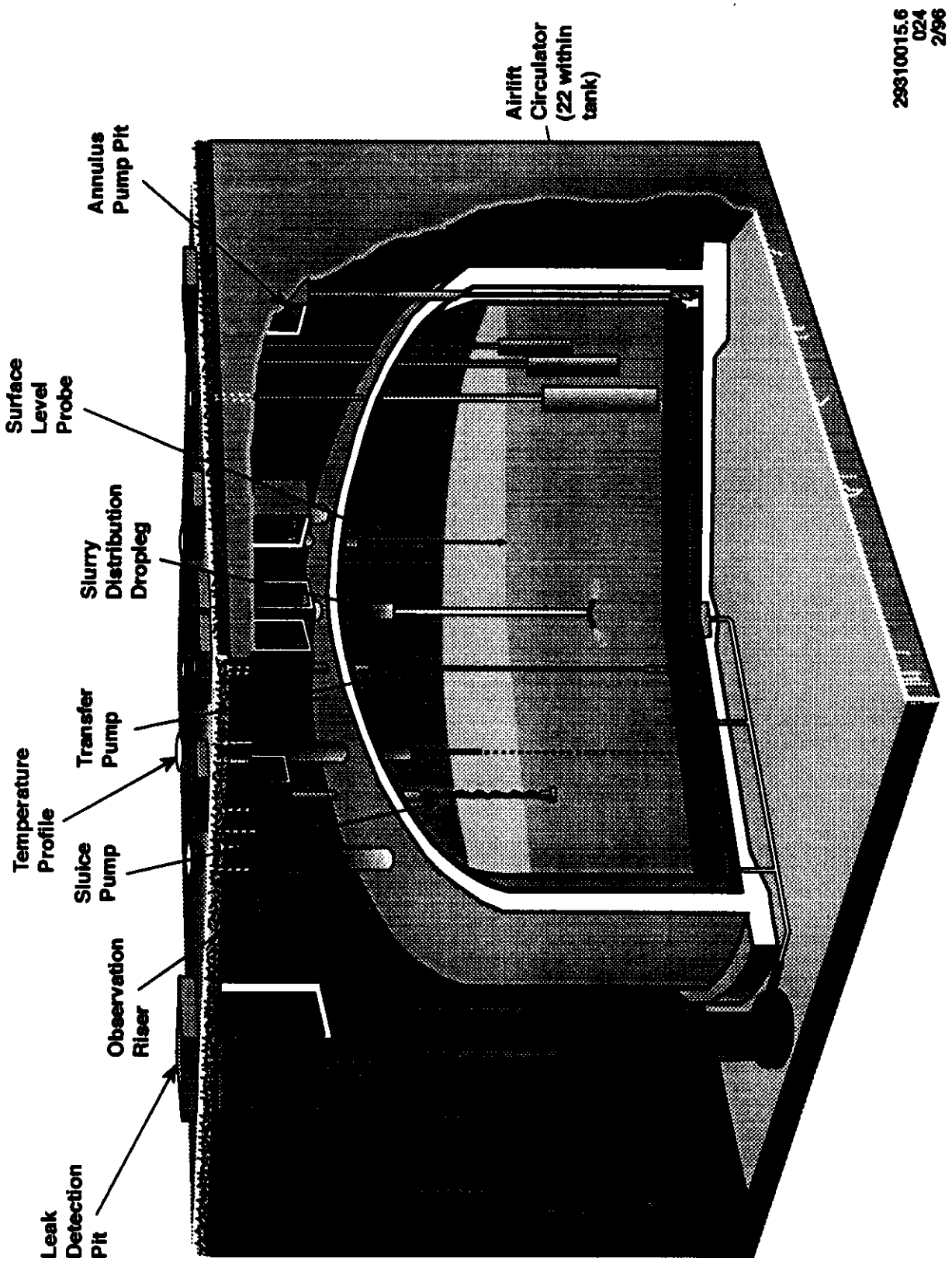


Figure 2-7. Aging Waste Facility Primary and Backup Ventilation System (241-A-702). (Sheet 1 of 2)

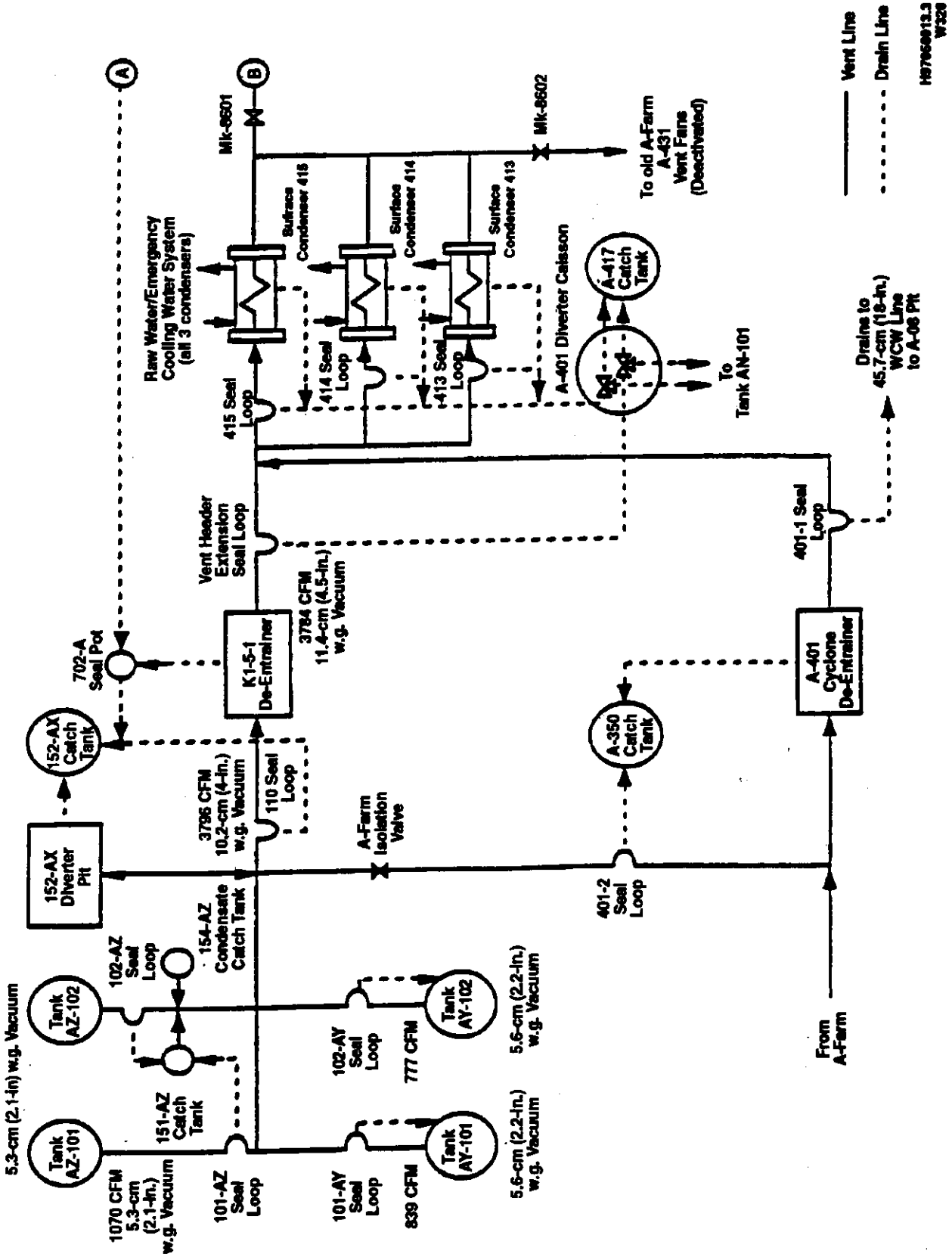


Figure 2-7. Aging Waste Facility Primary and Backup Ventilation System (241-A-702). (Sheet 2 of 2)

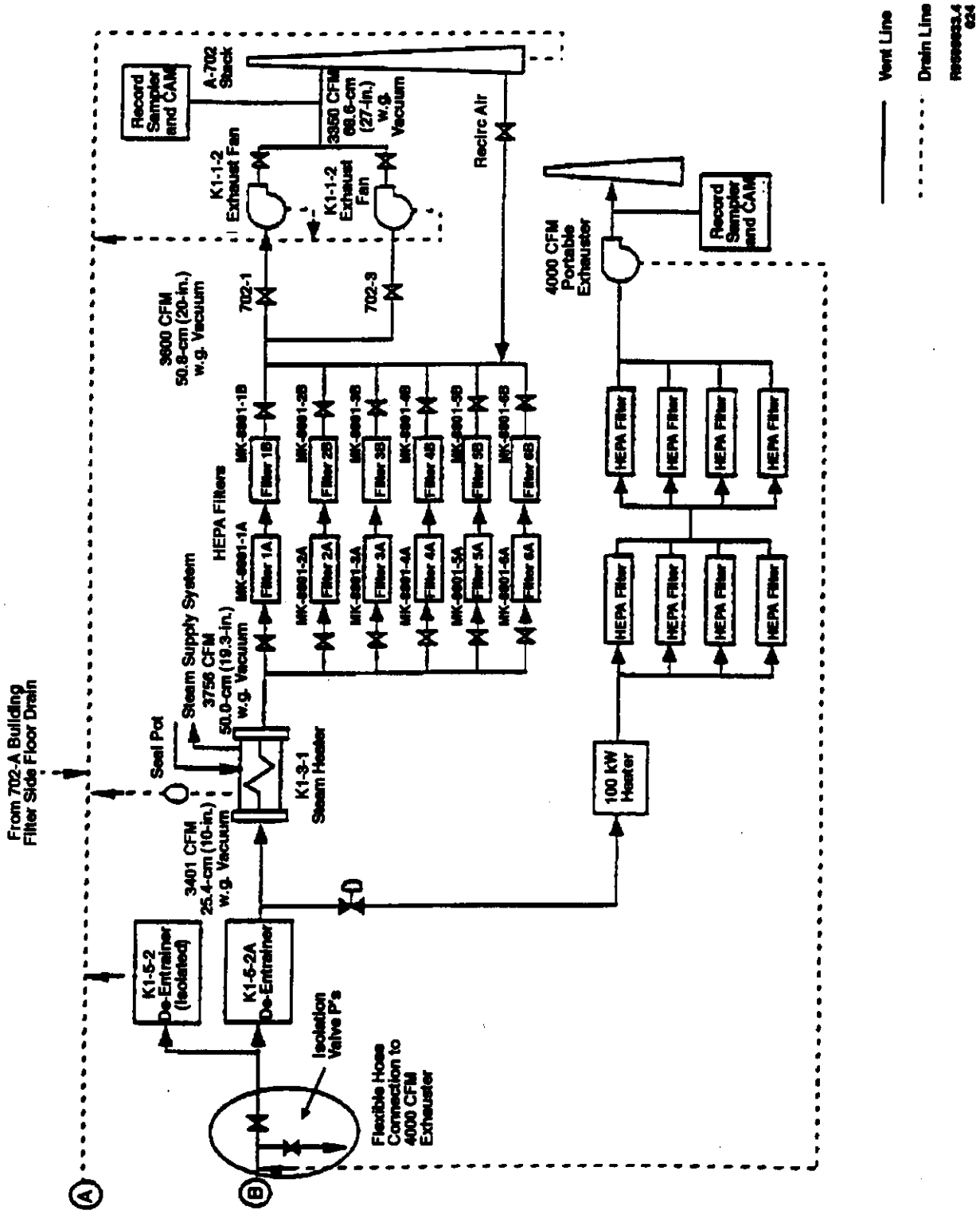


Figure 2-8. Annulus Ventilation System Tank 241-AY-102.

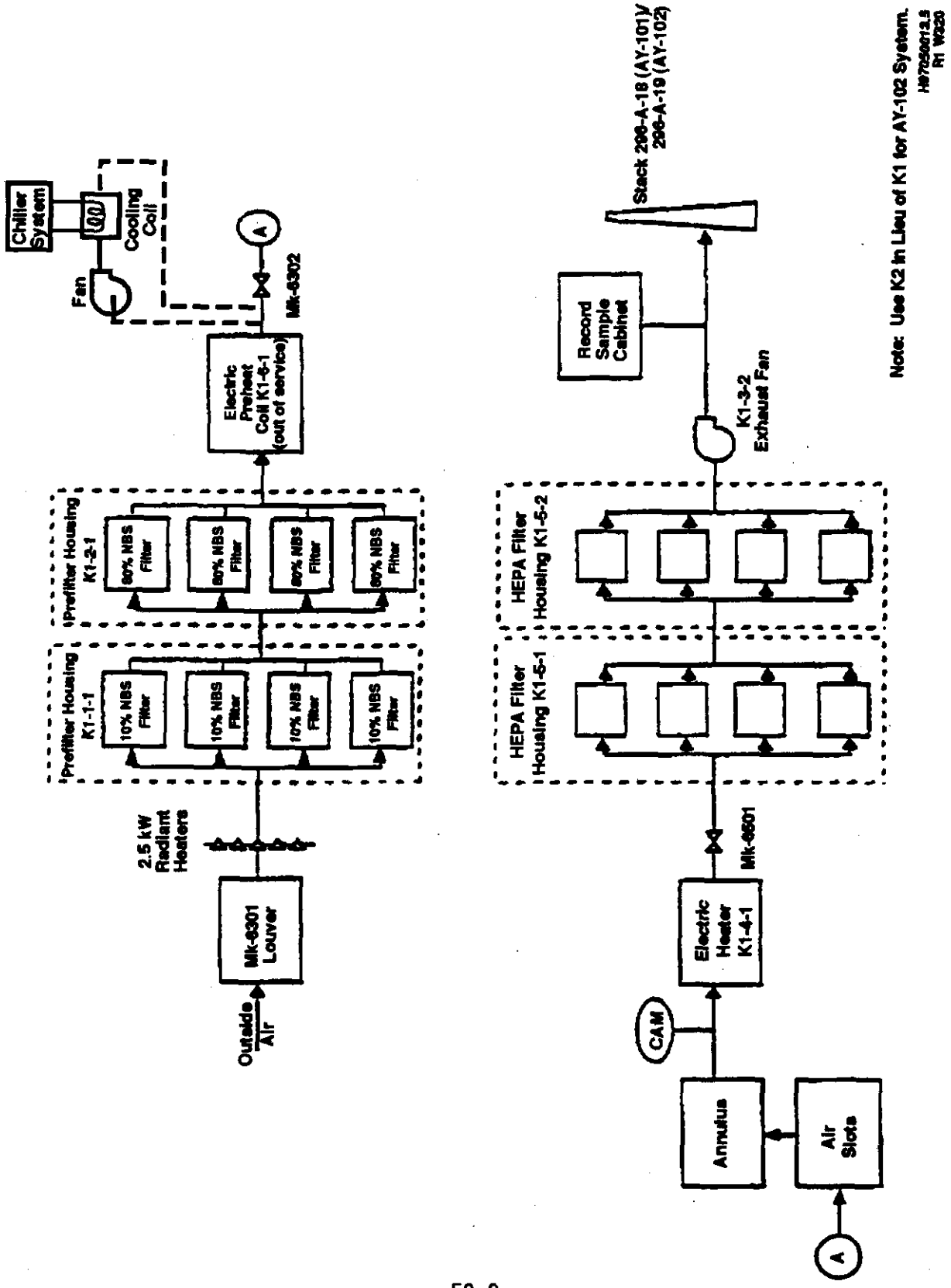


Figure 2-9. 241-AZ-702 Ventilation Upgrade System.

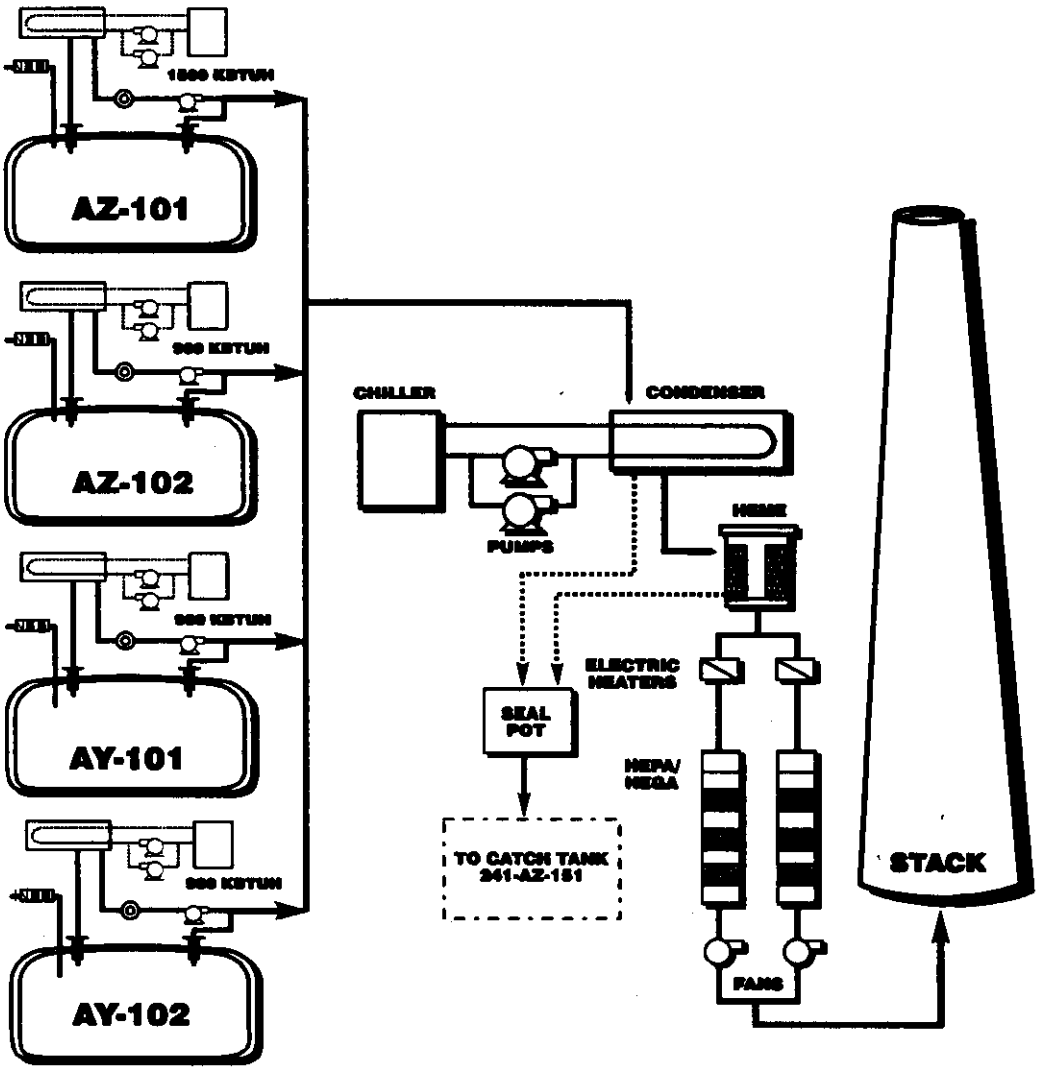
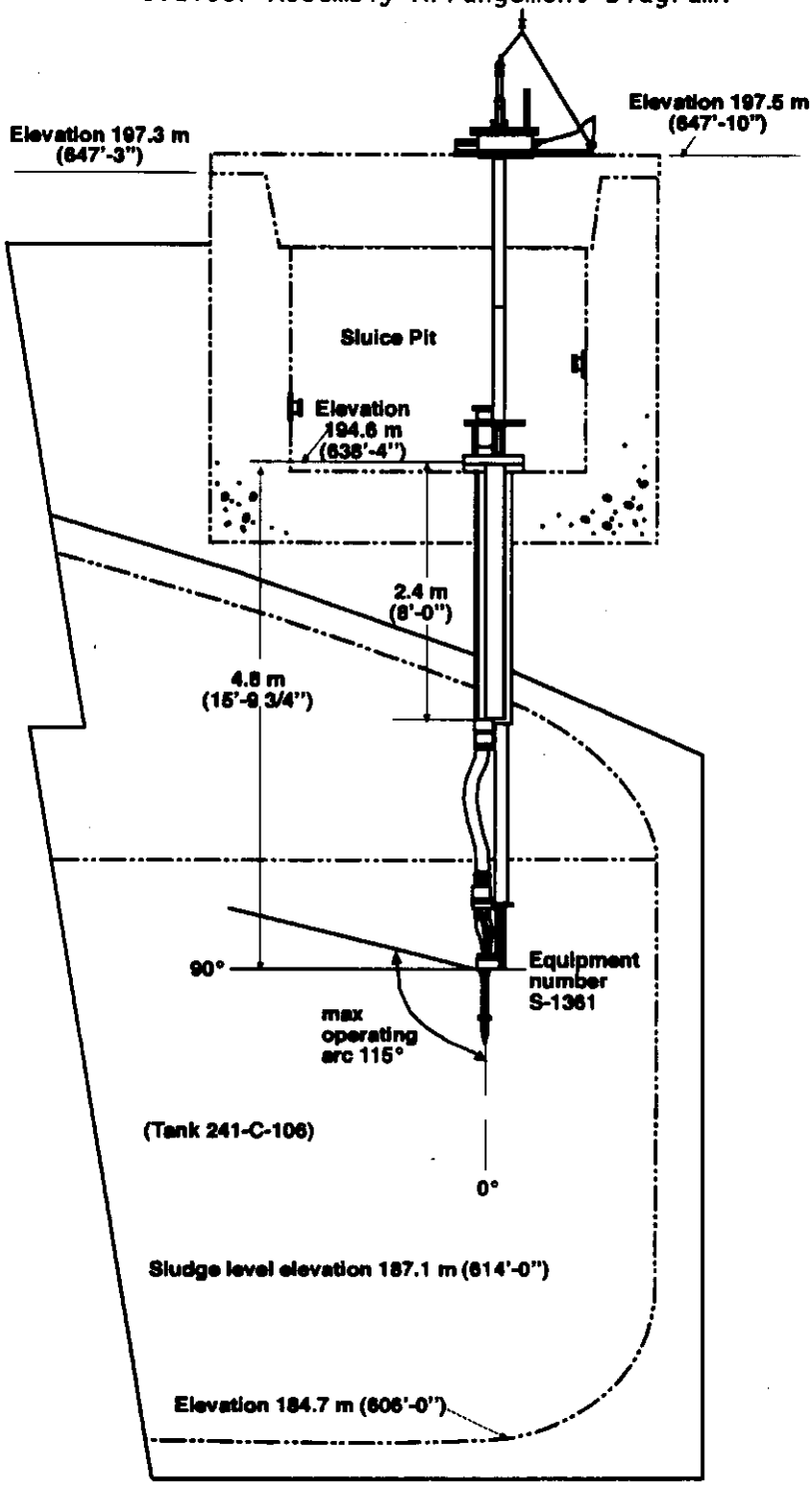


Figure 2-10. Tank 241-C-106 Waste Retrieval Sluicing Sluicer Assembly Arrangement Diagram.



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CHAPTER 3.0
HAZARD EVALUATIONS AND ACCIDENT ANALYSES

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CHAPTER 3.0
HAZARD EVALUATIONS AND ACCIDENT ANALYSES

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3.0 HAZARD EVALUATIONS AND ACCIDENT ANALYSES

3.1 INTRODUCTION

This chapter describes the methodology and presents the results of the hazard and accident analyses performed for WRSS components and operations described in Chapter 2.0, "Facility Description." This chapter also includes the facility hazard classification for WRSS. Based on the results of the hazard and accident analyses, Safety-Class and Safety-Significant structures, systems, and components (SSCs); Technical Safety Requirements (TSRs); and additional Defense-in-Depth controls are identified for protection of the public, onsite workers, and facility workers. This chapter also identifies design and operational features required specifically to protect the environment from uncontrolled releases of radioactive and hazardous material. Chapter 4.0 provides details of the safety structures, systems, and components identified herein. Chapter 5.0 provides the derivation basis of Technical Safety Requirements necessary to support the separate Technical Safety Requirement document required by DOE 5480.22, *Technical Safety Requirements*.

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3.2 REQUIREMENTS

The U.S. Department of Energy orders and standards that provide requirements and guidance for performing hazard and accident analyses to establish the safety basis of nuclear facilities are as follows:

- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)
- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (1992)
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (1994).

Additional design codes, standards, regulations, and U.S. Department of Energy orders relevant to specific hazards are identified as required in other sections of this addendum.

Risk evaluation guidelines to be used in this Addendum are contained in Table 3.3.1.5-1 of the main text of the FSAR.

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3.3 HAZARD ANALYSIS

This section contains the methodology and results of the hazards analysis conducted for the WRSS facilities and operations. The types of events considered in the WRSS hazards analysis are internal events, external events, and natural phenomena that can cause the uncontrolled release of radioactive or hazardous materials and affect the public, workers, or the environment. Sabotage and terrorism are not considered.

3.3.1 Methodology

The methodology used to perform the WRSS hazards analysis is the same as that described in Section 3.3.1 of the FSAR. Details of the hazards analysis, as related to the WRSS, are presented below.

3.3.1.1 Hazard Identification. The hazards analysis includes identification of the hazards associated with the WRSS design, processes, and operations. The same methodology described in Section 3.3.1.1 of the FSAR was used for the WRSS. The hazard identification form and related checklist used for the WRSS evaluation are the same as those shown in Tables 3.3.1.1-1 and 3.3.1.1-2 of the FSAR.

It should be noted that the WRSS material at risk assumptions are based on the following:

- **Chemical Inventory** — The source for the WRSS maximum hazardous chemical inventory is WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*. This document contains the bounding limits for chemical-unit-liter concentrations of the waste to be transported through the WRSS.

- **Radiological Inventory** — The WRSS worst-dose radiological inventory is based on WHC-SD-WM-SARR-016, *Tank Waste Composition and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, and WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*. These documents contain bounding unit-liter doses for the tanks within the TWRS facility.

3.3.1.2 Hazard Topography. The TWRS hazard topography is described in Section 3.3.1.2 of the FSAR. The hazardous conditions identified for the components and activities of the WRSS were mapped into this topography.

3.3.1.3 Hazard Evaluation. Detailed discussions of hazard evaluation techniques are presented in Section 3.3.1.3 of the FSAR. The methodology described in these sections was applied to the hazard evaluation of the WRSS. A hazards and operability (HAZOP) study was performed by a team of cognizant Project, Operations, and Engineering personnel; safety analysts familiar with the WRSS; and technical experts in specialty areas for the WRSS. The results of the WRSS hazard evaluation are contained in Appendixes A through C of this addendum.

3.3.1.4 Candidate Accident Selection. The methodology for candidate accident selection is described in Section 3.3.1.4 of the FSAR. This methodology was applied to accident selection for the WRSS. The initial list of accident groupings (bins) was based on the list of candidate accidents developed for the FSAR.

3.3.1.5 Controls Identification. The methodology for controls identification is described in Section 3.3.1.5 of the FSAR. This FSAR methodology was also applied to controls identification for the WRSS.

3.3.2 Hazard Analysis Results

This section summarizes the results of the hazards analysis activities, control decision process, and accident analysis for onsite consequences. This includes results of the hazard identification and evaluation, accident selection, and control identification activities. Section 3.4 describes the accident analysis and consequences. Details of the hazard analysis are provided in the following appendices of this addendum:

- Appendix A, "Hazard Topography"
- Appendix B, "Representative Analyzed Accidents"
- Appendix C, "Hazard Evaluation Results"
- Appendix D, "Control Allocation Tables."

3.3.2.1 Hazard Classification. DOE 5480.23 requires the hazard classification of nuclear facilities and operations. Guidelines for hazard classifications that meet the requirements of DOE 5480.23 are provided in DOE-STD-1027-92. DOE-STD-1027-92 classifies a facility as either Hazard Category 1, 2, or 3 depending on the quantities of radioactive material in the facility. Hazard Category 2 and 3 facilities contain quantities of radioactive material in excess of the threshold values in Table A.1 of DOE-STD-1027-92. A facility that does not exceed the DOE-STD-1027-92 Hazard Category 3 threshold for radioactive material, but possesses some radioactive material, is considered a radiological facility.

Waste retrieval operations were specifically excluded from the current FSAR; the WRSS safety documentation is intended to augment the current FSAR for retrieval of the Tank 241-C-106 waste via sluicing. The WRSS operations involve different mixtures of waste types than covered in the FSAR. WRSS operations involve higher pressures and flow rates than analyzed in the FSAR. In addition, new ventilation systems are considered. The results of the hazard evaluation done specifically for WRSS operations are summarized in Table 3.3.2-1. Table 3.3.2-2 provides a tabulation of some of the differences between WRSS operations and those covered in the FSAR.

WRSS will transfer waste from Tank 241-C-106 to the double-shell Tank 241-AY-102, both of which are part of the Tank Waste Remediation System (TWRS). The TWRS has a Hazard Category 2 designation as described in the FSAR main text. WRSS will not have any waste associated with it other than the waste it is transferring from one tank to the other. It is not a separate facility, but is physically attached to TWRS. Based on these factors, it is recommended that WRSS be given a Hazard Category 2 designation.

3.3.2.2 Hazard Evaluation. The hazard evaluation activity for the WRSS (documented in LA-UR-97-1581, *Preliminary Hazard Analysis for Project W-320*) determined a set of potential hazardous conditions that could result in the uncontrolled release of radioactive and/or hazardous material. The results of the accident selection, frequency/consequence assessment, and control allocation are given in Appendixes B, C, and D, respectively of this addendum.

The hazard evaluations support the selection of accidents for more detailed analysis and the identification of safety controls. The controls for the safe operation of WRSS are identified based on both the accident and the hazard analysis results. This section addresses the accident selection and identification of controls. It covers controls for offsite, onsite, worker, and environmental consequences. Section 3.4 describes the details of the accident consequence analysis.

3.3.2.2.1 Accident Selection. Hazardous conditions identified by the hazard evaluation, specifically conducted for WRSS operations, were used to select accidents for analysis and evaluation (LA-UR-97-1581). The design characteristics and configuration of the WRSS equipment was considered in determining the hazards. The hazards specific to WRSS operations are summarized in Table 3.3.2-1 and were compared with those identified for the FSAR. This comparison resulted in the grouping of the identified hazards into groups (or bins) for further evaluation which corresponded to the groups established for analysis in the main text of the FSAR. The groups of hazards are represented in the accident analysis by representative and bounding accidents. The titles of the representative accidents were changed to match the terminology of the FSAR main text, as reflected in Table 3.3.2-2. Further evaluation was then performed to determine if the analysis in the main text of the FSAR was bounding or if the WRSS operations required specific analyses. Table 3.3.2-3 identifies each analyzed accident and provides a reference to the appropriate section of the addendum and the main text of the FSAR.

It is important to note that all the hazardous conditions represented by the same accident analysis are not the same in every respect. Each unique hazard represented by a specific analysis can have different initiating events, which can result in different controls being applied to prevent or mitigate the hazard.

Appendix B of this addendum lists the analyzed (representative) accidents as developed in the hazards evaluation, as well as the hazardous conditions represented by each accident.

For each hazardous condition listed in Appendix B of this addendum, the following information is provided:

- The accident release category that identifies hazardous conditions that could result in common accident release attributes
- A specific and unique identification number associated with each hazardous condition
- The material at risk
- The hazardous condition that defines a release (information is provided on the location of the release and whether the material is hazardous or toxic)
- The cause of the hazardous condition

- The initial frequency and consequence assessment for an accident associated with a particular hazardous condition (this assessment assumes no controls or active systems were in place)
- A cause group identifier
- A representative accident number that is assigned to a hazardous condition grouping (bin).

3.3.2.2.2 Defense-in-Depth. The hazardous conditions identified for the WRSS are shown in Appendix C of this addendum and are arranged according to consequence category. Where applicable, Defense-in-Depth controls have been allocated to hazardous conditions. In addition, Defense-in-Depth controls have been allocated to the hazardous conditions with significant facility worker consequences. For each accident analyzed, a summary of the structures, systems, and components and Technical Safety Requirements along with the Defense-in-Depth controls are shown in Table 3.3.2-4.

3.3.2.2.3 Facility Worker Protection. In the course of the WRSS hazards analysis process, a number of potential hazardous conditions only affecting the facility worker were identified. These hazardous conditions were divided into radiation protection and occupational safety concerns.

Radiation Protection. This section discusses only potential facility worker radiation exposure not related to the loss of containment of radioactive material. As a result of the hazards analysis performed for WRSS, four potential facility worker radiation exposure concerns specifically associated with WRSS were identified. These potential facility worker radiation exposure hazardous conditions, along with their identifiers and causes, are presented in Table C-5 of Appendix C of this addendum. All WRSS-specific radiation protection issues are currently covered under the Hanford Site radiation protection program.

Occupational Safety. The hazards analysis performed on WRSS and its physical interfaces with other facilities also identified a number of potential facility worker occupational safety concerns. Potential facility worker occupational safety hazardous conditions, along with their identifiers and causes, are presented in Appendix C, Table C-6 of this addendum. All of the identified occupational hazards identified for WRSS are covered under the Hanford Site occupational safety program and are addressed in HNF-SD-WM-HSP-002, *Tank Farms Health and Safety Plan*.

3.3.2.2.4 Environmental Protection. The hazard evaluation included a qualitative assessment of the environmental impact of hazardous conditions that could potentially result in an uncontrolled release of radioactive or hazardous material. The results of this assessment are given in Appendix C, Table C-4 of this addendum. Hazardous conditions with significant environmental consequences (E2 or E3) are identified in the hazard analysis conducted for the WRSS (Table C-4 in Appendix C of this addendum). Section 3.3.2.3.4 of the main text of the FSAR provides discussion and additional required controls to protect the environment.

The impacts of tank waste leaking to the soil are covered in DOE/EIS-0189, *Final Environmental Impact Statement for the Tank Waste Remediation System*, and in WHC-SD-WM-ES-218, *Engineering Study of Tank Leaks Related to Hydraulic Retrieval of Sludge from Tank 241-C-106*. Multiple options, including the no action which postulates all the waste from 177 tanks leaks to the ground, are reported in DOE/EIS-0189. Appendix F, Table F.2.2.13 of DOE/EIS-0189 gives duration of the contaminant release as occurring over a time period of 2.85 to 158 years. The waste reaches the interface between the vadose zone and the groundwater 140 to 250 years later (DOE/EIS-0189). A postulated 151,400 L (40,000 gal) during sluicing operations is assumed in WHC-SD-WM-ES-218. Travel time to the aquifer is estimated to be 60 years (WHC-SD-WM-ES-218). The effect of the leak to the soil (including previous leaks and spills in the tank farms) may require some form of soil remediation. This will cause future clean up costs to be increased. However, both these studies indicate that there is no short-term risk (1 year or less) to the onsite receptor located at 100 m (328 ft) or the offsite receptor.

Table 3.3.2-1. Project W-320 Hazards Identification.[a]

Energy Classification	Accident Number[b]	
	PT	PE
Corrosive	2,4,5	1,2,4,5
Explosive/pyrophoric	6,7,8	6,7,8
Nuclear criticality	15,16	15
Flammable materials	11,13,14	11,13,14
Thermal radiation	5	N/A
Chemical reactions	1	N/A
Friction	3,5	1,2,3,5
Electrical	3,4,5,6,9,10,11,14,16	3,4,5,6,7,8,9,10,11,12,14,16,18
Kinetic-rotational	2,3,4	2,3,4,7
Kinetic-linear	1,5,7	1,4,5,7
Mass, gravity, height	3,5,11,15,16	2,3,5,10,11,15,16
Pressure-volume	7,9,11	5,6,8,9,11,12
Thermal (except radiant)	N/A	3,6

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

[b]The numbers correspond to a section number, 3.4.2.x, for example the number "3" refers to Section 3.4.2.3.

N/A = not applicable.
PT = potentially present in the facility.
PE = potentially present elsewhere in/adjacent to facility.

Table 3.3.2-2. Candidate Accidents Versus Analyzed Accidents Used for WRSS Analysis. (2 sheets)

Difference between Representative Accidents and Analyzed Accidents		
Representative Accidents	Analyzed Accidents	Comments
1. Pump Vortices Criticality in Tank	1. Nuclear Criticality	WRSS-specific analysis performed
2. Release through Failed HEPA Filter due to a Tank Bump	2. HEPA Filter Failure - high temperature - high pressure	WRSS-specific analysis performed - source term for WRSS operations different from FSAR analysis
3. Ventilation Ducting Breach/Unfiltered Release	3. HEPA Filter Failure - high temperature - high pressure	Consequences bounded by accident 2, above
4. Flammable Gas Ignition in Pit	4. Fuel Fire in Contaminated Area	FSAR analysis found to be bounding
5. Caustic Spray Leak	5. Caustic Spray Leak	FSAR analysis found to be bounding
6. Tank Failure due to Flooding Dome Load	6. Tank Failure due to Excessive Loads	WRSS-specific analysis performed - analyzed using AWF solids
7. Tank Failure due to Excessive Vacuum	7. Tank Failure due to Excessive Loads	Consequences bounded by accident 6, above
8. Flammable Gas Release Event with Ignition	8. Flammable Gas Deflagrations	FSAR analysis (qualitative) adopted
9. Organic Layer Formation and Subsequent Organic Fire	9. Organic Solvent Fire - Pool Fires - Puddle Fires - Wick Stabilized Fires	WRSS-specific analysis performed, analyzed different organic solvent than the FSAR
10. In-Tank Propylene Glycol Fire	10. In-Tank Fuel Fire/Deflagrations	Consequences bounded by accident 9, above
11. Steam Bump	11. Tank Bump	WRSS-specific analysis performed - unique to WRSS activities
12. Liner Breach due to Steam between Steel Liner and Concrete Shell in C-106	12. Liner Breach due to Steam between Steel Liner and Concrete Shell in C-106	WRSS-specific analysis performed - accident scenario not part of the FSAR
13. Transfer Line Develops Leak and Secondary Casing is Defective	13. Subsurface Leak remaining Subsurface	WRSS-specific analysis performed - transfer line configuration different than that analyzed in the FSAR
14. Local Flooding during Transfer/Line Uncovered and Breached	14. Subsurface Leak Resulting in Pool	WRSS-specific analysis performed - higher flow rate/pressure and ULDs than analyzed in the FSAR
15. Pipe Break or Leak in Pit, Drain Cover On, Pit Fills and Overflows	15. Surface Leak Resulting in Pool	WRSS-specific analysis performed - higher flow rate/pressure and ULDs than analyzed in the FSAR
16. Spray Leak from Flushing Connection in AY-102 Pit during Sluicing Transfer	16. Spray Leak from Structure	WRSS-specific analysis performed - unique WRSS configuration
17. Spray Leak from Waste Transfer Line	17. Spray Leak from an Underground Waste Transfer Line	WRSS-specific analysis performed - higher flow rate/pressure and ULDs than analyzed in the FSAR

Table 3.3.2-2. Candidate Accidents Versus Analyzed Accidents Used for WRSS Analysis. (2 sheets)

Difference between Representative Accidents and Analyzed Accidents		
Representative Accidents	Analyzed Accidents	Comments
18. Natural Phenomena - high wind - dust devil - flood - range fire - ash fall - lightning - seismic	18. Natural Phenomena (Note: Not analyzed)	No specific analyses Natural Phenomena were performed. They were considered as potential initiators for the accidents listed above

AWF = Aging Waste Facility.
HEPA = High-efficiency particulate air (filter).
ULD = Unit-liter dose.
WRSS = Waste retrieval sluicing system.

Table 3.3.2-3. Accident Analysis Sections.

Section which addresses analyzed accident			
Number	Analyzed accidents	Addendum Section	FSAR Section
1	Criticality	3.4.2.1	3.3.2.4.1
2	HEPA Filter Failure Due to Exposure to High Pressure or High Temperature	3.4.2.2	3.3.2.4.2
3	Unfiltered Release	3.4.2.3	3.3.2.4.2
4	Fire in Contaminated Area	3.4.2.4	3.3.2.4.3
5	Caustic Spray Leak	3.4.2.5	3.3.2.4.9
6	Tank Failure Due to Excessive Loads	3.4.2.6	3.4.2.1
7	Tank Failure Due to Excessive Vacuum	3.4.2.7	3.4.2.1
8	Flammable Gas Deflagration	3.4.2.8	3.4.2.2
9	Organic Solvent Fire	3.4.2.9	3.4.2.4
10	In-Tank Fuel Fire/Deflagration	3.4.2.10	3.4.2.5
11	Tank Bump	3.4.2.11	3.4.2.11
12	Liner Breach Due to Steam Between the Steel Liner and Concrete Shell in 241-C-106	3.4.2.12	N/A
13	Subsurface Leak Remaining Subsurface	3.4.2.13	3.3.2.4.7
14	Subsurface Leak Resulting in a Pool	3.4.2.14	3.4.2.8
15	Surface Leak Resulting in a Pool	3.4.2.15	3.4.2.7
16	Spray Leak from Structure	3.4.2.16	3.4.2.9
17	Spray Leak from an Underground Waste Transfer Line	3.4.2.17	3.4.2.9
18	Natural Phenomena	3.4.2.18	3.4.2.12

N/A = not applicable.
HEPA = high-efficiency particulate air (filter).

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
1.	Nuclear Criticality (3.4.2.1)	None required	SL: None required LCS: None required LCO: None required AC 5.7 Nuclear Criticality Safety - Establish CPSs based on CSERs - Recovery actions if limits exceeded - Criticality training program	None
2.	HEPA Filter Failure-Exposure to High Temperature or Pressure (3.4.2.2)	SS: Continuous air monitor-interlock on 241-A-702 ventilation system SS: Continuous air monitor-interlock on 241-AZ-702 ventilation system SS: Continuous air monitor-interlock on 296-P-16 ventilation system SS: Continuous air monitor-interlock on 296-C-006 ventilation system	SL: None required LCS: None required LCO 3.1.4 Ventilation Stack CAM Interlock Systems AC 5.18 HEPA Filter Controls - Periodic radiation surveillance - Replacement based on accumulation - Aerosol test upon installation (AWF 241-AZ-702) - Periodic aerosol test (AWF 241-AZ-702)	HEPA Filter Delta P - Low Delta P interlock across the HEPA filters on the ventilation system (where provided) - High Delta P alarm across the HEPA filters on the ventilation system - Periodic surveillance of HEPA Delta P and continuous air monitor Record Sampler Heater Over Temperature - Interlock/alarm (where provided) HEPA Filter Replacement - Typically performed at 1 mSv/h (100 mrem/h)
3.	Unfiltered Release (3.4.2.3)	SS: Continuous air monitor-interlock on 241-A-702 ventilation system SS: Continuous air monitor-interlock on 241-AZ-702 ventilation system SS: Continuous air monitor-interlock on 296-P-16 ventilation system SS: Continuous air monitor-interlock on 296-C-006 ventilation system SS: SSCs in FSAR Addendum 1, Section 3.4.2.11 (Tank Bump) also apply as Safety Significant	SL: None required LCS: None required LCO: None required AC 5.25 Ventilation Controls - Visual inspection of aboveground recirculation ventilation ductwork for Tank 241-C-106 every 24 hours during sluicing (only applies after 296-C-006 ventilation system is installed) TSR controls in FSAR Addendum 1, Sections 3.4.2.2 (HEPA Filter Failure) and 3.4.2.11 (Tank Bump) also apply	Transfer Controls: - Waste compatibility controls Ignition Controls - Speed Limit Controls Plastic sleeves on aboveground ventilation flanges

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
4.	Fire in Contaminated Area (3.4.2.4)	None required	SL: None required LCS: None required LCO: None required AC 5.10 Ignition Controls - Vehicle fuel system protection - Physical barriers outside tank farms - Speed limit controls AC 5.14 Emergency Preparedness - Response procedures	Fire Protection Program Radiation Protection Program Contamination Control Program Vehicle positioning spotters Tank Farm fences Vegetation Control Program
5.	Caustic Spray Leak (3.4.2.5)	None required	SL: None required LCS: None required LCO: None required AC 5.23 Caustic Transfer Controls - Plastic sleeving around delivery piping - Caustic delivery system transfer pressure ≤ 125 psig or below sodium hydroxide cargo tanks specified maximum allowable operating pressure whichever is lower - Piping thickness - Sodium hydroxide cargo tanks meet applicable DOT specifications - Traffic barriers around cargo tank	Operator training TWRS Hazardous Material Protection Program Emergency response plans and procedures
6.	Tank Failure Due to Excessive Loads (3.4.2.6)	None required	SL: None required LCS: None required LCO: None required AC 5.16 Dome Loading Controls - <u>Hanford Site Hoisting and Rigging Manual</u> for critical lifts - Limits on load height - Uniform and concentrated load limits	Radiation Protection Program Health and Safety Plan - restricting activities in high winds Job Control System - including requirement to place load absorber material around riser when very heavy loads are installed Operator training Operating procedures Emergency response plans and procedures

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
7.	Tank Failure Due to Excessive Vacuum (3.4.2.7)	None required	SL: None required LCS: None required LCO: None required AC: None required	None
8.	Flammable Gas Deflagrations (3.4.2.8)	SC: 241-AY-102 Primary tank ventilation system SC: Primary tank leak detection systems SC: 241-C-106 tank ventilation system	SL: None required LCS: None required LCO 3.2.1 DST and AWF Tank Ventilation Systems LCO 3.2.2 SST Ventilation Systems - Active LCO 3.2.6 Primary Tank Leak Detection Systems AC 5.9 Flammability Controls AC 5.10 Ignition Controls AC 5.11 Flammable Gas Monitoring Controls AC 5.14 Emergency Preparedness - Response Procedures AC 5.18 HEPA Filter Controls - Periodic radiation surveillance - Replacement based on accumulation	Monitor dome pressure in Tanks 241-C-106 and 241-AY-102 during sluicing. Periodic video monitoring of the waste in Tank 241-AY-102. Measure background concentrations in both tanks for 3-4 weeks prior to sluicing. Monitor the ventilation flow rates in both tanks during and after sluicing. Monitor level growth and use barometric pressure evaluation after sluicing. Flammable gas monitoring during sluicing HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h).

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
9.	Organic Solvent Fire (3.4.2.9)	None required	SL: None required LCS: None required LCO: None required AC 5.10 Ignition Controls - Lightning (stop intrusive work, secure elevated equipment) - Barrier for hot metal during flame cutting - Vehicle fuel system protection - Physical barriers outside tank farms - Speed limit controls AC 5.12 Transfer Controls - Evaluate impact on organic solvent transfer AC 5.14 Emergency Preparedness - Response procedures AC 5.18 HEPA Filter Controls - Periodic radiation surveillance - Replacement based on accumulation - Aerosol test upon installation (AWF 241-AZ-702) - Periodic aerosol test (AWF 241-AZ-702)	Vehicle positioning spotters Tank farm fences HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h)
10.	In-Tank Fuel Fire/ Deflagration (3.4.2.10)	None required	SL: None required LCS: None required LCO: None required Note: This accident credits the same TSR controls as the Organic Solvent Fire above (3.4.2.9).	Note: This accident credits the same Defense-in-Depth controls as the Organic Solvent Fire above (3.4.2.9)

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
11.	Tank Bump (3.4.2.11)	SC: Tank 241-C-106 ventilation system SC: Tank 241-AY-102 annulus ventilation system SC: Tank 241-AY-102 primary tank ventilation system	SL: None required LCO 3.2.1 DST and AWF Ventilation systems LCS/LCO 3.3.1 SST Waste Temperature Controls - Temperature ≤ 91 °C (205 °F) LCS/LCO 3.3.2 DST and AWF Tank Waste Temperature Controls - Temperature ≤ 91 °C (195 °F) (or 91 °C/102 °C [195 °F/215 °F] based on waste level) LCO 3.3.3 Tank 241-AY-102 Annulus Ventilation System - Operability AC 5.12 Transfer Controls - Incremental transfer with material balance after each sluicing batch of 12 hours maximum duration during transfer operations - Ensure final tank state within analyzed conditions AC 5.19 Process Instrumentation and Measuring and Test Equipment - Calibrate and properly maintain AC 5.25 Ventilation Controls - Provide cooling capability for Tank 241-AY-102 after 0.6 m (2 ft) of waste added (primary and annulus ventilation systems)	ALCs will be disabled prior to the start of sluicing Communications between the 241-C-106 and 241-AY-102 control trailers will be maintained during sluicing operations Pump pit and sluice pit cover blocks (including removable plugs) will be in place prior to any sluicing operations and prior to enabling of the sluice or slurry pumps The transfer pumps associated with the sluice and slurry lines will be administratively locked out except as necessary for actual sluicing operations Emergency Response Plan/Procedures

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
11.	Tank Bump (3.4.2.11) (Continued)		AC 5.26 Tank 241-C-106 Waste Temperature Controls: - Predict saturation temperatures at the bottom of Tank 241-C-106. Use predicted height of the waste throughout the incremental transfer and periodically monitor the waste temperature. - During the first two 0.3 m (1 ft) transfer increments, the liquid level established before start of each sluicing increment will be maintained throughout the increment.	

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
12.	Liner Breach Caused by Steam Between the Steel Liner and Concrete Shell in Tank 241-C-106 (3.4.2.12)	None required	SL: None required LCS/LCO 3.3.1 SST Waste Temperature Controls (prior to start of sluicing) - Temperature ≤ 96°C (205 °F) AC 5.12 Transfer Controls - Ensure final tank state within analyzed conditions AC 5.19 Process Instrumentation and Measuring and Test Equipment - Calibrate and properly maintain AC 5.26 Tank 241-C-106 Waste Temperature Controls - Establish temperature controls that are < T_{sat} for existing tank conditions (applies during and after sluicing)	Active ventilation or other heat removal mechanisms will be maintained Pump pit and sluice pit cover blocks (including removable plugs) will be in place whenever the conditions for initiation of a liner breach are present (i.e., known leaking liner, active ventilation system down indefinitely) Emergency response plan/procedures A material balance after each sluicing batch of 12 hours maximum duration during transfer operations Level monitoring to identify leakage into the liner of Tank 241-C-106 Syphon protection is provided on the slurry distributor and the submersible sluice pump discharge line within Tank 241-C-106 Communication between control rooms for Tanks 241-C-106 and 241-AY-102 will be maintained during sluicing operations Raw water is metered Design feature - The hose is engineered to maintain integrity Design feature - Positive mechanical stops are provided to limit nozzle travel to less than 25° above horizontal Sluicing Controls - Sluice stream not directed at waste near the walls during early stages

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
13.	Subsurface Leak Remaining Subsurface (3.4.2.13)	SS: Transfer Line pipe-in-pipe encasement SS: Transfer leak detection systems SS: Tank level detection systems	SL: None required LCS: None required LCO 3.1.3 Transfer Leak Detection Systems AC 5.12 Transfer Controls - Establish communication between control rooms for Tanks 241-C-106 and 241-AY-102 during sluicing operations - Material balance after each sluicing batch of 12 hours maximum duration during transfer operations - Configuration management - Independent transfer route verification AC 5.13 Encasement Seal Loop Controls - Encasement drain line valve not closed AC 5.17 Excavation Controls (3.4.2.17) AC 5.20 Transfer Pump Administrative Lock Controls	Pressure/leak testing of transfer route before material transfer Operator training Operating procedures Emergency response plan/procedures Seismic shutdown switches
14.	Subsurface Leak Resulting in Pool (3.4.2.14)	SC: Transfer Line pipe-in-pipe encasement SC: Transfer leak detection systems SS: Tank level detection systems	SL: None required LCS: None required LCO: 3.1.3 Transfer Leak Detection Systems AC 5.12 Transfer Controls - Material balance after each sluicing batch of 12 hours maximum duration during transfer operations - Establish communications between control rooms for Tanks 241-C-106 and 241-AY-102 during sluicing operations - Configuration management - Independent route verification during transfer setup AC 5.14 Emergency Preparedness - Response procedures	Walkdowns are performed once/shift to detect surface leaks from transfer line WRSS transfer lines are equipped with encasement leak detectors Monitor flow rate Seismic shutdown switches

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
15.	Surface Leak Resulting in a Pool (3.4.2.15)	SC: Transfer leak detection system SS: Transfer System Covers SS: Tank level detection systems SC: Primary tank leak detection system SC: Transfer Line pipe-in-pipe encasement SS: Backflow preventers	SL: None required LCS: None required LCO 3.1.1 Transfer System Covers and Entry Doors LCO 3.1.3 Transfer Leak Detection Systems LCO 3.2.6 Primary Tank Leak Detection Systems AC 5.12 Transfer Controls - Material Balance after each sluicing batch of 12 hours maximum duration during transfer operations - Establish communication between control rooms for Tanks 241-C-106 and 241-AY-102 during sluicing operations - Configuration management - Cap/blank nozzles when not in use - Vehicle restrictions around transfer lines AC 5.14 Emergency Preparedness - Response procedures AC 5.17 Excavation Controls (3.4.2.17) AC 5.20 Transfer Pump Administrative Lock Controls AC 5.22 Transfer System Cover Removal Controls	Tank farms are visually surveyed by operators at least once a day Pit drains, where open Encasement leak detectors Backflow preventers Material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation Seismic shutdown switches

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
16.	Spray Leak from Structure (3.4.2.16)	SC: Transfer system covers SS: Backflow preventers SC: Transfer Line pipe-in-pipe encasement SC: Stack CAM and interlock to exhaust fan (241-A-702, 241-AZ-702, 296-P-16, and 296-C-006 Ventilation Systems)	SL: None required LCS: None required LCO 3.1.1 Transfer System Covers and Entry Doors LCO 3.1.4 Ventilation Stack CAM Interlock Systems AC 5.12 Transfer Controls - Configuration management - Independent transfer route verification - Vehicle restrictions AC 5.13 Encasement Seal Loop Controls - Encasement drain line valve not closed AC 5.20 Transfer Pump Administrative Lock Controls AC 5.22 Transfer System Cover Removal Controls	Repositioned jumpers are in service tested during initial sluicing. Cameras lowered through penetrations in the cover block are used to verify initial jumper integrity during the leak test Process pit and vault pit leak detectors Material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation Encasement leak detectors Isolation valves; manual valve is closed to isolate the flush system when not in use Backflow preventers Seismic shutdown switches
17.	Spray Leak from an Underground Waste Transfer Line (3.4.2.17)	None required	SL: None required LCS: None required LCO: None required AC 5.17 Excavation Controls - An excavation permit shall be required when excavating in areas where waste transfer lines exist - Encased pipe outside of the tank farm boundaries shall be identified with permanent aboveground labels	Access control • T-bars and chains Material balances after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation Seismic shutdown switches

Table 3.3.2-4. Safety SSCs and TSRs and Defense-in-Depth Controls for Representative Accidents. (11 sheets)

#	Representative Accidents FSAR Addendum	Structures, Systems, and Components	Technical Safety Requirement	Defense-In-Depth Controls
17.	Spray leak from an Underground Waste Transfer Line (3.4.2.17 Continued)		- Waste transfers are prohibited through lines uncovered by excavation activities unless compensatory controls are established - Waste transfers shall not be conducted in transfer lines located within approximately 4.6 m (15 ft) of ongoing excavation activities. - Prior to initiation of an excavation activity, identify emergency response actions and establish communications between the excavation site and operations personnel to ensure immediate shutdown of waste transfers when leakage is indicated.	
18.	Natural Phenomena - Seismic Events (3.4.2.18)		SL: None required LCS: None required LCO: None required AC: Refer to FSAR main text	Refer to FSAR main Text

AC = Administrative control.
ALC = air lift circulator.
AWF = aging waste facility.
CAM = continuous air monitor.
DOT = Department of Transportation.
DST = double-shell tank.
FSAR = Final Safety Analysis Report
HEPA = high-efficiency particulate air (filter).
JCO = Justification for Continued Operation.
LCO = Limiting Condition for Operation.
LCS = Limiting Condition for Safety.
SC = Safety-Class.
SL = safety limit.
SS = Safety-Significant.
SST = single-shell tank.
TSR = Technical Safety Requirement.
TWRS = Tank Waste Remediation System.

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3.4 ACCIDENT ANALYSIS

The following sections describe the results of the analyses of the potential accidents identified in Section 3.3.2. The consequence calculation methods common to the analyses are summarized in Section 3.4.1, "Methodology," of the FSAR, including a discussion of receptor locations and exposure pathways, radionuclide and hazardous chemical inventories and associated unit liter dose (ULD) and sum-of-fraction values, atmospheric dispersion, and the equations used to calculate downwind radiological and toxicological consequences. Section 3.4.1 of this addendum describes how the WRSS-unique ULD and sum-of-fraction values were selected.

Results of the evaluation basis accident analyses that are unique to WRSS are presented in Section 3.4.2. Evaluation basis accidents are analyzed to identify the set of Safety-Class and Safety-Significant structures, systems, and components and TSRs. These are identified by performing an analysis in which no credit is taken for preventive or mitigative controls. The results of the analyses without controls are compared to risk guidelines. If the guidelines are exceeded, safety structures, systems, and components and TSRs that reduce the event frequency or consequences are added. Analyses with controls (that assume the identified controls are functioning as intended) are then performed.

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3.4.1 Methodology

This section summarizes the general calculation methods used to quantify the radiological and toxicological consequences of postulated accidents. The individual analyses, presented in Section 3.4.2, summarize the consequence calculation methods specific to individual postulated accidents. Accidents involving the transfer lines, such as the spray leaks and pool leaks, were evaluated at a flow rate of 28.4 L/s[1] (450 gpm) for normal flow and 41.0 L/s (650 gpm) for flow without restriction. The project requested that the accident analysis use these values to provide a conservative envelope for the anticipated flow rate of approximately 22.1 L/s (350 gpm). In addition, the source term is expected to change over the course of the transfer operations because of factors like dissolution of solids and liquid/solid fractions. To account for these, conservative assumptions have been made (below). Samples will be periodically taken to ascertain that the project is remaining within the analyzed envelope.

3.4.1.1 Radiological Consequence Calculation Methodology.

3.4.1.1.1 Radionuclide Inventory. WHC-SD-WM-SARR-037 discusses in detail the development of the radionuclide inventory. Table 3.4.1-1 lists the radionuclide constituents that make up the individual ULDs that were used in the accident analysis for WRSS operations.

3.4.1.1.2 Exposure Pathways. Two potential radiological exposure pathways (i.e., internal and external) are associated with releases of radioactive materials. The total effective dose equivalent calculated for an individual is equal to the sum of the dose contributions from these two exposure pathways. See Section 3.4.1.1.2 of the FSAR for more detail.

3.4.1.1.3 Dose Calculation Methods. WHC-SD-WM-SARR-016 presents an overview of (1) the method used to calculate the inhalation dose to the maximum onsite individual, and (2) the inhalation, ingestion, and resuspension dose to the maximum offsite individual. WHC-SD-WM-SARR-037 presents a detailed description of the derivation of ULD values. This section develops the application of specific ULDs and liquid/solid ratios for the WRSS.

Liquid/Solid Ratios. Table 3.4.1-2 lists the liquid/solid waste ratios used in the WRSS analysis. The basis for the 67/33 ratio in Tank 241-C-106 and the slurry line is the expected maximum solids loading during sluicing. It is anticipated that 33% solids in the slurry will be bounding. The same ratio is assumed for the Tank 241-C-106 headspace and HEPA filters because the contamination in these areas originates from the Tank 241-C-106 aqueous phase.

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[1]Most of the units involved in this project are measured in English units. For example, the flow rate is 450 gpm. The metric conversion for this is 28.4 L/s, that is, this is a "hard" conversion. The values are reported with enough decimal places so that conversion back to the original units results in little if any error. For example, rounding 28.4 L/s to 28 L/s and converting back to English units would give 443.8 gpm; obviously not the correct value. Therefore, to reduce conversion errors, this practice is followed throughout this document.

This is obviously conservative, because loading the headspace and the HEPA filters would take considerable time at 67/33 and the sluicing operation is of limited duration.

The basis for the 90/10 ratio in Tank 241-AY-102 and the sluice line is the same as the 67/33 ratio assumed for Tank 241-C-106. The reduced solids content is assumed because of the large layer of supernate in Tank 241-AY-102 (approximately 9.14 m [30 ft]), and the operational intention to draw the sluice stream from the top of the tank and inject the slurry stream into the bottom of the tank using a slurry distributor. A lower entrainment of solids in the sluice line (i.e., supernate of Tank 241-AY-102) is needed for the sluicing to be successful.

Composite Unit Liter Doses for Liquids and Solids. DOE-STD-3009-94 requires the Evaluation Basis Accidents to be analyzed in an unmitigated format (without administrative controls and active systems) and, if necessary, a mitigated format (taking control strategies into consideration). As part of this approach, two cases were chosen for waste transfer-related accident scenarios to provide ULDs for the liquids and solids. The first is a bounding case intended to provide a conservative estimate of ULDs. The second is a reasonable case that assumes minimal mixing of Tank 241-AY-102 solids, more representative of conditions expected in the controlled incremental sluicing activity of the WRSS. The terms "bounding" and "reasonable" were chosen based upon radiological considerations, not toxicological.

Bounding Case. For the bounding case (or the case without controls), the liquids ULD is assumed to be composed of 100% Aging Waste Facility (AWF) tank liquids, and the solids ULD is assumed to be composed of 100% AWF tank solids (the AWF ULDs are in Table 3.4.1-3). These ULDs are then used with the liquid/solid ratios found in Table 3.4.1-2 to arrive at the composite ULDs used in the unmitigated transfer accident scenarios (the columns labeled "inhalation bounding case" and "ingestion bounding case" in Table 3.4.1-4). The bounding ULDs used in the accident analysis are comprised entirely of AWF solids and AWF liquids. The ULD for the SST liquids is larger than the ULD for AWF liquids. However, the SST liquids ULD is bounded by the composite ULDs used for this project (Table 3.4.1-4). Since Tank 241-C-106 contains mostly sludge, there is very little SST liquid actually available to contribute to the source term. If the SST liquids ULD is used instead of the AWF liquids in the "bounding" case, the results are within 5%. This would not result in any meaningful changes when comparing to guidelines, setting safety structures, systems and components, or developing controls.

Reasonable Case. For the accident consequences with controls a more reasonable source term assumption was used which is more representative of conditions expected in the controlled incremental sluicing activity of the WRSS. It is assumed that the slurry distributor does not significantly mobilize the aging waste solids. This source term assumption will be confirmed during sluicing by calculating the total solids loading transferred after each batch of 12 hours maximum duration. For the reasonable case (or the case with controls), the liquids ULD is modeled as having a composition consisting of 10% SST liquids and 90% AWF tank liquids. This mixture of ULDs accounts for some of the SST liquids to be entrained during sluicing; however, the vast majority of liquids will be from Tank 241-AY-102, which provides the

sluice stream. The solids ULD for the mitigated accident scenarios is modeled as having a composition consisting of 10% AWF solids and 90% SST solids. This is a reasonable mixture, considering the nature of the operations: SST solids (Tank 241-C-106) are to be sluiced and pumped on top of AWF tank solids (Tank 241-AY-102) in a manner that minimizes mixing and disturbance of the Tank 241-AY-102 solids.

Assuming that 10% of the solids entrained in the sluicing operation are AWF tank solids is considered a reasonable upper bound for selection of ULDs. The representation of Tank 241-AY-102 solids by the AWF solids source term is conservative. The solids in Tank 241-AY-102 are much more benign than the AWF solids source term, which is based on a maximized isotopic distribution from sample data representing all four AWF tanks. For example, the significant inhalation dose contributor to the AWF source term dose is ^{241}Am, which represents 76% of the total inhalation dose. The concentration of ^{241}Am from Table 3.4.1-1 is 1.1 E+10 Bq/L. Data from 241-AY-102 (WHC-SD-WM-ER-454) indicate a ^{241}Am concentration of 9.3 E+08 Bq/L. Because of the conservatism in this term, it is only necessary to confirm the total solids loading after each batch during WRSS operations. Confirmation of a total solids loading in the slurry line of less than 33% will provide reasonable assurance that conditions in the field are bounded by the analysis. Historical data from past sluicing indicates that the actual solids loading in the slurry line will normally be below 10%. As a result, a much lower concentration of solids in the sluice line is necessary for sluicing to be successful.

The ULDs from Table 3.4.1-3 multiplied by the ratios discussed above and weighted by the liquid/solid ratios from Table 3.4.1-2 result in the composite ULDs that are used when reasonable accident consequences are estimated (the columns labeled "inhalation reasonable case" and "ingestion reasonable case" in Table 3.4.1-4). Other controls would also be credited at this time to form the total "mitigated" accident consequences.

3.4.1.2 Toxicological Consequence Calculation Methodology.

3.4.1.2.1 Chemical Inventory.

Gases, Liquids and Solids. The chemical composition of tank waste has been determined based on an evaluation of currently available data that characterizes the tank waste. Similar to the approach used for radionuclides, scatter plots for each of the 24 analytes were generated for both solid and liquid single-shell and double-shell tank samples, and the concentrations were reviewed by an expert panel to determine the maximum valid concentration. The scatter plots, along with the supporting data, procedures, and assumptions are documented in WHC-SD-WM-ER-400, *Tank Waste Source Term Inventory Validation*. WHC-SD-WM-SARR-011 presents a detailed discussion of the development of the chemical inventory. Table 3.4.1-5 provides the chemical constituents used to develop the liquid and solid sum-of-fraction of risk guidelines.
Table 3.4.1-6 provides the chemical constituents in the released slurry gases used for the gaseous sum-of-fractions of risk guidelines.

3.4.1.2.2 Exposure Pathways. The toxicological source terms resulting from TWRS accidents comprise liquid and solid particulates and gases. The effects of chemical exposure are evaluated based on the airborne pathway only,

because the toxicological risk guidelines are based on the chemical concentration at the location of the maximum onsite and offsite individuals. Inhalation of chemicals, and exposure to the skin and eyes, were considered in developing the risk guidelines.

3.4.1.2.3 Exposure Calculation Methods. The basic sums-of-fractions used in the analysis are taken from WHC-SD-WM-SARR-011. The application of specific sums-of-fractions for the WRSS is developed in this section.

Following the information provided earlier on the liquid/solid ratios and the bounding and reasonable composites, sums-of-fractions were developed for each frequency category and for the case of a continuous release or a puff release. Table 3.4.1-7 provides the values used in this document. As discussed earlier, the terms "bounding" and "reasonable" were chosen based upon radiological considerations, not toxicological. Even though the toxicological sum-of-fractions labeled "bounding" is less than the sum-of-fractions labeled "reasonable," both were used in the calculations and compared against the risk guidelines. The derivation of unit release sum-of-fraction values are discussed in more detail in WHC-SD-WM-SARR-011.

Table 3.4.1-1. Maximum Sample Activity Concentrations for Tank Farms Waste (based on the 100% inventory bounding activity concentrations).

Nuclide	Activity concentration, Bq/L			
	SST Liq	SST Sol	AWF[a] Liq	AWF[a] Sol
^{14}C	1.0 E+05	1.2 E+05	5.8 E+04	1.0 E+05
^{60}Co[d]	9.5 E+06	4.2 E+08	7.7 E+05	4.9 E+08
^{79}Se	[c]	1.7 E+04	[c]	[c]
^{90}Sr[d]	1.1 E+10	1.6 E+12	5.6 E+09	2.9 E+12
^{90}Y[d]	1.1 E+10	1.6 E+12	5.6 E+09	2.9 E+12
^{99}Tc	1.7 E+07	1.2 E+10	1.2 E+07	2.8 E+08
^{106}Ru	9.9 E+02	7.2 E+04	[c]	[c]
^{125}Sb	3.4 E+04	1.8 E+08	[c]	[c]
^{129}I	1.0 E+04	6.4 E+06	4.4 E+01	4.1 E+06
^{134}Cs	1.2 E+05	1.4 E+06	1.3 E+04	[c]
^{137}Cs[d]	2.2 E+10	1.0 E+11	8.8 E+10	9.8 E+10
^{144}Ce	9.1 E+00	3.4 E+02	[c]	[c]
^{147}Pm	[c]	[c]	[c]	[c]
^{154}Eu[d]	2.4 E+09	5.8 E+09	[c]	1.1 E+10
^{155}Eu	5.9 E+07	5.0 E+06	[c]	[c]
^{237}Np[d]	[c]	3.0 E+07	9.2 E+04	9.9 E+08
^{238}Pu[d]	9.2 E+04	1.9 E+08	2.8 E+03	6.7 E+07
^{239}Pu[b,d]	3.6 E+07	4.4 E+08	1.2 E+06	4.4 E+08
^{241}Pu[d]	2.6 E+08	3.2 E+09	3.4 E+05	1.7 E+09
^{241}Am[d]	4.2 E+07	2.3 E+08	1.1 E+06	1.1 E+10
^{242}Cm	[c]	[c]	[c]	2.0 E+02
^{244}Cm[d]	4.2 E+05	2.3 E+06	1.1 E+04	6.1 E+07

[a]Aging waste facility (AWF) tanks (Tank Farms 241-AY and 241-AZ).
[b]The ^{239}Pu activity concentration also includes ^{240}Pu.
[c]No available data. These radionuclides have a negligible impact on the dose calculations due to their low activity concentrations.
[d]Eleven dominant isotopes.
SST = single-shell tank.

Table 3.4.1-2. Project W-320 Analysis Liquid/Solid Ratios.

Location	% Liquid/% solid
Tank 241-C-106 - Headspace	67/33
- Aqueous phase	67/33
- HEPA filters	67/33
Slurry line	67/33
Tank 241-AY-102 - Headspace	90/10
- Aqueous phase	90/10
- HEPA filters	90/10
Sluice line	90/10

HEPA = high-efficiency particulate air (filter).

Table 3.4.1-3. Unit Liter Doses Used in the Waste Retrieval Sluicing System Analyses.

Waste type	Inhalation, Sv/L	Ingestion, Sv/L
SST liquids	1.1 E+04	0.05
SST solids	2.2 E+05	4.10
AWF tank liquids	1.4 E+03	0.09
AWF tank solids	1.7 E+06	8.10

AWF = aging waste facility.
SST = single-shell tank.

Table 3.4.1-4. Project W-320 Analysis Composite Unit Liter Doses.

Location	% Liquid/ % solid	Inhalation bounding case[a], Sv/L	Inhalation reasonable case[b], Sv/L	Ingestion bounding case[a], Sv-m^3/s-L	Ingestion reasonable case[b], Sv-m^3/s-L
Tank 241-C-106 - Headspace	67/33	5.6 E+05	1.2 E+05	2.73	1.54
- Aqueous phase	67/33	5.6 E+05	1.2 E+05	2.73	1.54
- HEPA filters	67/33	5.6 E+05	1.2 E+05	2.73	1.54
Slurry line	67/33	5.6 E+05	1.2 E+05	2.73	1.54
Tank 241-AY-102 - Headspace	90/10	1.7 E+05	3.9 E+04	0.89	0.53
- Aqueous phase	90/10	1.7 E+05	3.9 E+04	0.89	0.53
- HEPA filters	90/10	1.7 E+05	3.9 E+04	0.89	0.53
Sluice line	90/10	1.7 E+05	3.9 E+04	0.89	0.53

[a]Modeled as 100% AWF liquids and 100% AWF solids.
[b]Modeled as 90% AWF and 10% SST liquids, and 10% AWF and 90% SST solids.
AWF = aging waste facility.
HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

Table 3.4.1-5. Tank Waste Liquids and Solids Analyte Concentrations (Revised). (2 sheets)

Composites concentrations (g/L)				
Analyte	SST solids	SST liquids	DST/AWF solids	DST/AWF liquids
Ammonia (NH3)	3.3 E-01	5.1 E-01	6.6 E+00	7.1 E+00
Antimony (Sb)	1.5 E+00	3.6 E-03	9.2 E-01	6.4 E-03
Arsenic (As)	1.2 E+00	3.0 E-03	5.7 E+00	1.1 E-02
Barium (Ba)	4.0 E+01	5.3 E-02	5.9 E+00	3.3 E-02
Beryllium (Be)	2.6 E-02	3.0 E-04	2.4 E-01	3.8 E-03
Cadmium (Cd)	1.7 E+00	5.0 E-02	2.6 E+01	7.0 E-02
Calcium (Ca)	5.1 E+01	1.1 E+00	2.6 E+01	1.3 E+00
Cerium (Ce)	9.0 E-01	1.8 E+00	2.6 E+00	5.8 E-02
Chromium (Cr+3)	6.9 E+01	[a]	1.5 E+02	[a]
Cobalt (Co)	5.4 E-01	1.3 E-03	4.4 E+00	8.8 E-03
Cyanide (Cn)	8.2 E+00	5.3 E+00	4.7 E-01	9.1 E-02
Dysprosium (Dy)	[a]	[a]	[a]	[a]
Lanthanum (La)	5.0 E+01	1.9 E-01	3.0 E+01	1.0 E+00
Mercury (Hg)	5.4 E+01	3.1 E-01	1.2 E-01	2.4 E-04
Neodymium (Nd)	2.4 E-01	1.4 E-01	7.0 E+00	5.6 E-03
Oxalate (C2O4)	2.8 E+02	3.7 E+00	2.8 E+02	[a]
Selenium (Se)	3.5 E+00	8.2 E-02	1.9 E+00	2.8 E-01
Sodium Hydroxide (NaOH)	2.1 E+02	2.1 E+02	2.3 E+02	2.1 E+02
Sodium (Na) - NaOH[b]	4.8 E+02	2.1 E+02	3.50 E+02	2.1 E+02
Tellurium (Te)	2.0 E-01	[a]	9.3 E-01	2.7 E-03
Thallium (Tl)	1.2 E+00	3.2 E-03	1.5 E+01	3.7 E-02
Total Organic Carbon (TOC) -Oxalate[b]	1.0 E+02	4.0 E+01	7.5 E+01	4.0 E+01

Table 3.4.1-5. Tank Waste Liquids and Solids Analyte Concentrations (Revised). (2 sheets)

Composites concentrations (g/L)				
Analyte	SST solids	SST liquids	DST/AWF solids	DST/AWF liquids
Uranium (U)	2.8 E+02	1.8 E+00	4.4 E+01	1.1 E+01
Vanadium (V)	3.3 E-02	4.1 E-03	1.2 E-01	2.1 E-03

[a]The best available data indicates the concentrations of this analyte in this composite is not significant.

[b]To avoid counting the same analyte twice, the oxalate concentration was subtracted from the TOC concentration and NaOH was subtracted from the Na concentration. Na(table) = Na(sample)-23/40(NaOH sample data)

AWF = Aging Waste Facility.
DST = double-shell tank.
SST = single-shell tank.

Table 3.4.1-6. Headspace Gas Composite Concentrations.

	Slurry gas composite[a]	
Gas	Concentration (ppmv)	Concentration (mg/m^3)[b]
Acetonitrile	13	21.8
Ammonia	61,300	40,000
Benzene	0.4	1.3
1,3 Butadiene	0.1	0.19
Butanol	58	164
Dodecane	45	296
2-Hexanone	0.8	2.7
Methylene chloride	2	22
Nitrous oxide	67,000	110,000
Propanenitrile	5	11
Tributyl phosphate	1	12
Tridecane	50	390

[a]Based on worst case composites including slurry gas released.
[b]The conversion from ppmv to mg/m^3 assumes a temperature of 38 °C (100 °F) and a pressure of 0.1 MPA (740 torr).

Table 3.4.1-7. Composite Sum-of-Fractions Values Used in WRSS Analyses.

Composite[a]	% Liquid/% solid					
	67/33	90/10	67/33	90/10	67/33	90/10
	10^{+0} to 10^{-2}		10^{-2} to 10^{-4}		10^{-4} to 10^{-6}	
Onsite continuous, s/L						
Bounding[b]	1.3 E+04	1.1 E+04	1.6 E+03	1.0 E+03	3.5 E+02	2.5 E+02
Reasonable[c]	1.9 E+04	1.2 E+04	6.8 E+03	2.6 E+03	4.5 E+02	2.8 E+02
Onsite puff, 1/L						
Bounding[b]	3.7 E+03	3.1 E+03	4.7 E+02	3.0 E+02	1.0 E+02	7.2 E+01
Reasonable[c]	5.6 E+03	3.7 E+03	2.0 E+03	7.5 E+02	1.3 E+02	7.9 E+01
Offsite continuous, s/L						
Bounding[b]	6.8 E+01	2.7 E+01	1.1 E+01	9.1 E+00	1.3 E+00	8.4 E-01
Reasonable[c]	4.0 E+01	1.8 E+01	1.6 E+01	1.0 E+01	5.6 E+00	2.1 E+00
Offsite puff, 1/L						
Bounding[b]	2.8 E-01	1.1 E-01	4.2 E-02	3.7 E-02	5.3 E-03	3.4 E-03
Reasonable[c]	1.6 E-01	7.1 E-02	6.2 E-02	4.1 E-02	2.3 E-02	8.6 E-03

[a]The labels "bounding" and "reasonable" were chosen based upon the effect of the mixtures (as defined below) on the radiological ULDs. Even though the toxicological sum-of-fractions labeled "bounding" is less than the sum-of-fractions labeled "reasonable," both were used in the calculations and compared against the risk guidelines.

[b]Modeled as 100% AWF tank liquids and 100% AWF tank solids.

[c]Modeled as 90% AWF tank and 10% SST liquids, and 10% AWF tank and 90% SST solids.

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3.4.2 Evaluation Basis Accidents

This section presents analyses of evaluation basis accidents identified in Table 3.3.2-1. The evaluation basis accidents are analyzed to identify Safety-Class and Safety-Significant SSCs and TSRs.

The first step in the analytical process is to quantify the consequences and frequency of a postulated accident, assuming the absence of existing preventive or mitigative features. As stated in DOE-STD-3009-94 assuming the absence of preventive or mitigative features "does not require denying the physical design of facility structures, systems, and components." Accordingly, credit is taken for certain design features, primarily those that are passive (e.g., in a waste transfer analysis, it is assumed that a waste transfer line is encased).

Understanding that an "analysis without controls" is an evaluation of a hypothetical condition and not an evaluation of the current operational configuration of a subject facility is important. The purpose of performing the analysis without controls is to establish a baseline risk (i.e., a consequence and frequency) that can be compared to the risk guidelines. This comparison puts the relative importance of the need for controls into perspective and defines the need for further analysis.

Consequences for analyses without controls are calculated by not taking credit for mitigative features (e.g., filtered ventilation pathways) during source term development. Frequencies are based on the absence of controls, not the failure of controls at a defined rate, and are therefore equal to the initiating event frequencies. Based on this approach, the frequency of accidents without controls typically falls in the anticipated category (i.e., $>1 \times 10^{-2}$ to $\leq 1 \times 10^{0}$ per year). This should not be misinterpreted to mean that the consequences of an accident without controls can actually occur at a TWRS facility at an anticipated frequency. As already stated, these are evaluations of hypothetical conditions performed to establish a baseline risk.

Once determined, the consequences and frequency of the accident without controls are compared to the risk guidelines. If the consequences are within both the onsite and offsite guidelines at the applicable frequency, no further quantitative analysis is performed to define controls. In such cases, existing controls are typically defined as providing Defense-in-Depth.

If the risk guidelines are exceeded, additional analysis is required to identify Safety-Class or Safety-Significant SSCs and TSRs. In accordance with WHC-CM-4-46[2], *Safety Analysis Manual*, Safety-Class SSCs are required if the offsite guidelines are exceeded. Safety-Significant SSCs are required if the onsite radiological or toxicological guidelines are exceeded.

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[2]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," of the FSAR for the cross-walk between sitewide controlled manuals (e.g., WHC-CM-X-XX) superseded by FDH procedures (e.g., HNF-PRO-XXX).

Consistent with DOE-STD-3009-94, safety SSCs and TSRs are selected using an iterative process in which credit for preferentially selected controls is taken incrementally and the results are compared with the risk guidelines. The result is an "analysis with controls." In these analyses, consequences and frequencies are determined, assuming that the identified controls function as intended. If the controls are mitigative, the accident frequency remains unchanged relative to the analysis without controls, but consequences are reduced. If the controls are preventative, the means by which the controls prevent the accident (or serve to reduce its frequency) are described, but no consequences are calculated. Although these analyses make the assumption that the controls function as intended, it is recognized that each identified SSC and TSR has an associated failure rate.

Controls were selected using the process and control decision criteria discussed in the FSAR main text, Section 3.3.1.5. When comparing the results of analyses with and without controls to the guidelines, consideration was given to the margin by which the guidelines were met and the reliability of the selected controls. For cases in which the margin was small, the need for additional controls was evaluated. In these evaluations, the degree of conservatism in the consequence calculation was considered. Controls known to be of low reliability were not selected. For cases in which the degree of reliability was uncertain, the need for additional controls was evaluated.

The following sections summarize the findings of the evaluation basis accident analyses. A scenario, source term, consequence analysis, and comparison with guidelines are presented for each evaluation basis accident, both without and with controls. Selected safety structures, systems, and components; TSRs; and Defense-in-Depth controls are identified and defined. Each scenario describes the accident progression that links initiating events with other contributing phenomena and, for the analyses with controls, selected preventive or mitigative controls. For operational accidents, the scenario frequencies were developed from TWRS operating history and applicable equipment failure rates and human error probabilities. The frequencies were developed to a level of detail sufficient to place the event in a two-order of magnitude category as defined by the risk guidelines (i.e., 10^{-4} to 10^{-2}/yr).

Source terms and consequences of the postulated accidents were calculated using the method described in Section 3.4.1. The calculations are deterministic. Realistic, yet conservative, values were selected for each parameter used in the source term calculations. The ULDs, sum-of-fractions, and adverse meteorological conditions used in the consequence calculations also add conservatism. Such a compounding of conservatisms results in consequence values which when combined with the event frequency, can overstate the actual risk. This conservatism, however, is relied on to ensure that associated uncertainties are bounded. The sensitivities of key assumptions used in the consequence calculations are presented following the comparison with guidelines.

3.4.2.1 Criticality. The WRSS criticality accident is an internally initiated operational accident.

3.4.2.1.1 Scenario Development. WHC-SD-W320-CSA-001, *Criticality Safety Assessment of the Tank 241-C-106 Remediation*, concludes that an inadvertent criticality as a result of the activities associated with WRSS is not considered possible for the plutonium concentration determined to be in tank waste and the WRSS process to be applied to the tank waste (WHC-SD-W320-CSA-001). The criticality safety evaluation considered the potential settling behavior of the sludge in both tanks, the behavior of the sludge in pumps used in both tanks, and the resultant mixture of sludges in the receiver tank. The following paragraphs summarize the information found in WHC-SD-W320-CSA-001.

Tank 241-C-106 stores a total mass of plutonium that may be higher than in any other waste storage tank on the Hanford Site. For this reason, Tank 241-C-106 has the potential for a higher localized concentration of plutonium than any other waste tank. The best estimate of the highest concentration of plutonium that could be drawn into the transfer pump was identified, and the impact of discharging the fissile material bearing solids into Tank 241-AY-102 was determined.

Because core samples are mixed and homogenized before analysis, the analysis will not detect high plutonium concentration layers in the sludge. If a high plutonium concentration layer is formed and drawn into the discharge pump housing, the possibility exists that a more favorable geometry with respect to criticality might be achieved. Because the composition of the waste currently stored in Tank 241-C-106 and Tank 241-AY-102 cannot be observed, the estimate of the highest concentration of plutonium that may exist was determined largely by comparing historical records, transfer data, sample data, and computer modeling. Worst-case scenarios were chosen to investigate the concentrating mechanisms and the mass/geometry consequences of distributing the solids in both tanks.

Existing documents agree that waste in Tank 241-C-106 consists of four major waste layers. The plutonium concentration in each layer was estimated from a combination of flowsheet and sample information documented in WHC-MR-0132, *A History of the 200 Area Tank Farms*; LA-UR-94-2657, *Hanford Defined Wastes: Chemical and Radionuclide Compositions*; LA-UR-96-3860, *Hanford Tank Chemical and Radionuclide Inventories of HDW Model Rev. 4*; and WHC-EP-0793, *Estimation of Plutonium in Hanford Site Waste Tanks Based on Historical Records*. A review of sample data stored in the waste characterization data files supported the estimated composition of the waste layers.

A value for the highest plutonium concentration that may exist in a layer in the major waste types was based on a study of more than 260 waste transfers from the Plutonium-Uranium Extraction (PUREX) Plant to Tank 241-AZ-101 (HNF-SD-W151-CSA-001, *CSER 96-014: Criticality Safety of Project W-151, 241-AZ-101 Retrieval System Process Test*). Quantified uncertainties about the analogy between Tank 241-C-106 and Tank 241-AY-102 were not attempted, because empirical data on the plutonium concentrations of thin layers of waste in either tank are not available. The information from Tank 241-AZ-101 was used

because both tanks received plutonium-bearing waste in small batches, the waste in each batch was made alkaline before discharge, the plutonium-bearing solids settled out in layers, and the plutonium precipitate is expected to exhibit the same chemical and physical characteristics in both tanks. The highest plutonium concentration in the solid phase of a transfer from PUREX was estimated to be as much as six times greater than the average concentration of a waste layer. However, the layer of solids from a single transfer is estimated to be only a millimeter thick and will be diluted in the sluicing process.

For Hanford Site waste, the plutonium concentration must be at least 2.6 g Pu/L before criticality becomes possible, even in an unlimited volume of waste. This value is based on a uniform mixture of plutonium and other materials. The waste solids are conservatively assumed to match the Rogers Waste Model (WHC-SD-SQA-CSA-20356, *CSER 92-009: An Analytical Model for Evaluating Subcritical Limits for Waste in Hanford Site Storage Tanks*), which defines a minimum neutron absorber composition, assumes a solids density of 1.2 g/cc, and assumes the water content is optimized. This subcritical limit is set for k_∞ not exceeding 0.95 at a 95% confidence level. After considering the uncertainty, the calculated k_∞ is 0.935.

Potential segregation of plutonium-bearing solid particles is a primary concern with the activities associated with WRSS. Computer simulations estimated the segregation of various particle sizes in the pump well in Tank 241-C-106 and in layers settling in Tank 241-AY-102. The segregation of plutonium was evaluated by extrapolating the data from the models with the assumption that the plutonium existed exclusively as one of the particle sizes modeled (5 to 10 μm, 25 to 35 μm, or 50 to 55 μm). The largest particles (50 to 55 μm) are expected to exhibit the greatest degree of particle segregation from the bottom of the hole (pump well) to the top. The finest particles (5 to 10 μm) are the most uniformly distributed; the medium-sized particles and the plutonium-bearing solids in the conservative representation are expected to exhibit only moderate segregation.

The composition of solids and liquids involved in the retrieval operation will affect the behavior of plutonium in the sludges. Both plutonium solubility and plutonium sorption/desorption on the sludge particles are affected by solid and liquid composition. In Tank 241-AY-102, the average concentration of plutonium in the sludge is a factor of 34 lower than the minimum critical concentration of 2.6 g/L. The mass ratios for Fe/Pu and Mn/Pu are 1070 and 147, respectively. The Fe/Pu and Mn/Pu mass ratios are much greater than the minimum critical mass ratios for these neutron absorbers of 160 and 32, respectively. To reach these minimum criticality limits, the average sludge material must undergo a chemical alteration that concentrates the plutonium 34 times and that separates plutonium from iron and manganese by factors of 6.7 and 4.6, respectively.

Any chemical mechanism for concentrating the plutonium in a waste tank would require transport of plutonium from the solid phase to the aqueous liquid phase, and then to a small volume solid phase. Hence, for the first step, sorbed plutonium must be desorbed into the aqueous phase of the waste mixture. Plutonium sorption on oxyhydroxides is known to be mostly irreversible unless the solution composition in contact with the plutonium is

dramatically altered. This would require (1) the addition of organic or inorganic plutonium complexants, (2) a change in the REDOX potential of the solution by adding oxidants, or (3) acidification of the solution. None of these dramatic changes are part of the scope of the WRSS. A primary parameter for ensuring criticality safety is the mass ratios of insoluble absorbers to plutonium, i.e., Fe and Mn. The transport of soluble solids from the solid phase to the sluicing supernate will not impact the mass ratios of Fe/Pu and Mn/Pu. Even though the plutonium concentration per liter of solids may increase, the mixture will be subcritical regardless of the moderation or quantity.

A hole (e.g., pump well) was sluiced into the Tank 241-C-106 waste so that the immersible pump could be installed. The estimated concentration of plutonium in the slurry inside the hole depends on the initial plutonium concentration and the assigned particle size. The concentration of plutonium in all the solids entering the hole was assigned the high concentration of 0.78 g Pu/L of solids. Even though the medium-sized particles (25 to 35 μm) are considered conservative, the plutonium was assigned the coarsest particle dimension to provide a bounding analysis. The plutonium concentration of the slurry was determined to be 0.55 g Pu/L near the bottom of the hole and 0.12 g Pu/L of slurry near the surface of the hole. The other particle sizes were also evaluated and, as predicted, the plutonium concentration is fairly uniform throughout the hole, ranging from 0.12 g Pu/L to 0.2 g Pu/L of slurry. These concentrations are highly subcritical regardless of the geometry, quantity, or moderation.

Assuming that plutonium exists as the largest particle size (50 to 55 μm), the increase in plutonium concentration caused by settling was investigated. The particle segregation predictions discussed in WHC-SD-WM-TI-757, *Fluid Dynamic Particulate Segregation, Chemical Process, and Natural Ore Analog Discussions that Relate to the Potential for Criticality in Hanford Tanks* indicate that, for the most realistic scenarios, the level of segregation of fissile material from neutron absorbers is roughly a factor of 2.5. To bound these conclusions, the plutonium concentration was assumed to be increased by a factor of three. This results in a plutonium concentration of settled solids at the bottom of the pumpout well of 2.34 g Pu/L. Since the quantity of neutron absorber materials present is over 10 times the amount necessary to preclude a criticality, it is concluded that the waste will remain subcritical.

An operational scenario that was evaluated consists of the slurry pump being shut down for a time sufficient enough to allow all the solids in the hole to settle. The assumed retrieval rate of the slurry pump for this scenario is 18.9 L/s (300 gpm), so the slurry entering the hole was assumed to be 18.9 L/s (300 gpm) with a 30 wt% solids, with a mean residence time in the hole of about 1.5 minutes. If the solids entering the hole have a plutonium concentration of 0.78 g Pu/L, then over 1.5 minutes the hole will contain 306.6 L of solids for a total mass plutonium of 239.1 g. Since the minimum critical mass of plutonium is 520 g in idealized plutonium-water conditions, the solids in the hole will be highly subcritical.

The impact of pulling the layer with the highest estimated plutonium concentration into the slurry pump and transferring it to Tank 241-AY-102 was

investigated. Tank 241-AY-102 currently contains some plutonium-bearing solids, but the solids from Tank 241-C-106 are expected to settle in a relatively flat slab across the top of these solids. This evaluation, which was based on the available data, input, and assumptions, did not identify a mechanism for concentrating or segregating plutonium particles into a concentration or geometry sufficient to allow a criticality accident. These results, together with the fact that the quantity of neutron absorber materials present in both tanks is over 10 times the amount necessary to preclude a criticality, establish a reasonable degree of assurance that a criticality will not occur.

3.4.2.1.2 Source Term Analysis. The postulated WRSS criticality accident is considered to be beyond extremely unlikely. Because the accident is considered beyond extremely unlikely, no source term analysis is performed.

3.4.2.1.3 Consequence Analysis. The postulated WRSS criticality accident is considered to be beyond extremely unlikely. Because the accident is considered beyond extremely unlikely, no consequence analysis is performed.

3.4.2.1.4 Comparison to Guidelines. Because the postulated WRSS criticality accident is considered to be beyond extremely unlikely, no comparison to guidelines is performed.

3.4.2.1.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. Because the criticality accident is considered beyond extremely unlikely, no safety structures, systems, and components are required. A TSR control has been identified, however, to protect key assumptions made in the analysis (Table 3.4.2.1-1). These provide reasonable assurance that the waste will remain subcritical during WRSS operations. These criticality safety conclusions are supported by the following evaluations: WHC-SD-W320-SP-001, *Project W-320 Position Paper - Criticality Concern*, and WHC-SD-W320-CSA-001.

Table 3.4.2.1-1. Technical Safety Requirement Control for Nuclear Criticality Accident.

Control	Safety Function	Comments
Nuclear Criticality Safety Program Key Elements • Establish CPSs based on CSERs • Recovery actions if limits are exceeded • Criticality training program	Prevents the occurrence of a nuclear criticality	None

CPS = Criticality Prevention Specification.
CSER = Criticality Safety Evaluation Report.

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3.4.2.2 High-Efficiency Particulate Air Filter Failure Due to Exposure to High Pressure or High Temperature. Active ventilation is maintained across single-shell Tank 241-C-106 and double-shell aging waste facility Tank 241-AY-102. Chapter 2.0 describes Tank 241-C-106 and Tank 241-AY-102 ventilation systems and facilities. Potential releases of radioactive and hazardous materials resulting from ventilation system failures are evaluated in the following sections. This differs from Section 3.3.2.4.2 of the main text of the FSAR because the unit liter doses for the material at risk for the WRSS are larger.

In the following two sections, potential releases of radioactive and hazardous materials resulting from High-Efficiency Particulate Air (HEPA) filter failures are evaluated. Section 3.4.2.2.1 presents an accident analysis of HEPA filter failure caused by exposure to high temperatures. Section 3.4.2.2.2 presents a nonmechanistic consequence analysis of HEPA filter failure caused by exposure to high pressure. Section 3.4.2.3 presents the accident analysis for an unfiltered release.

3.4.2.2.1 HEPA Filter Failure - Exposure to High Temperature. High temperatures associated with an external fire (occurring in close proximity to the ventilation system) or the failure of an in-line heater (present in some ventilation systems) could degrade the ventilation system filters. If the integrity of the filters were compromised, the inventory on the filters could be released, followed by an unfiltered release from the tank vapor space if the exhaust fans continue to operate.

Scenario Development. The postulated scenario assumes that a fire occurs in or around a ventilation system, the heat from the fire degrades the filters, a fraction of the inventory of tank waste accumulated on HEPA filters and other ventilation system components is released, and an unfiltered release pathway is established. For actively ventilated systems, the exhaust fans continue to run. For one case, releases from the unfiltered pathway are assumed to continue for up to one year.

Table 3.4.2.2-1 includes the conversion factor for calculation of the one year dose. This duration is in contrast to other potential WRSS accidents that have relatively short-term durations (i.e., minutes or hours). The one-year unfiltered release consequences show the sensitivity of the analysis to assumptions regarding release duration, and were used in conjunction with 12- and 24-hour consequences to select the necessary and sufficient set of controls.

The event frequency for this high temperature accident scenario is anticipated ($> 10^{-2}$ yr^{-1} to $\leq 10^{0}$ yr^{-1}) based on the initiating event frequency for either a heater failure or an external fire. Heaters in the ventilation system have failed in the past, resulting in high temperatures in the exhaust air and some degradation of the filters. The failure of the heater to shut off could create an high temperature situation and cause the failure of the filters in the ventilation system. An external fire around the ventilation system would likely cause a filter degradation, as analyzed here. This event frequency is consistent with the analysis presented in Section 3.4.2.4 that evaluates the consequences of a fire in a contaminated area.

Source Term Analysis. The source term and the unit liter doses for the accident analysis are presented in Section 3.4.1. It is assumed that the contamination on the Tank 241-AY-102 ventilation system filters and in the Tank 241-AY-102 headspace air, during sluicing operations and afterwards, is composed of 90% liquids and 10% solids. The contamination on the Tank 241-C-106 filters and in the Tank 241-C-106 headspace air is composed of 67% liquids and 33% solids. For both tanks, the liquid portion of the aerosol is assumed to be a mix of 10% single-shell tank liquids and 90% aging waste facility liquids. The solid portion of the aerosol is assumed to be a mix of 90% single-shell tank solids and 10% aging waste facility solids. The aerosol in Tank 241-AY-102 has a unit liter dose equal to 3.9×10^4 Sv/L (3.9×10^6 rem/L). The aerosol in Tank 241-C-106 has a unit liter dose equal to 1.2×10^5 Sv/L (1.2×10^7 rem/L).

The material at risk on the HEPA filters was assumed to have a filter housing contact dose rate of less than or equal to 2 mSv/h (200 mrem/h). Because this is an assumption for filter loading, it requires a TSR control. This contact dose rate is based on operational history and bounds the contact dose rates historically used to replace HEPA filters in the tank farms. HNF-SD-WM-CN-099, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, uses the contact dose rate and conservative sluicing source term to back calculate the inventory on the filters.

The material at risk on the High-Efficiency Gas Adsorber (HEGA) in the 241-AZ-702 ventilation system is assumed to be 100% of the material that passes through the upstream HEPA filter. A TSR control is required to protect the HEGA filter loading assumption in the analysis. To limit the material that could potentially accumulate on the HEGA filter, it will be replaced before the upstream HEPA filter in the associated filter train has been replaced 20 times, or upon indication of degraded HEPA filter performance.

The High-Efficiency Mist Eliminator (HEME) and High-Efficiency Metal Filter (HEMF) on the 296-C-006 ventilation system were assumed to be flushed to limit the dose rate at the radiation detector to less than or equal to 1 mSv/h (100 mrem/h). The radiation detector is set to alarm at a dose rate of 0.2 mSv/h (20 mrem/h) for purposes of personnel radiation protection, independent of the accident analyses. Since the dose rate is an assumption for filter loading, it requires a TSR control. The HEME for the 241-AZ-702 ventilation system is located in a vault and is not subject to internal or external heat sources. The de-entrainers for the 241-AZ-702 and the 296-P-16 ventilation systems are located in caissons and are not subject to internal or external heat sources. Thus, the HEME and de-entrainers do not contribute to the source term for a high temperature or fire condition.

Based on information presented in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Non-reactor Nuclear Facilities*, the respirable release fraction for HEPA filters exposed to high temperature or fire is 1.0×10^{-4}. This release fraction is judged to be suitable for the HEME and HEMF for the 296-C-006 ventilation system. The HEGA contains activated carbon for the adsorption of gases in the tank ventilation airstream. It is assumed that 100% of the HEGA inventory may be released as respirable particulate in the event of a fire.

The unfiltered effective continuous release amount was based on the ventilation flow and calculated by multiplying the nominal volumetric flow rate by a partition factor to convert it to an equivalent outflow of radioactive contaminant. An "agitated tank" partition factor of 1.0×10^{-8} was used. The partition factor cited here is based on experiment results published in RHO-RE-SA-216, *Characterization of Airborne Radionuclide Particulates in Ventilated Liquid Waste Tanks*, for agitated (1.0×10^{-8}) and unagitated (1.0×10^{-10}) tanks under active and passive ventilation.

Consequence Analysis. Appropriate dispersion coefficients and breathing rates are applied to the release amounts to calculate the radiological consequences. These consequence calculations are presented in HNF-SD-WM-CN-099.

The total consequences of the HEPA filter failure event without controls are calculated by adding the consequences resulting from the amount of respirable material released during the HEPA filter failure and the subsequent continuous, unfiltered release following the filter failure. Consequences resulting from the unfiltered release pathway were calculated for 12 hours (onsite receptor) and 24 hours (offsite receptor).

Table 3.4.2.2-1 summarizes the onsite and offsite radiological and toxicological consequences, without controls for releases from failed ventilation system filters. The factor for determination of the one-year unfiltered release consequences is also shown in Table 3.4.2.2-1. The one-year consequences indicate the sensitivity of the analysis to assumptions regarding release duration. Table 3.4.2.2-2 presents the consequences with controls.

Comparison to Guidelines. Table 3.4.2.2-1 presents the radiological and toxicological consequences of the accident scenario without controls. The radiological onsite consequences are above the risk guidelines for each of the ventilation systems except for 296-P-16. Table 3.4.2.2-1 shows that, for the 24-hour unfiltered release, the offsite radiological risk guidelines are not exceeded. The onsite and offsite toxicological risk guidelines also are not exceeded. A control has been developed to lower the consequences of the onsite radiological dose. This TSR control requires the active ventilation to be shut off within 10 minutes of detecting an unfiltered release. The consequences summary in Table 3.4.2.2-2 shows that, in the case with controls, the onsite radiological dose is kept at or below the risk guideline. The offsite radiological dose is below the risk guidelines. Toxicological consequences are assumed to be related to peak concentration and the peak concentration occurs at filter failure, any reduction in unfiltered event duration has no effect on the calculated sum-of-fractions of the risk guidelines.

Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems and Components. The radiological dose to the onsite receptor exceeds the risk guideline (see Table 3.4.2.2-1) for each system except the 296-P-16 ventilation system. The continuous air monitor interlocks that shut off the ventilation system within 10 minutes for each of

the ventilation systems on Tank 241-AY-102 and Tank 241-C-106 are selected as safety significant components. The continuous air monitor interlock was also identified as safety significant in Section 3.3.2.4.2 of the main text of the FSAR.

Table 3.4.2.2-3 lists the safety structures, systems, and components selected to lower the consequences of HEPA filter failure. For each safety structure, system, and component the safety function is described and additional comments are provided as appropriate.

Technical Safety Requirement Controls. Table 3.4.2.2-4 lists the TSRs selected to lower the consequences of HEPA filter failure. The TSRs require the CAM to detect high radioactivity caused by HEPA filter failure and the interlock to shut down the ventilation system. The filter loading is protected by requiring periodic testing, monitoring, and filter change out criteria.

Defense-in-Depth. In addition to the identified safety structures, systems, and components and TSRs that are further described in Chapters 4.0 and 5.0, respectively, other engineering and administrative controls provide defense-in-depth protection for the public and workers against the risk of HEPA filter failure. The defense-in-depth controls are identified in Table 3.4.2.2-5. The function of the defense-in-depth controls and additional comments are also included in the table, as appropriate.

3.4.2.2.2 HEPA Filter Failure - Exposure to High Pressure. A pressure differential of 2.5 Kpa (0.36 lb/in^2 [10 in. water gauge]) can fail HEPA filters. Upon failure, the inventory on the filters could be released, followed by an unfiltered release from the tank vapor space. The purpose of this analysis is to provide a common set of reference values to be used in analyzing potential accidents that could raise tank pressures to greater than 2.5 Kpa. These accidents include the following: flammable gas deflagrations (Section 3.4.2.8), organic solvent fire (Section 3.4.2.9), in-tank fuel fire/deflagrations (Section 3.4.2.10), tank bump (Section 3.4.2.11) and liner breach in tank 241-C-106 (Section 3.4.2.12).

Scenario Development. An overpressurization event is postulated to occur within a waste tank. All filters in the ventilation system fail because of the pressure increase, a fraction of the inventory of tank waste accumulated on the filters plus the ventilation system ductwork is released, and an unfiltered release pathway is established. The exhaust fan continues to run, releasing aerosols from the tank headspace. The event frequency is based on the initiating event frequency (e.g., tank bump in-tank fuel fire, etc.). The frequencies associated with the initiating event are discussed in the accident analyses in the sections identified above.

Source Term Analysis. The source term and the unit liter doses for the accident analysis are presented in Section 3.4.1 and discussed in Section 3.4.2.2.1.

The dose rate on the HEME for the 241-AZ-702 ventilation system was assumed to be limited to 8 mSv/h (800 mrem/h). Since this dose rate is an assumption for filter loading, it requires a TSR control. The waste inventory

in the de-entrainers for the 241-AZ-702 and the 296-P-16 ventilation system was calculated based on field survey data. Other vent system component loading assumptions are as discussed in Section 3.4.2.2.1.

Bounding values for fiberglass filters are based on information presented in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, for HEPA filters subjected to explosive stresses (e.g., shock, blast, and venting) or thermal stress. The airborne respirable release fraction used to determine the amount of respirable material released from the filter as a result of crushing is 1.0×10^{-2} (DOE-HDBK-3010-94). The cited airborne respirable release fraction for HEPA filters subjected to explosive stresses is considered applicable and conservative for use in this analysis because the fiberglass filters used in tank farm ventilation systems are similar to those empirically evaluated in DOE-HDBK-3010-94.

Consequence Analysis. Appropriate dispersion coefficients and breathing rates are applied to the release amounts to calculate the radiological consequences. Toxicological consequences are calculated using a frequency dependent sum-of-fractions methodology. This analysis presents sum of fractions values based on the assumption that the event falls in the anticipated frequency category.

Table 3.4.2.2-6 summarizes the onsite and offsite radiological and toxicological consequences, without controls for releases from failed ventilation system filters. The consequences associated with the unfiltered release are presented in Section 3.4.2.2.1.

Comparison to Guidelines. Doses calculated for the HEPA filter overpressurization accident are not related to an event frequency nor compared with guidelines limits. This is because the frequencies of the initiating events (e.g., tank bump, etc.) will differ. Thus, different guidelines will apply to each initiating event, since the guidelines are a function of event frequency. The section describing the specific accident scenario will provide such information.

Summary of Safety Structures, Systems, and Components and Technical Safety Requirements Controls.

Safety Structures, Systems, and Components. The safety structures, systems, and components are defined according to the specific accident scenario. Thus, appropriate safety structures, systems, and components are described in the applicable sections discussing the accidents.

Technical Safety Requirements Controls. Technical Safety Requirements controls are developed for specific accident scenarios. Thus, appropriate controls are described in the applicable sections. A Technical Safety Requirement control is established for filter loading (see Table 3.4.2.2-4).

Defense-in-Depth. Additional controls that provide defense-in-depth are determine based on the specific accident scenario that initiates the event (e.g., tank bump, etc.). Thus, appropriate defense-in-depth controls are described in the sections discussing the specific accidents.

Table 3.4.2.2-1. Summary of Consequences and Frequencies for Filter Failure Due to High Temperature Without Controls.

CONSEQUENCES									
Ventilation System	Radiological (Sv)				Toxicological (SOF)				Frequency
	Calculated Dose		Risk Guideline		Calculated SOF		Risk Guideline		
	Onsite*	Offsite**	Onsite	Offsite	Onsite	Offsite	Onsite	Offsite	
241-A-702									
Unfiltered Release***	5.8 E-02	8.3 E-05			2.5 E-01	3.4 E-04			
Release from Filter Failure	2.9 E-05	2.5 E-08			7.2 E-03	1.0 E-05			
Total	5.8 E-02	8.3 E-05	5 E-03	1 E-03	2.6 E-01	3.5 E-04	1 (ERPG-1)	1 (PEL-TWA)	Anticipated
241-AZ-702									
Unfiltered Release***	2.9 E-02	4.8 E-05			1.2 E-01	1.7 E-04			
Release from Filter Failure	1.0 E-03	8.8 E-07			2.5 E-01	3.5 E-04			
Total	3.0 E-02	9.6 E-05	5 E-03	1 E-03	3.7 E-01	5.2 E-04	1 (ERPG -1)	1 (PEL-TWA)	Anticipated
296-P-16****									
Unfiltered Release***	3.1 E-03	4.5 E-06			6.3 E-03	1.3 E-05			
Release from Filter Failure	6.5 E-05	5.6 E-08			7.6 E-03	1.6 E-05			
Total	3.2 E-03	4.6 E-06	5 E-03	1 E-03	1.4 E-02	2.9 E-05	1 (ERPG-1)	1 (PEL-TWA)	Anticipated
296-C-006									
Unfiltered Release***	1.6 E-02	2.3 E-05			3.2 E-02	6.8 E-05			
Release from Filter Failure	1.6 E-03	1.3 E-06			1.8 E-01	3.8 E-04			
Total	1.8 E-02	2.4 E-05	5 E -03	1 E-03	2.1 E-01	4.5 E-04	1 (ERPG-1)	1 (PEL TWA)	Anticipated

*12-hour Release
**24-hour Release
***Calculated dose can be converted to one-year doses by multiplying by 15.2 and 9.8 for the onsite and offsite receptors respectively.
****296-P-16 ventilation system is not operated during sluicing operations.

Table 3.4.2.2-2. Summary of Consequences and Frequencies for Filter Failure Due to High Temperature With Controls.

CONSEQUENCES									
Ventilation System	Radiological (Sv)				Toxicological (SOF)				Frequency
	Calculated Dose		Risk Guideline		Calculated SOF		Risk Guideline		
	Onsite*	Offsite**	Onsite	Offsite	Onsite	Offsite	Onsite	Offsite	
241-A-702									
Unfiltered Release	5.0 E-03	4.3 E-06			2.5 E-01	3.4 E-04			
Release from Filter Failure	2.9 E-05	2.5 E-08			7.2 E-03	1.0 E-05			
Total	5.0 E-03	4.3 E-06	5 E-03	1 E-03	2.6 E-01	3.5 E-04	1 (ERPG-1)	1 (PEL-TWA)	Anticipated
241-AZ-702									
Unfiltered Release	2.5 E-03	2.2 E-06			1.2 E-01	1.7 E-04			
Release from Filter Failure	1.0 E-03	8.8 E-07			2.5 E-01	3.5 E-04			
Total	3.5 E-03	3.1 E-06	5 E-03	1 E-03	3.7 E-01	5.2 E-04	1 (ERPG -1)	1 (PEL-TWA)	Anticipated
296-P-16**									
Unfiltered Release	2.7 E-04	2.3 E-07			6.3 E-03	1.3 E-05			
Release from Filter Failure	6.5 E-05	5.6 E-08			7.6 E-03	1.6 E-05			
Total	3.3 E-04	2.9 E-07	5 E-03	1 E-03	1.4 E-02	2.9 E-05	1 (ERPG-1)	1 (PEL-TWA)	Anticipated
296-C-006									
Unfiltered Release	1.4 E-03	1.2 E-06			3.2 E-02	6.8 E-05			
Release from Filter Failure	1.6 E-03	1.3 E-06			1.8 E-01	3.8 E-04			
Total	2.9 E-03	2.5 E-06	5 E -03	1 E-03	2.1 E-01	4.5 E-04	1 (ERPG-1)	1 (PEL TWA)	Anticipated

*10-minute Release
**296-P-16 ventilation system is not operated during sluicing operations.

Table 3.4.2.2-3. Safety Structures, Systems, and Components for High-Efficiency Particulate Air Filter Failure.

Structures, systems, or components	Safety classification		Safety function	Comments
	SC	SS		
Continuous air monitor-interlock on ventilation system	--	X	Prevents the unfiltered release from occurring for more than 10 minutes	Applies to the 241-A-702 and 241-AZ-702 ventilation systems for Tank 241-AY-102 and the 296-C-006 and 296-P-16 ventilation system for Tank 241-C-106.

SC = Safety-Class.
SS = Safety-Significant.

Table 3.4.2.2-4. Technical Safety Requirement Controls for High-Efficiency Particulate Air Filter Failure.

Control	Safety function	Comments
Ventilation Stack CAM Interlock System	Detects the high radioactivity and shuts off ventilation within 10 minutes for Tank 241-C-106 and Tank 241-AY-102 ventilation systems. This prevents the potential unfiltered release from occurring for more than a short period of time.	The 10 minute period for the 296-P-16 ventilation system comes from the existing analysis in the main text of the FSAR (Section 3.3.2.4.2).
HEPA Filter Control with the following key elements: - Periodic radiation survey to monitor HEPA, HEME, and HEMF filter loading - HEPA filter replacement per change-out criteria, i.e., ≤ 2 mSv/h (200 mrem/h) - 241-AZ-702 HEME replacement per change out criteria (8 mSv/h (800 mrem/h) - Periodic radiation survey to verify that 296-C-006 HEME/HEMF dose contribution is ≤ 1 mSv/h (100 mrem/h) at location of radiation detector that monitors the HEME/HEMF	Reduces consequences from a possible HEPA filter failure by limiting the inventory available.	
- Replacement of the 241-AZ-702 HEGA before the upstream HEPA filter has been replaced 20 times, or upon indication of degraded HEPA filter performance - Aerosol test upon installation (AWF 241-AZ-702) - Periodic aerosol test (AWF 241-AZ-702)	HEPA filter efficiency testing protects the HEGA filter (241-AZ-702) source term assumption in the analysis.	Applies to HEPA filters upstream of the HEGA filters.

CAM = continuous air monitor
HEGA = high-efficiency gas adsorber
HEME = high-efficiency mist eliminator
HEMF = high-efficiency metal filter
HEPA = high-efficiency particulate air (filter)

Table 3.4.2.2-5. Defense-In-Depth Controls for High-Efficiency Particulate Air Filter Failure.

Control	Function	Comments
Low Delta P interlock across the HEPA filters on the ventilation system	Shuts off the ventilation system to prevent unfiltered release	Where provided
High Delta P (across the HEPA filters) alarm (remotely, at a manned facility) on the ventilation system	Directs the operator to have filters replaced	Workers trained in responding properly to all alarms
Testing of filters following installation and annually, thereafter	Ensures the operability of the filters on the ventilation system	Workers trained in testing the filters
Record sampler	Provides quantitative release amounts reported to state (a higher-than-normal amount would indicate that an unfiltered release is occurring)	Record samplers tested periodically
Interlock/alarm on heater over temperature	Shuts down heater on high temperature indication to protect ventilation system	Interlock/alarms tested periodically, where provided
Periodic surveillance of HEPA Delta P and continuous air monitor	Ensures the operability of the HEPA filters and the filtration monitoring system	None
HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h)	Limits inventory available for release and limit dose rate to workers in the vicinity of the filters	None
Flushing of HEME and/or HEMF on the 296-C-006 ventilation system performed at dose rate of 0.2 mSv/h (20 mrem/h)	Limits inventory available for release and limit dose rate to workers in the vicinity of the filters.	None

HEPA = high-efficiency particulate air (filter).

Table 3.4.2.2-6. Summary of Consequences for Filter Failure Due to High Pressure Without Controls.

CONSEQUENCES				
Ventilation System	Radiological (Sv)		Toxicological (SOF)	
	Calculated Dose		Calculated Dose	
	Onsite*	Offsite**	Onsite	Offsite
241-A-702 Release from Filter Failure	1.6 E-02	1.4 E-05	4.0 E+00	5.5 E-03
241-AZ-702 Release from Filter Failure	1.2 E-02	1.0 E-05	2.9 E+00	4.1 E-03
296-P-16 Release from Filter Failure	2.7 E-02	2.3 E-05	3.1 E+00	6.6 E-03
296-C-006 Release from Filter Failure	2.6 E-01	2.2 E-04	3.0 E+01	6.4 E-02

Note: These consequences are not compared to risk guidelines since they are components of the consequences of the overpressure accidents
*Does not include unfiltered release
**24 Hour Release

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3.4.2.3 Unfiltered Release. This accident category refers to various failures of the WRSS ventilation systems (existing or new systems [Chapter 2.0]) not associated with the failure of HEPA filters analyzed in Section 3.4.2.2. The WRSS unfiltered release accidents identified in the hazard analysis can be grouped according to the following phenomena:

- **Unfiltered Flow (296-C-006 ventilation system)** — A duct breach in the recirculation loop of the 296-C-006 ventilation system could result in the forced release of unfiltered tank headspace gases if recirculation fans continue to operate.

- **Loss of Vacuum and Cooling (241-A-702, 241-AZ-702 and 296-P-16 ventilation systems)** — A duct breach or exhaust fan failure occurs, resulting in a loss of tank vacuum and a loss of tank cooling (no recirculation cooling is available).

- **Overheating** — The ventilation system continues to operate, but does not provide sufficient waste cooling (because of excess heat load in the tank, excess fluffing of waste, or high sluice water temperature.

- **High pressure** — Miscellaneous transient or minor high pressure events occur (e.g., air in slurry distributor line entering Tank 241-AY-102, a nitrogen line break in Tank 241-C-106).

- **Excess Vacuum** — Excess vacuum in tank headspace (caused by ventilation control or alignment error) causes the inlet seal loop to fail. The tank vacuum cannot be maintained after the vent system error is corrected, resulting in an unfiltered release out the failed seal loop.

- **Degraded Filtration** — Degraded filtration caused by the generation of excess aerosols in the tank dome occurs (may be caused by damage or excess flow to the slurry distributor or sluicer).

3.4.2.3.1 Scenario Development. Each of the scenarios listed above is discussed below.

Loss of vacuum and high temperature. The loss of vacuum and high temperature release scenarios are related to excess bulk waste temperatures. By definition, these scenarios do not result in waste overheating that is severe enough to cause a tank bump. Once cooling is lost, the tank waste will heat up and eventually begin to boil. The following assumptions are made for the loss-of-flow and overheating scenarios:

- The tank begins to boil immediately (or was already boiling as the result of excess heat load)

- Steam generated by the boiling tank does not condense, but escapes unfiltered from the inlet risers or failed ventilation ductwork

- The tank heat load is 52 kW (177,400 Btu/h), corresponding to the heat load in Tank 241-AY-102 after transfer of the maximum quantity of Tank 241-C-106 solids (Section 3.4.2.11).

Using these assumptions, the steam generation rate is roughly as follows (assuming supernate has properties of water):

(177,400 Btu/h)/(201 Btu/lb) * (26.8 ft^3/lb) = approx. 400 ft^3/min (11.3 m^3/min)

This steam generation rate is roughly one-tenth the flow assumed for the unfiltered ventilation release accident analyzed in Section 3.4.2.2. It is assumed that the partition fraction used for the Section 3.4.2.2 scenario also applies to the boiling tank. Therefore, the consequences of the unfiltered release scenario caused by a loss of ventilation are bounded by the scenario described in Section 3.4.2.2.

High pressure. Limited high pressure events result in small unfiltered releases caused by excess pressure generated in the tank dome from a release of noncondensible gas from one of the tank components. Consequences of these events also are bounded by the high pressure scenarios in Section 3.4.2 such as tank bump (3.4.2.11) and organic solvent fire (3.4.2.9). The total flow from the operating ventilation system with failed HEPA filters is much higher than the flow expected from limited high pressure events.

Excess Vacuum. An excess tank vacuum scenario has no consequences unless the ventilation system is shut down after the high-vacuum event. If the ventilation system is shut down, unfiltered releases could occur as the result of passive breathing. The releases during passive breathing would be much less than the release from an operating ventilation system with failed HEPA filters.

Degraded Filtration. The degraded filtration scenario is caused by high levels of aerosol flow through a tank ventilation system caused by a failure in the slurry distributor or sluicer. The large aerosol load builds up on the filters, degrading performance and resulting in the release of high levels of emissions out the stack of the affected ventilation system. The degraded filters would still provide some mitigation of the release, so the consequences would be bounded by the unfiltered release scenario developed in Section 3.4.2.2.1.

3.4.2.3.2 Source Term Analysis. The unfiltered effective continuous release amounts listed in Section 3.4.2.2 were based on the ventilation flow rate and calculated by multiplying the nominal volumetric flow rate by a partition factor to convert it to an equivalent outflow of radioactive contaminant. An "agitated tank" partition factor of 1.0×10^{-8} was used. The partition factor cited here is based on experiment results published in RHO-RE-SA-216, *Characterization of Airborne Radionuclide Particulates in Ventilated Liquid Waste Tanks*, for agitated (1.0×10^{-8}) and unagitated (1.0×10^{-10}) tanks under active and passive ventilation.

3.4.2.3.3 Consequence Analysis. The consequences for an unfiltered release are developed in Section 3.4.2.2 and summarized in Tables 3.4.2.2-1 and 3.4.2.2-2.

3.4.2.3.4 Comparison with Guidelines. Refer to Tables 3.4.2.2-1 and 3.4.2.2-2.

3.4.2.3.5 Summary of Safety Classification and Technical Safety Requirement Controls. Controls developed for the Section 3.4.2.2 scenario are directed at controlling an unfiltered release by shutting down the ventilation system and limiting the inventory on the HEPA filters. Controls directed at shutdown of the ventilation system also apply to the unfiltered release scenarios discussed in this section. Controls for high pressure scenarios are applied to the initiating event (e.g., temperature controls to prevent a tank bump). One scenario addressed in this section is unique and will require a TSR control. A control is needed to inspect the recirculation duct on the 296-C-006 ventilation system. This inspection will provide indication of a duct breach that could lead to an unfiltered release. Note that minor transient overpressures were considered to have acceptable consequences, and no special controls were specified for these events.

Safety Structures, Systems, and Components. For the overheating scenarios, the safety-related structures, systems, and components determined for the Section 3.4.2.11 tank bump scenario are also credited here. Section 3.4.2.11 determines that the Tank 241-AY-102 annulus ventilation system and the primary ventilation systems for Tanks 241-AY-102 and 241-C-106 are Safety-Class structures, systems, and components. The safety function is to provide adequate cooling to prevent sludge or supernatant from reaching the local saturation temperature. See Section 3.4.2.11 for further discussion of structures, systems, and components related to the Tank 241-AY-102 annulus ventilation system.

The structures, systems, and components developed for the Section 3.4.2.2 HEPA filter failure scenario also apply to the degraded filtration scenarios. For the HEPA filter failure accident scenario, CAM interlocks on the 241-A-702 (if returned to service), 241-AZ-702, 296-P-16, and 296-C-006 ventilation systems were credited as Safety-Significant. The safety function of these components is to shut down the ventilation system and limit the duration of forced release of unfiltered headspace gases. Table 3.4.2.3-1 provides a reference to the applicable sections of Addendum 1 for safety structures, systems, and components.

Technical Safety Requirement Controls. The TSR controls developed for the Section 3.4.2.11 tank bump scenario are also credited for the overheating accident scenarios. The controls for the tank bump scenario establish tank waste temperature limits, ensure operability of tank waste temperature monitoring instrumentation, and ensure that waste transfers do not create in-tank conditions conducive to overheating. See Section 3.4.2.11 for further discussion of TSRs related to temperature control.

The TSRs developed for the Section 3.4.2.2 HEPA filter failure scenario also apply to the degraded filtration scenarios. The CAM interlock operation controls were also credited as a TSR that mitigates accident consequences. See Section 3.4.2.2 for further discussion regarding these controls.

For the unfiltered-flow and loss-of-vacuum scenarios, a ventilation control program requiring daily visual inspection of the aboveground recirculation ventilation ductwork for Tank 241-C-106 (during sluicing) is credited as a TSR that prevents continued operation of a breached duct found during sluicing (Table 3.4.2.3-2). The ventilation control only applies to the operation of the 296-C-006 ventilation system.

Defense-in-Depth. The Defense-in-Depth controls developed for the Section 3.4.2.2 HEPA filter failure scenario also apply to the degraded filtration scenarios. Table 3.4.2.3-3 summarizes these controls.

For the unfiltered-flow and loss-of-vacuum scenarios, an ignition control for limiting vehicle speed was credited as a Defense-in-Depth feature preventing a vehicle accident from damaging ventilation ductwork.

Another possible cause identified in the hazard analysis for unfiltered flow and loss of vacuum was excessive corrosion of the ventilation ductwork caused by aerosols of the new waste introduced into Tank 241-AY-102. A transfer control that includes waste compatibility controls provides Defense-in-Depth against excessive corrosion caused by adding waste to Tank 241-AY-102.

Table 3.4.2.3-1. Safety Structures, Systems, and Components for Unfiltered Releases.

Safety Structures, Systems, and Components in FSAR Addendum 1, Sections 3.4.2.2 (HEPA Filter Failure) and 3.4.2.11 (Tank bump) apply as safety significant for unfiltered releases.

Table 3.4.2.3-2. Technical Safety Requirement Control for Unfiltered Releases.

Control	Safety function	Comments
Ventilation Controls with the following key elements: - Visual inspection of the aboveground ductwork for Tank 241-C-106 every 24 hours during sluicing (only applies to operation of the 296-C-006 ventilation system).	Prevent continued operation of a damaged ventilation duct (during sluicing)	The recirculation ducts could be breached without affecting the rest of the system, therefore an inspection is required.

Note: TSR controls credited in Sections 3.4.2.2 and 3.4.2.11 also apply.

Table 3.4.2.3-3. Defense-in-Depth Controls for Unfiltered Releases.

Control	Safety function	Comments
Transfer controls with the following key element: - Waste compatibility controls	Prevents excessive corrosion of the ductwork caused by the addition of new waste to Tank 241-AY-102	--
Ignition Controls with the following key element: - Speed limit controls	Prevents damage to exposed ductwork	--

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3.4.2.4 Fire in Contaminated Area. This accident analysis addresses possible WRSS fire scenarios in contaminated areas. The basis for the scenarios includes the hazards analysis found in Section 3.3, Section 3.3.2.4.3 in the main text of the FSAR and in WHC-SD-WM-CN-056, *Fire in a Contaminated Area.* The WHC-SD-WM-CN-056 analysis bounds fires in contaminated areas by investigating vehicle fuel fires, which is the most severe type of fire. The hazards analysis in Section 3.3 identifies flammable gas deflagrations and propylene glycol fires as additional potential fire scenarios.

3.4.2.4.1 Scenario Development. The three basic scenarios considered in the WRSS fire in a contaminated area analysis are a vehicle fuel pool fire, propylene glycol fire, and flammable gas deflagration.

Vehicle Pool Fire. The vehicle fuel pool fire is the same as discussed in Section 3.3.2.4.3 of the main text of the FSAR.

Propylene Glycol Fire. The possibility of a propylene glycol fire in a contaminated area is not a significant hazard. Propylene glycol is present in two pits that are associated with WRSS sluicing operations, the sluice pump pit and the Tank 241-C-106 ventilation system pit. The two chillers are designed to cool the sluice pump associated with Tank 241-AY-102 and to cool air flowing through the Tank 241-C-106 ventilation system. The propylene glycol in the chillers is present as a solution in water (46% propylene glycol and 54% water) and is not significantly volatile or ignitable. The propylene glycol in the chillers presents little hazard to the potential contamination present in a pit and is, therefore, not addressed further in this analysis.

Flammable Gas Deflagration in a Pit. A fire in a contaminated area in Tank 241-AY-102 or Tank 241-C-106 as a result of flammable gas (e.g., hydrogen) generated within the tank is addressed in Section 3.4.2.8.

Accident Frequency Without Controls. See main text of the FSAR, Section 3.3.2.4.3.

Accident Frequency With Controls. See main text of the FSAR, Section 3.3.2.4.3.

3.4.2.4.2 Source Term Analysis. See main text of the FSAR, Section 3.3.2.4.3.

3.4.2.4.3 Consequence Analysis. The radiological consequences for this analysis are presented in Table 3.4.2.4-1. The consequences shown in the table for the fire are taken directly from WHC-SD-WM-CN-056.

The toxicological consequences for this analysis are presented in Table 3.4.2.4-2. The source terms are taken from the source term analysis and the sum-of-fractions values are taken from Section 3.4.1, excluding headspace gases. Note that the source term for the fire scenario is taken from WHC-SD-WM-CN-056.

3.4.2.4.4 Comparison to Guidelines.

Comparison to Guidelines Without Controls. Table 3.4.2.4-3 compares the calculated consequences to the onsite and offsite evaluation guidelines. As can be seen from Table 3.4.2.4-3, all onsite radiological and toxicological guidelines are exceeded; no offsite guidelines are exceeded.

Comparison to Guidelines With Controls. Because the accident scenarios are prevented as well as mitigated in the scenario with controls, no consequences were calculated, so no comparison to guidelines is possible for the scenario with controls.

3.4.2.4.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirements.

Safety Structures, Systems, and Components. No safety structures, systems and components have been identified for this event.

Technical Safety Requirement Controls. The TSR controls related to this accident are described in Table 3.4.2.4-4. The TSRs that prevent a vehicle fuel fire from occurring are a multiple control strategy for ignition prevention. This strategy requires a program for protection of the vehicle fuel system, physical barriers, and speed limit controls. The strategy also requires emergency plans to mitigate the consequences of a fire.

Defense-in-Depth. Additional controls that provide Defense-in-Depth are described in Table 3.4.2.4-5. These include a fire protection program, a radiation protection program, a contamination control program, vehicle position spotters, tank farm fences, and a vegetation control program.

Table 3.4.2.4-1. Fire in a Contaminated Area Radiological Consequences.

Case	Source term (L)	Inhalation ULD[c] (Sv/L)	Breathing rate[a] (m^3/s)	Onsite		Offsite	
				χ/Q[a] (s/m^3)	Dose[b] Sv (rem)	χ/Q[a] (s/m^3)	Dose[b,c] Sv (rem)
Pool fire	0.084[a]	5.6 E+05	3.3 E-04	3.41 E-02	5.3 E-01 (5.3 E+01)	2.83 E-05	4.4 E-04 (4.4 E-02)

[a]Taken from WHC-SD-WM-CN-056, 1996, Fire in a Contaminated Area, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
[b]The dose is calculated as (source term)*(ULD)*(breathing rate)*(χ/Q).
[c]Offsite ingestion doses were taken to be negligible and were excluded.
ULD = unit liter dose.

Table 3.4.2.4-2. Fire in a Contaminated Area Toxicological Consequences.

Case	Source term[a] (L)	Onsite		Offsite	
		SOF multiplier[b] (1/L)	SOF[c]	SOF multiplier[b] (1/L)	SOF[c]
Pool fire	0.084[d]	450	38	5.6	0.47

[a]Includes only the respirable source term.
[b]Taken from Section 3.4.1 for the "extremely unlikely" frequency category. The pool fire is treated as continuous and the deflagration and detonation are treated as puffs.
[c]Sum-of-fractions of risk guidelines calculated as (source term)*(SOF multiplier).
[d]Taken from WHC-SD-WM-CN-056, 1996, Fire in a Contaminated Area, Rev. 2, Westinghouse Hanford Company, Richland, Washington.
SOF = sum-of-fractions.

Table 3.4.2.4-3. Summary of Consequences and Frequencies for Fire in a Contaminated Area Without Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Pool fire	5.3 E-01 (5.3 E+01)	1.0 E-01 (1.0 E+01)	4.4 E-04 (4.4 E-02)	4.0 E-02 (4.0 E+00)	38	1	0.47	1	Extremely Unlikely

SOF = sum-of-fractions.

Table 3.4.2.4-4. Technical Safety Requirement Controls for Fire in Contaminated Area.

Control	Safety function	Comments
Ignition Controls with the following key elements: - Vehicle access within the tank farms shall be limited to vehicles whose fuel systems are protected from damage caused by potential collisions with tank structures - Physical barriers shall restrict vehicle access to those aboveground structures outside of tank farm boundaries that can direct liquids into waste tanks. Only vehicles with protected fuel systems will be allowed within barriers - Speed limit controls	Prevent vehicle fuel system damage in the event of collisions with tank structures within the tank farms. Outside the tank farms where vehicle access can not be controlled, prevent vehicle access to tank structures	--
Emergency Preparedness with the following key element: - Response procedures for fire in contaminated area	Mitigates the consequences of a fire in contaminated area	--

Table 3.4.2.4-5. Defense-In-Depth Controls for Potential Fire in Contaminated Area.

Control	Safety function	Comments
Fire protection program	Fire prevention	Program contains a number of provisions that would prevent fires in a pit from causes other than ruptured fuel tanks
Radiation protection program	Facility workers will use masks when working in areas with the potential for airborne contamination	Provides protection for facility workers that would be closest to the accident location
Contamination control program	Survey and cleanup of areas with loose surface contamination	For the scenario analyzed, would reduce the concentration and quantity of contamination in the valve pit
Vehicle positioning spotters	Spotters provide additional level of control in positioning cranes/vehicles	Reduces probability of analyzed accident
Tank farm fences	Provide line of demarcation within which Ignition Control Program key elements related to vehicle fuel systems must be met	Fence gates are typically closed and locked
Vegetation control program	Prevents range fires from impacting Tank Farm facilities	None

3.4.2.5 Caustic Spray Leak. Sodium hydroxide is used to adjust the concentration of hydroxide (OH-) ions in the waste tank contents to minimize corrosion. A pressurized spray leak of caustic solution during a transfer to a waste tank could disperse a significant amount of respirable sodium hydroxide particles. These particles could cause potentially significant onsite or offsite toxicological consequences.

Because quantitative analysis does not exist for overpressurization of a sodium hydroxide carrying cargo tank, qualitative results are presented here and are used as the basis for deriving controls. The qualitative analysis of a pressurized cargo tank rupture and spray leak is presented in HNF-SD-WM-CN-065, *Consequence Analysis of NaOH Solution Spray Release During Addition to Waste Tank*. This analysis will be incorporated into the main body of the FSAR when the technical content of this addendum is fully integrated within the FSAR. No radioactive materials are associated with this event.

3.4.2.5.1 Scenario Development.

Sequence of Events. Sodium hydroxide is either procured from an offsite vendor and transported in tanker trucks to the tank farms or mixed onsite. The caustic solution may be as strong as 19 M (50 wt%). The solution may be transferred into a given waste tank using a mixer pump or transferred directly through an available riser.

The initiating event is assumed to be a overpressurization of a sodium hydroxide cargo tank. In the worst case scenario, this overpressurization causes the tank to rupture, spraying its contents. Other possible initiators of a spray leak include a crack developing in the cargo tankers and the transfer piping. However, the consequences of the rupture case are assumed to be bounding.

It is important to note that the system analyzed here consists of a pressurized cargo tank, fittings, and flexible polyethylene hose sections. The volume of the analyzed cargo tank is 26,500 L (7,000 gal). This will be the system used to add sodium hydroxide during WRSS operations. The scenario analyzed in Section 3.3.2.4.9 of the main text of the FSAR is another possible system of caustic addition. The main text scenario involves a 208 L (55 gal) drum, a pump, hard piping, and hose.

Accident Scenario Without Controls. For the accident scenario without controls, the sodium hydroxide cargo tank was postulated to rupture after becoming overpressurized, forming an atomizing spray. The pressure inside the cargo tank is assumed to be 862 kPa (125 psi), based on the maximum pressure attainable by the plant air supply, which could be used to pressurize the tank. The vendor could also supply an air compressor, which is assumed to provide less than 862 kPa (125 psi). A rupture of the tanker truck caused by a failure during overpressure was also analyzed.

Accident Frequency Without Controls. The frequency without controls of a cargo tank rupture has not yet been ascertained.

Accident Scenario With Controls. The controls selected for the caustic spray leak are preventive as well as mitigative and are presented in

Section 3.4.2.5.4. These controls prevent overpressurization and leaks, therefore no release scenario is postulated for the case with controls.

Accident Frequency With Controls. With the controls identified for the caustic spray leak in Section 3.4.2.5.4, the accident is prevented although controls are also specified to mitigate the accident.

3.4.2.5.2 Source Term Analysis.

Accident Source Term Without Controls. The main text of the FSAR (Section 3.3.2.4.9) presents the results of the analysis of a spray leak in caustic transfer piping (of the skid system) caused by a crack with a minimum depth of 2.77 mm (0.109 in.) and a maximum length of 25 mm (1 in.). The results of this analysis can be found in HNF-SD-WM-CN-065. The SPRAY Code, Version 3.0, was used to calculate leak rates and small particle fractions for an assumed break in the liquid containment boundary. The crack width was optimized to produce the highest respirable particle fraction using the SPRAY Code (WHC-SD-GN-SWD-200007, *A Model for Predicting Respirable Releases from Pressurized Leaks*).

Particles less than about 10 μm tend to remain suspended in the air for long distances, but particles larger than 10 μm released from a non-elevated source tend to fall out within the first 50 to 100 m (164 to 328 ft) of travel. The size of the liquid particles will decrease in transit by evaporation of the liquid component. Ultimately, only smaller particles of the solid material previously in liquid solution will remain. Therefore, the small particle fraction of the spray release, which is a function of solution concentration and crack width, was determined using the initial diameter of a solution particle (with the given solid fraction) that will shrink to 10 μm by evaporation. The leak rate and atomization efficiency increase with decreasing viscosity and increasing temperature. Therefore, the high end of the temperature range for this liquid (50 °C [122 °F]) was assumed.

A parametric study was then performed using the SPRAY Code to determine the worst case solution concentration within a range of 5% to 50% NaOH to be used for tank additions. The worst case small particle release rate was calculated over a range of NaOH concentrations. These calculations accounted for variation in viscosity and density with concentration. Results of the calculations indicated that a 12% solution was optimal for small particle generation. For this case, the unevaporated particle size range was less than or equal to 20.3 μm and the respirable NaOH release rate was 1.68 g/s. Standard roughness and flow parameters for steel pipe were assumed. For the cases where critical flow developed in the crack, friction factors for laminar flow were assumed for conservatism.

The source term for this accident has been analyzed qualitatively in HNF-SD-WM-CN-065. This analysis shows that a crack in the cargo truck can result in caustic concentrations at the offsite receptor that exceed the risk guidelines. The analysis for tank rupture also shows that caustic concentrations at the offsite receptor can exceed the risk guidelines. In addition, if the offsite guidelines are exceeded, so are onsite guidelines. The caustic spray leak scenario frequency is anticipated (HNF-SD-WM-CN-065).

Accident Source Term with Controls. No source term with controls was derived because the accident controls are preventive as well as mitigative.

3.4.2.5.3 Consequence Analysis. The onsite and offsite toxicological exposures in HNF-SD-WM-CN-065 were determined qualitatively.

Analysis Results.

Consequences Without Controls. The toxicological consequences of the rupture release are qualitatively presented in Table 3.4.2.5-1. A quantitative analysis has not yet been performed (HNF-SD-WM-CN-065).

Consequences With Controls. No consequences with controls were derived because the accident controls are preventive as well as mitigative.

3.4.2.5.4 Comparison to Guidelines. Table 3.4.2.5-1 compares caustic spray leak consequences to risk guidelines. The criterion is exceeded at the onsite receptor location and the offsite receptor location.

3.4.2.5.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems, and Components. No safety structures, systems, and components are required.

Technical Safety Requirement Controls. The TSR controls for the caustic spray leak accident analysis are listed in Table 3.4.2.5-2.

Defense-in-Depth. Defense-in-Depth controls for the caustic spray leak accident are listed in Table 3.4.2.5-3.

Table 3.4.2.5-1. Qualitative Consequences of a Caustic Spray Leak Assuming No Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Caustic Spray Leak from the Tanker Truck	N/A	N/A	N/A	N/A	Above guidelines	1	Above guidelines	1	Anticipated
Caustic Release from Rupture of the Tanker Truck	N/A	N/A	N/A	N/A	Above guidelines	1	Above guidelines	1	Anticipated

N/A = not applicable.
SOF = sum-of-fractions.

Table 3.4.2.5-2. Technical Safety Requirement Control* for Caustic Spray Leak.

Control	Safety function	Comments
Caustic Transfer Controls with the following key elements:		
- Plastic sleeving around delivery piping	Prevents or mitigates the consequences of a spray leak	Sleeving shall have a thickness ≥ 4 mil
- Caustic delivery system pressure ≤ 125 psig or below sodium hydroxide cargo tanks specified maximum allowable operating pressure, whichever is lower	Reduces the consequences of a leak by reducing the leak rate. Ensures that sodium hydroxide tanks will not be subject to overpressurization	Overpressurization of sodium hydroxide cargo tanks could result in tank rupture
- Steel pipe shall be Schedule 10 or heavier wall thickness; polyethylene hose or other delivery pipe shall be designed for appropriate pressure delivery. Caustic transfer piping will have a wall thickness of < 0.109 in.	Prevents or mitigates the consequences of a leak by reducing the leak rate	A thinner walled pipe would have worse consequences
- Vendors will be required to provide documentation that the sodium hydroxide cargo tanks to be used for caustic transfers meet Department of Transportation Specifications	Ensures that tank relief valves are operable, ensures that minimum wall thickness is at least 0.100 in., and provides for inspections of cargo tanks. This prevents or mitigates release from cracks or ruptures of the tank	
- Traffic barriers shall surround the cargo tank (e.g., traffic cones or stanchions and chains)	Reduces the probability of a caustic leak	

*Note: Controls analyzed are for a skid system and for a cargo tank system, as applicable (e.g., the cargo tank truck does not use steel pipe).

Table 3.4.2.5-3. Defense-in-Depth Controls for Caustic Spray Leaks.

Control	Safety function	Comments
Operator training	Prevents or minimizes the effects of a leak	The operating procedures contain a number of checks to ensure that piping connections are secure and equipment functioning properly. Regular instrument checks during transfers minimize consequences of a leak
TWRS Hazardous Material Protection Program	Prevents or minimizes consequences to a worker from a hazardous material release	The TWRS HMP program is a collection of industrial hygiene programs designed to protect workers against the type and magnitude of hazards identified in Chapter 3.0, "Hazard and Accident Analyses." See Chapter 8.0, "Hazardous Material Protection," for a discussion of the HMP program
Emergency response plans and procedures	Mitigates the consequences of leaks or spills	Emergency response plans and procedures are in place to respond to and mitigate the consequences of accidental leaks or spills of hazardous material. See Chapter 15.0, "Emergency Preparedness Program," for a discussion of the emergency preparedness program

WHC-SD-WM-CN-065, 1997, Consequence Analysis of a NaOH Solution Spray Release During Addition to Waste Tank, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
HMP = Hazardous Material Protection.
TWRS = Tank Waste Remediation System.

3.4.2.6 Tank Failure Caused by Excessive Loads. This accident category refers to structural failures of Tank 241-AY-102 or Tank 241-C-106 caused by the excess loads discussed in the following paragraphs. The load drop accident scenario analyzed here is analogous to the scenario analyzed in Section 3.4.2.1 of the main text of the FSAR. It is argued that the mixer pump used in the main text load drop analysis causes more damage than the heavy equipment specific to WRSS. However, the main text consequence analysis was modified to account for the possibility that aging waste solids could be aerosolized in the hypothetical accident. The main text analyzed consequences of a load drop using non-AWF double-shell tank solids.

Load Drop. A load drop could occur during a crane lift of heavy equipment that is being installed or removed from Tank 241-AY-102 or Tank 241-C-106. The following equipment is of concern for the WRSS:

- Concrete cover blocks (several types, all under 14,514 kg [32,000 lb])
- Two booster pumps (1,814 kg [4,000 lb] each)
- One sluicer assembly (771 kg [1,700 lb])
- One winch pump assembly (3,016 kg [6,650 lb]).

The consequences of dropping these pieces of equipment are bounded by the consequences of dropping the 101-SY mixer pump (9,100 kg [20,000 lb]) vertically into a tank pump pit from the maximum crane lift height (for further details on the mixer pump drop, see discussion in the scenario development section). The mixer pump represents the combination of large total mass with a small cross-sectional area of impact that would produce maximum damage to the tank dome. Concrete cover blocks dropped from a similar height would not penetrate the dome because of their large cross-sectional area (see further discussion in the scenario development section). The booster pumps also have a large cross-sectional area and would cause much less damage than the cover blocks because they weigh much less. The sluicer assembly and winch pump assembly have cross-sectional areas comparable to the mixer pump, but have much less mass and would generate a smaller source term even if it is assumed that they could penetrate the tank dome if dropped.

3.4.2.6.1 Scenario Development. Load drops will cause localized structural damage to a riser pit floor and the tank dome if drop heights are great enough and if the items dropped are rigid enough. The failure mode for equipment drops at heights > 6.1 m (20 ft) is the result of excess local shear stresses in the dome. A load drop event can occur as a result of the following:

- Drop of the load as the result of cable failure, brake failure, or operator error
- Drop of the boom (with or without the load) as the result of boom or boom cable failure.

The load can drop onto the soil cover over Tank 241-AY-102 or Tank 241-C-106, onto the pits over the tank, primarily the pump pit, or onto a riser. The worst case is a load drop into a pump pit because, of all the possible drop locations that could result in the load reaching the tank waste, the pump pit is structurally the weakest.

All load drop accidents are bounded by the consequences of a mixer pump drop. Although a mixer pump will not be used for WRSS operations, a mixer pump drop was used in the analysis to provide an upper bound on the consequences of dropping the heavy equipment that will be used in the project sluicing operations. The WRSS accident scenario assumes that a 9,100 kg (20,000 lb) mixer pump (the weight of the lifting hardware is ignored) is dropped into the pump pit of Tank 241-AY-102 or Tank 241-C-106. Although some cover blocks are heavier than mixer pumps, the cover block drop height necessary to damage the dome is at least 10 times greater (WHC-SD-WM-TI-775, *Structural Assessment of Accident Loads*) than for a mixer pump. The factor of 10 is directly related to the impact area. The impact area for the cover block is 0.13 m^2 (200 in^2); for the pump the impact area is 0.023 m^2 (36 in^2). Another reason the mixer pump drop is considered to be the worst case drop is the orientation of the equipment during the lift. The pump would be lifted so that the axis is vertical. The cover block would be lifted flat.

Accident Scenario Without Controls. See main text of the FSAR, Section 3.4.2.1.1.

Accident Frequency Without Controls. Because the pumps and heavy equipment assemblies are already installed in Tank 241-AY-102 and Tank 241-C-106, pump replacement is not planned during WRSS operations unless a pump unit fails during sluicing operations. However, as a worst case or upper bound on the load drop frequency, it is assumed that both the sluicer and winch pump assemblies must be replaced annually because of operator error or a delay in the start of the WRSS operations.

Installation of large loads in the tank requires several critical lifts. Replacing a pump assembly requires removal of the cover blocks, booster pump, and sluicer or winch pump assembly, then replacement with the new parts. A drop of the cover blocks or booster pumps will not penetrate the tank dome because of the relatively large surface area of impact. This leaves four critical lifts that may penetrate the tank dome during replacement of the sluicer and winch pump assemblies. Thus, the upper bound on the dome penetration frequency (per year) is four times the probability of dropping an object during a critical lift.

The frequency of a heavy load drop for the WRSS operations is in the "unlikely" category, as in Section 3.4.2.1.1 of the main FSAR text.

Accident Scenario With Controls. See main text of the FSAR, Section 3.4.2.1.1.

Accident Frequency With Controls. See main text of the FSAR, Section 3.4.2.1.1.

3.4.2.6.2 Source Term Analysis. This section quantifies the material released should a load drop occur.

Source Term Without Controls. As discussed in the main text of the FSAR, the total waste made respirable is 0.51 L (0.126 gal). After accounting for the amount that is suspended and the amount that is removed from the tank, a total of 0.005 L of respirable material is released.

Source Term With Controls. Because the accident is prevented with controls in place, there is no source term with controls.

3.4.2.6.3 Consequence Analysis. The consequences of the load drop scenario were calculated in accordance with the methodology presented in Section 3.4.1.

The radiological consequences are based on the unit liter dose for aging waste facility tank solids. As previously discussed, use of the dry salt cake source term with the unit liter dose for aging waste facility tank solids does not realistically represent an object drop into sludge or slurry in Tank 241-AY-102 or Tank 241-C-106. Rather, the aging waste facility tank unit liter dose source term should be interpreted as an upper bound on the more realistic source term from a drop into liquid.

Consequences Without Controls. Table 3.4.2.6-1 summarizes the radiological and toxicological consequences of the load drop scenario without controls. The doses were calculated using the bounding χ/Q' values.

$$EDE_{onsite} = (0.005\ L)\left(3.41 \times 10^{-2}\ \frac{s}{m^3}\right)\left(3.3 \times 10^{-4}\ \frac{m^3}{s}\right)\left(1.7 \times 10^{6}\ \frac{Sv}{L}\right)$$
$$= 0.096\ Sv$$
$$\approx 0.1\ Sv$$

$$EDE_{offsite} = (0.005\ L)\left(2.83 \times 10^{-5}\ \frac{s}{m^3}\right)\left(3.3 \times 10^{-4}\ \frac{m^3}{s}\right)\left(1.7 \times 10^{6}\ \frac{Sv}{L}\right)$$
$$+ (0.005\ L)\left(2.83 \times 10^{-5}\ \frac{s}{m^3}\right)\left(8.1\ \frac{Sv \cdot m^3}{s \cdot L}\right)$$
$$= 8.1 \times 10^{-5}\ Sv$$

The "all solids" toxicological sum-of-fractions was chosen to bound the toxicological consequences (see Section 3.4.1.2 of the main text of the FSAR). The accident happens in a short period of time, so the sum-of-fractions for a puff release is assumed. The frequency of this event is in the "unlikely" category as discussed above.

$$T_{onsite} = (0.005\ L)\left(6.6 \times 10^{3}\ \frac{1}{L}\right)$$
$$= 33$$
$$T_{offsite} = (0.005\ L)\left(1.7 \times 10^{-7}\ \frac{1}{L}\right)$$
$$= 8.5 \times 10^{-4}$$

Consequences With Controls. Because the accident is prevented with controls, there are no consequences with controls.

Sensitivity of the Results to Key Parameters and Assumptions. See FSAR, Section 3.4.2.1.

3.4.2.6.4 Comparison with Guidelines. The onsite radiological consequences without controls of 0.1 Sv (10 rem) is above the onsite evaluation guidelines of 0.05 Sv (5 rem) for an "unlikely" event (Table 3.4.2.6-1). The offsite guidelines of 0.005 Sv (0.5 rem) are easily met. The onsite toxicological consequences without controls of 33 exceed the onsite guidelines of 1.0. The offsite guidelines are met.

With controls, the event is prevented; therefore no consequences are calculated.

3.4.2.6.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. The following paragraphs present safety classification and TSR controls for the load drop accident. They also cover Safety-Class SSCs and TSR controls for uniform and concentrated load scenarios.

Safety Structures, Systems, and Components. No Safety-Class or Safety-Significant equipment is specified for this accident. Instead, the controls focus on TSRs that prevent the accident.

Technical Safety Requirement Controls. Table 3.4.2.6-2 summarizes the TSR controls. The TSR control chosen for the load drop event is an administrative control that states the height to which a load is raised shall not exceed the critical height of 6.1 m (20 ft) above the soil at grade or the floor of the pits. Justification for a 6.1 m (20 ft) drop is provided in WHC-SD-WM-TI-782, *Load Drop Evaluation*. The pit floors are chosen because the cover blocks over the pits do not provide much resistance to a load drop. The numerical value of the critical height is based on the lack of penetration of the worst case hypothetical load (the Tank 241-SY-101 mixer pump) dropped onto the weakest point that could result in dome penetration (the pump pit). Details are in the load drop calculations presented in WHC-SD-WM-TI-782. Load drops from the critical height will not result in penetration of the dome.

Another element of the Technical Safety Requirement requires use of DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*, which provides guidelines for inspection, personnel qualification, training, equipment to be used, and critical lift procedures for lifts over all TWRS facilities.

It has previously been demonstrated that dome or roof collapse caused by excessive loads is not credible. However, because different cranes can be brought to the Site, a control is required to protect the assumption. The maximum loads above which the dome or roof could fail are presented in WHC-SD-WM-TI-775 and WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*. The Technical Safety Requirement load limits must be set well below the failure loads because the stresses caused by the loads must meet code allowables.

The concentrated load shall not exceed 90,800 kg (100 tons) over Tank 241-AY-102 or Tank 241-C-106 either permanently or temporarily (WHC-SD-WM-TI-775).

Defense-in-Depth. Defense-in-Depth features are those operational practices that also serve to prevent an accident or mitigate its consequences (Table 3.4.2.6-3). The load drop event has six Defense-in-Depth features including a radiation protection program, a facility Health and Safety Plan, a Job Control System, operator training, operating procedures, and emergency response plans/procedures.

Table 3.4.2.6-1. Consequences of a Load Drop Assuming No Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Load Drop Without Controls	1.0 E-01 (1.0 E+01)	5.0 E-02 (5.0 E+00)	8.1 E-05 (8.1 E-03)	5.0 E-03 (5.0 E-01)	33	1	0.00085	1	Unlikely

SOF = sum-of-fractions.

Table 3.4.2.6-2. Technical Safety Requirement Control for Load Drops.

Control	Safety function	Comment
Dome Loading Control with the following key elements:		Critical lifts are defined in the Hanford Site Hoisting and Rigging Manual
- For critical lifts over SSTs and DSTs:		
• Hanford Site Hoisting and Rigging Manual requirements shall be met	Prevents load drop accidents (i.e., reduces the frequency of load drops)	The cover blocks offer little resistance to load drops due to their failure at low bending moments and are not considered in determining compliance with the (6.1 m) 20 ft limit. The (6.1 m) 20 ft limit considers the largest mixer pump (9,100 kg [20,000 lbs]) and cover blocks as the limiting loads
• Height of the bottom of the load shall not exceed 6.1 m (20 ft) over the soil or pit floor	Limits load handling over a tank so that in the event the load is dropped the tank dome would not collapse	
- External load on the tank dome:	Prevents exceeding external loads that may cause tank dome failure	
• SST uniform load shall not be modified		
• DST uniform loads shall be below 2.5 m (8.3 ft) of soil (AY and AZ tank farms, and 2.3 m (7.5 ft) of soil (SY, AW, AN, AP tank farms)		
• 100 series SST and DST concentrated load shall not exceed 90,800 kg (100 tons) on a temporary or permanent basis		

DOE/RL-92-36, 1996, Hanford Site Hoisting and Rigging Manual, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DST = double-shell tank.
SST = single-shell tank.

Table 3.4.2.6-3. Defense-in-Depth Controls for Load Drops.

Control	Safety function	Comments
A Radiation Protection Program will be established and implemented consistent with applicable procedures	Provides radiological controls to protect onsite and facility workers	--
A facility Health and Safety Plan will be established and implemented consistent with applicable procedures	Provides for worker protection by restricting activities in high winds	--
A Job Control System will be established and implemented consistent with applicable procedures	Provides assurance that work activities including appropriate controls are planned and approved. This includes requirements to place load absorber material around the riser when very heavy loads are installed	--
Operator Training is required prior to performance of activities affecting safety	Provides assurance that operation of facilities are by Hanford Site experienced crews with specific training in these activities	--
Operating procedures will be established and implemented for activities affecting safety	Provides assurance that operations are performed to approved plant procedures	--
Emergency Response Plan/Procedures will be established and implemented consistent with applicable procedures	Provides assurance that plans and procedures are in place to respond to emergency conditions	--

3.4.2.7 Tank Failure Caused by Excessive Vacuum. This accident category refers to structural failures of Tank 241-AY-102 or Tank 241-C-106 caused by excess vacuum in the tank headspace. The excess vacuum hazards discussed are analogous to those analyzed in Section 3.4.2.1 of the main text of the FSAR. Excess vacuum events specific to the WRSS have been identified in the WRSS hazard analysis. Special consideration has been given to the new ventilation systems that will be installed in the tanks before the WRSS starts up. This accident scenario is bounded by the analysis in Section 3.4.2.6.

Tank failure refers to loads or conditions that could result in dome or roof collapse; dome or roof settling (wall failure); or dome, roof, wall, or bottom perforation that can result in the release of radioactive waste to the environment through openings in the walls, the bottom, or the dome of a tank. The following accidents were identified in the WRSS hazard analysis as those that could lead to structural failure as the result of excessive vacuum in the tank headspace (Section 3.2).

- Fan controller failure or operator error increases fan speed
- Inlet ventilation damper accidentally closes
- Inlet ventilation plugged by ice (as the result of chiller malfunction or weather) or ash
- Incorrect ventilation system alignment reduces inflow
- Cold water spray into tank causes condensation in headspace
- Cool down of tank headspace after an in-tank fire.

The analysis in WHC-SD-TWR-RPT-002 for high internal vacuum states that single-shell and double-shell tanks can withstand -55 kPa (-8 psig) of vacuum. Vacuum due to fire, existing ventilation system failure (i.e., exhaust fan with all flow paths blocked), and vacuum cooling the dome space due to water spray cannot reach -55 kPa (-8 psig).

The new ventilation systems that will be installed in Tank 241-AY-102 and Tank 241-C-106 before startup of WRSS sluicing operations also cannot create a vacuum approaching -55 kPa (-8 psig). Assuming that all infiltration pathways into the tank headspace are blocked, the greatest vacuum that can be created with the new exhaust fans running at maximum design speed in either Tank 241-AY-102 or Tank 241-C-106 is less than 14 kPa (2 psig), as discussed in Chapter 2.0. Higher than design fan speeds would require some failure in the fan motor controller system (combined with blocked inlet pathways). To reach motor speeds much higher than the design speed, the overcurrent protection on the fan motor also would have to fail. Even if all the preceding controller failures occurred, the fan motor could not credibly reach speeds required to generate a vacuum of -55 kPa (-8 psig) before the motor circuits failed as the result of excess current.

Although structural failure is not deemed credible, an excessive vacuum event could result in failure of the ventilation system seal loops and small unfiltered releases because of inability to maintain tank headspace vacuum at nominal flow rates. Unfiltered release events resulting from excess vacuum are analyzed in Section 3.4.2.3 of this addendum.

3.4.2.7.1 Scenario Development. No credible tank failure resulting from an excessive vacuum scenario has been identified.

3.4.2.7.2 Source Term Analysis. Not applicable.

3.4.2.7.3 Consequence Analysis. Not applicable.

3.4.2.7.4 Comparison with Guidelines. Not applicable.

3.4.2.7.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. Safety structures, systems, and components and TSR controls need not be designated because excess vacuum cannot cause tank failure leading to an airborne release of radioactive material.

3.4.2.8 Flammable Gas Deflagration. This analysis addresses the hazards and controls associated with the generation, storage, release, and postulated combustion of flammable gases in Tank 241-AY-102, a double-shell AWF tank; Tank 241-C-106, a SST; and the associated transfer systems. This hazard was first identified as an unreviewed safety question (USQ) in 1990. This USQ was updated on November 1, 1996 (TF-96-0433, *Consolidation of Flammable Gas/Slurry Growth Unreviewed Safety Question Issues*) to account for increased understanding of the nature of the hazard and the affected facilities. The updated USQ addresses potential flammable gas hazards in the AWF tanks. The flammable gas USQ has been closed (Wagoner 1998) for the facilities associated with WRSS operations as of this writing.

This FSAR Addendum affirms the applicability of the U.S. Department of Energy, Richland Operations Office approved controls for the performance of WRSS operations (HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*). This affirmation is required for several reasons.

- The ventilation system on Tank 241-C-106 is being modified in a manner that will reduce flow rate from a nominal 67.9 m^3/min (2400 ft^3/min) to 10.2 m^3/min (360 ft^3/min). The reduction in ventilation flow rate will result in an increase in the flammable gas concentration in the tank headspace.

- The sluicing of the sludge in Tank 241-C-106 has the potential to release the flammable gas that has accumulated in the waste matrix and is trapped beneath the waste surface.

- The addition of Tank 241-C-106 sludge to Tank 241-AY-102 will increase the gas generation rate in this tank. This results in an increase in the chronic (or "steady state") gas release rate to the tank vapor space, and thus an increase in the gas concentration.

- The gas retention and release behavior of the sludge may be changed after it is moved from Tank 241-C-106 to Tank 241-AY-102. This may result from changes in gas generation rates, waste sludge rheology, and waste configuration where the sludge will be stored under a large amount of supernatant liquids in Tank 241-AY-102, whereas little supernate is currently contained in Tank 241-C-106. These changes may result in an increased likelihood of a buoyant displacement gas release event (GRE).

Evaluation Methodology. The sluicing and transfer of sludge from Tank 241-C-106 to Tank 241-AY-102 and subsequent storage of the sludge in Tank 241-AY-102 is evaluated by determining the impact of this sluicing and subsequent storage on key flammable gas phenomena as described in the main text of the FSAR. Controls specified for current operations and storage are justified as being adequate or are modified to be adequate for the sluicing and subsequent storage conditions.

Radioactive waste generates hydrogen through the radiolysis of water, thermolytic decomposition of organic compounds, and corrosion of the tank's carbon steel walls. Radiolysis and thermolytic decomposition also generate ammonia. Additional flammable gases (such as methane) and an oxidizer

(e.g., nitrous oxide) are generated by chemical reactions between various degradation products of organic chemicals originally present in the tank. Volatile or semi-volatile organic chemicals also produce organic vapors.

The gas generated through these processes may be released continually to the tank vapor spaces (historically referred to as steady state flammable gas generation) or be retained by the tank's waste matrix, potentially resulting in an episodic GRE. Steady state flammable gas generation from radiolysis, chemical decomposition, and corrosion is expected from all of the wastes in the Hanford Site underground storage tanks. With a GRE, gas is retained in the tank's waste matrix until it is spontaneously released or a release is induced during waste disturbing activities, such as waste sluicing operations.

An accident scenario for a representative flammable gas deflagration resulting from a GRE in an AWF tank is provided in the FSAR, Section 3.4.2.2. The representative GRE accident analysis assumes the release and ignition of sufficient trapped gas such that the resulting energy creates unfiltered release paths, but is insufficient to collapse the tank dome. A gas release of this size has never been observed, and is not expected for the current waste contents of either Tank 241-C-106 or Tank 241-AY-102. Therefore, the energy associated with the deflagration of such a release is considered bounding for these two tanks with their current waste contents.

The source terms selected for the representative GRE accident analysis in the FSAR are based on the current waste storage conditions. Changes to the source term may occur as a result of WRSS operations including: (1) bringing AWF waste slurries into Tank 241-C-106 via the sluicing line and (2) creating a slurry in Tank 241-AY-102 as a result of slurry transfer from Tank 241-C-106. The analysis in the main text of the FSAR assumes that the material released from an SST has a source term consistent with SST solids. The analysis in the FSAR assumes that the material released from an AWF tank has a source term consistent with AWF liquids. As seen in WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for use in Safety Analysis Consequence Assessments*, release of AWF slurries (a combination of liquids and solids) from Tank 241-C-106 rather than the assumed SST solid wastes could result in an increased radiological dose at the receptor locations. Additionally, the existence of a solids component in the material released from Tank 241-AY-102 would also result in an increased radiological dose over that when only AWF liquids are assumed to be released. Determination of the fraction of liquid versus solids that may be entrained in the release is an additional uncertainty associated with this event that is not associated with the flammable gas USQ.

As indicated in the FSAR, the consequence analysis for the representative GRE is not considered bounding. However, at this point in the resolution process of the open flammable gas safety issue, the analysis serves to indicate the need for an authorization basis control strategy. As provided in the FSAR, Appendix K, the control strategy is prevention. Controls related to monitoring and ignition sources are assigned to specific facilities and tanks on the basis of observed and estimated gas release behavior. These controls are not specifically derived from GRE consequence analysis, and would not be changed by variations in the magnitude of the calculated consequences

presented in the FSAR. The FSAR analysis results are discussed in detail in Section 3.4.2.2 and summarized in Table 3.4.2.2-5 of the FSAR main text. The results of the consequence analysis are not tabulated in this addendum.

Applicability of Flammable Gas Controls. The specific monitoring and ignition source controls applicable to the sluicing operation in Tank 241-C-106 are driven by assignment of this tank to flammable gas Facility Group 3 (FSAR, Appendix K) and the nature of activities and operations performed. The sluicing operation does not alter the assignment of Tank 241-C-106 to Facility Group 3. In addition, performance of the sluicing operation falls within the authorization basis definitions for the nature and location of activities and operations. Therefore, with respect to GRE behavior that may be associated with operation of the WRSS, the existing authorization basis monitoring and ignition source controls continue to apply.

The specific monitoring and ignition source controls applicable to the use of supernatant liquids from Tank 241-AY-102 as the sluicing fluid and the transfer and storage of sludge from Tank 241-C-106 to Tank 241-AY-102 are driven by assignment of Tank 241-AY-102 to flammable gas Facility Group 2 (main text of the FSAR, Appendix K) and the nature of activities and operations performed. The sluicing operation does not alter the assignment of Tank 241-AY-102 to Facility Group 2. In addition, performance of the sluicing operation falls within the authorization basis definitions for the nature and location of activities and operations. Therefore, with respect to GRE behavior that may be associated with the sluicing operation, the existing authorization basis monitoring and ignition source controls continue to apply. The impact of storing additional sludge in Tank 241-AY-102 on the flammable gas Facility Group assignment is discussed in the Gas Release Event evaluation section which follows.

The strategy to prevent or mitigate potential hazards associated with flammable gas in Tank 241-C-106 and Tank 241-AY-102 during the performance of the sluicing operation involves implementation of the controls detailed in the TSR (HNF-SD-WM-TSR-006). The FSAR, Appendix K strategy is to expeditiously implement achievable and practical controls to manage postulated flammable gas risks. While doing so, progress towards safety issue resolution and USQ closure will continue to concentrate on remaining uncertainties regarding the quantification of risk and effectiveness of control strategies.

The controls are aimed primarily at prevention of ignition of flammable gas (although certain aspects of the control strategy are mitigative in nature). Provisions for ventilation serve to prevent accumulation of chronically released gases and possibly reduce the time at risk assuming the occurrence of a spontaneous or induced gas release. Flammable gas monitoring requirements serve to validate ventilation effectiveness as well as prevent or halt manned activities when margin of safety is considered to be insufficient (i.e., conditions are such that the flammable gases exist in concentrations greater than 25% of the lower flammability limit [LFL]). Ignition controls related to work practices and equipment requirements serve to eliminate, to the greatest extent practical, ignition sources.

This three-pronged control strategy (ventilation, monitoring, and ignition source control) is effective in preventing the accumulation of flammable gases where ignition sources may be present or to eliminate ignition sources where flammable gases may potentially be present. Neither the FSAR nor this addendum present analysis results that quantitatively demonstrate the effectiveness of these controls to prevent flammable gas deflagrations. Quantitative demonstration of the effectiveness of controls will be accomplished as part of the flammable gas USQ closure process.

3.4.2.8.1 Steady State Generation.

Tank 241-C-106. Sluicing operations in Tank 241-C-106 will not increase the steady state generation of flammable gases. Steady state flammable gas generation is dependent on several parameters including waste volume, decay heat load, waste temperature, organic complexant chemical concentrations, and nitrate/nitrite concentration. Removing sludge from Tank 241-C-106 will decrease the gas generation rate.

Implementation of WRSS operations, however, does include modifications to the ventilation system provided to Tank 241-C-106. These modifications result in a ventilation flow rate reduction from a nominal 67.9 m^3/min (2400 ft^3/min) to 10.2 m^3/min (360 ft^3/min). Currently, Tank 241-C-106 is estimated to be generating and releasing hydrogen at a best estimate rate of 0.18 m^3/day (6.5 ft^3/day) (HNF-SD-WM-CN-114, *Project W-320 Primary Ventilation Air Flow Requirements for Mitigation of Steady State Flammable Gas Concentrations in the Headspaces of Tanks 241-C-106 and 241-AY-102*). This release rate requires 5.0×10^{-3} m^3/min (0.18 ft^3/min) ventilation flow rate to keep the headspace below 100% of the LFL, and 2.0×10^{-2} m^3/min (0.7 ft^3/min) ventilation flow rate to keep the headspace below 25% of the LFL. Using an upper bound hydrogen generation rate of 0.19 m^3/day (6.7 ft^3/day), the required ventilation flow rates are 5.1×10^{-3} and 2.1×10^{-2} m^3/min (0.18 and 0.74 ft^3/min) to keep the headspace below 100% and 25% of the LFL, respectively. If active ventilation were completely lost, the 2690 m^3 (95,000 ft^3) headspace of Tank 241-C-106 would reach 25% of the LFL in 117 days using the best estimate hydrogen generation rate and 113 days using the upper bound rate (HNF-SD-WM-CN-114).

Based on gas concentration measurements taken under high flow rate conditions, the current ventilation system is proven to provide adequate ventilation to sweep out the steady state generated gases. The new system has no operational history upon which to base the claim it will also provide adequate ventilation. However, analysis of the steady state hydrogen concentration in the headspace of Tank 241-C-106 indicates that only 2.1×10^{-2} m^3/min (0.74 ft^3/min) of ventilation airflow is needed to ensure that the flammable gas concentration in the headspace remains less than 25% of the LFL (HNF-SD-WM-CN-114). To confirm this, flammable gas monitoring will be used for a short time after full startup (steady state conditions attained) of the new ventilation system to confirm the system's ability to keep flammable gas concentrations below 25% of the LFL. As a backup, the higher capacity system will be maintained in an available condition until the monitoring is complete.

Tank 241-AY-102. Adding sludge to Tank 241-AY-102 will increase the gas generation rate in this tank. The implementation of the FSAR, Appendix K control strategy to Tank 241-AY-102 during and following WRSS operations, provides ventilation to prevent accumulation resulting from a steady state gas release. However, the safety margin provided by compliance with the ventilation requirements of the FSAR TSRs (HNF-SD-WM-TSR-006) may be decreased as a result of the sludge addition. This is due to the expected increases in waste volume, decay heat load, and waste temperature resulting from the added high heat load waste.

In order to provide some degree of confidence that the ventilation flow and AWF TSRs for ventilation restoration are adequate to prevent a flammable gas deflagration resulting from the increased gas generation rate, available gas monitoring and ventilation data were reviewed and a scoping analysis was performed via an engineering Calculation Note (HNF-SD-WM-CN-114).

This calculation note determined that Tank 241-AY-102 is generating and releasing hydrogen at the best estimate rate of 0.39 m^3/day (14 ft^3/day) (HNF-SD-WM-CN-114). The upper bound hydrogen generation rate is 0.57 m^3/day (20 ft^3/day). If all the waste in Tank 241-C-106 is transferred to Tank 241-AY-102, a best estimate is that Tank 241-AY-102 would generate 0.58 m^3/day (20.5 ft^3/day) hydrogen, with an upper bound of 0.75 m^3/day (26.7 ft^3/day) (HNF-SD-WM-CN-114). A second conservative assumption is that the headspace volume of Tank 241-AY-102 is limiting at 930 m^3 (33,000 ft^3) (HNF-SD-WM-CN-114).

Under the upper bound hydrogen generation rate conditions, a ventilation flow rate of 8.3 x 10^{-2} m^3/min (2.95 ft^3/min) is sufficient to ensure the headspace remains below 25% LFL. The minimum design flow rate provided by the upgraded AY/AZ vent system (241-AZ-702), 2.8 m^3/min (100 ft^3/min) per tank, exceeds the 25% LFL ventilation requirement by an order of magnitude. This evaluation provides some confidence in the adequacy of the ventilation system to prevent the steady state accumulation of flammable gas to levels above the LFL since the minimum ventilation flow rate provided by the existing 241-A-702 ventilation system ranges from approximately 11.3 to 17.0 m^3/min (400 to 600 ft^3/min) and the minimum ventilation flow rate provided by the 241-AZ-702 ventilation system is approximately 2.8 m^3/min (100 ft^3/min). To confirm this, flammable gas monitoring will be used for a short time after completing the sludge transfer to Tank 241-AY-102 (steady state conditions attained) to confirm the system's ability to keep flammable gas concentrations below 25% of the LFL. The risk of this approach is low since the calculations show a large margin between what is required (6.8 x 10^{-2} m^3/min) and what is provided (at least 2.8 m^3/min).

The scoping analysis then determined the flammable gas concentration increase transient, assuming a loss of forced ventilation. Based on the estimated gas generation rate after the addition of Tank 241-C-106 sludge, the amount of time with no forced ventilation flow before the dome space concentration would exceed 25% of the LFL is approximately 7.7 days, using upper bound generation rates (HNF-SD-WM-CN-114). In addition, the amount of time with no ventilation flow before exceeding the LFL is more than 33 days. This evaluation provides some confidence in the adequacy of the TSRs (HNF-SD-WM-TSR-006) to prevent the steady state accumulation of flammable gas

to levels above the LFL because ventilation restoration is required immediately, and gas monitoring is required to be initiated within 72 hours.

The implementation of the main text of the FSAR, Appendix K control strategy in conjunction with the application of the TSRs (HNF-SD-WM-TSR-006) provides adequate controls to prevent a flammable gas deflagration as a result of steady state flammable gas generation.

3.4.2.8.2 Gas Release Event.

Gas Release Events in Tank 241-C-106. The sluicing operation disturbs the waste sludge which could potentially result in a GRE. Sluicing is conservatively defined as a globally waste disturbing operation (FSAR, Appendix K). Waste disturbing activities represent the primary means of releasing gas retained in the waste matrix resulting in a GRE.

The controls required by the TSRs (HNF-SD-WM-TSR-006) are graded based on the tank Facility Group assignment and the nature of the operation or activity. Tank 241-C-106 is assigned Facility Group 3 status. This facility assignment means that GRE controls are focused on waste intrusive regions during normal storage when no waste disturbing operations are being performed. Gas release event controls are extended to the dome space intrusive regions during waste disturbing operations. Controls are <u>not</u> extended to ex-tank intrusive regions during globally waste disturbing operations (as would be the case for tanks assigned to Facility Group 2). The sluicing operation involves mobilizing portions of the sludge with a jet of liquid waste and pumping the resultant slurry out of the tank. This operation, therefore, is waste disturbing and GRE controls are required in the dome intrusive region during operation of the WRSS.

The equipment, materials, and work practices associated with the equipment used in Tank 241-C-106 for WRSS operations have been evaluated by the Flammable Gas Equipment Advisory Board (FGEAB) to verify that they are in compliance with the Ignition Source Control Sets #1 and #2 as detailed in TSR AC 5.10 (HNF-SD-WM-TSR-006). The FGEAB evaluation of the equipment, materials, and work practices associated with this project determined that the applicable Ignition Source Control Sets could be satisfied in all cases by implementing several design modifications. The required design modification will be verified to have been implemented during Operational Readiness Review.

Comprehensive compliance with the applicable Ignition Source Control Sets minimizes the potential for an ignition source in regions that could be flammable as a result of a small induced GRE. This control implementation is adequate for the performance of WRSS operations as a large GRE is not expected or postulated. These expectations are based on the following information.

- Small amounts of retained gas (WHC-SD-WM-ER-526, *Evaluation of Hanford Tanks for Trapped Gas*)

- Slurry growth and GRE behavior are associated with tanks that contain large quantities of organic complexants. Although Tank 241-C-106 might have contained organic complexant waste in the

past, samples indicate that almost all the complexants have decomposed to oxalate.

- No supernate to drive buoyant displacement GREs.

Thus, the implementation of the main text of the FSAR, Appendix K control strategy during sluicing in Tank 241-C-106 provides adequate control to prevent a flammable gas deflagration as a result of a GRE.

Gas Release Events in Tank 241-AY-102. Gas release events are postulated to occur in DST and AWF tanks spontaneously or as a result of waste disturbing operations and activities. The controls required by the TSRs (HNF-SD-WM-TSR-006) are graded based on the tank Facility Group assignment and the nature of the operation or activity. Tank 241-AY-102 is assigned Facility Group 2 status. This facility assignment means that GRE controls are focused on dome space intrusive and waste intrusive regions during non-waste disturbing or locally waste disturbing operations. Controls are extended to ex-tank intrusive regions during global waste disturbing operations. WRSS involves waste addition/removals or transfers in Tank 241-AY-102 which are defined as global waste disturbing operations. Therefore, the expanded controls are required during WRSS transfers.

The assignment of Facility Group 2 is based on consideration for future use of the tanks rather than current waste inventory or current observation of GRE behavior. All DST and AWF tanks are assigned to Facility Group 2 unless they have observed large spontaneous GRE behavior, in which case they are assigned Facility Group 1 status. The DSTs and AWFs are within their design life and are integral to the safe waste storage and disposal mission. They will receive new waste from other Hanford Site facilities and will undergo liquid reductions, waste consolidation, multiple transfers, and mixing.

Procedures are in place to minimize the likelihood that these operations would create conditions resulting in large spontaneous gas release behavior. However, it is recognized that some operations may result in increased gas generation and retention. Therefore, it is appropriate to categorize these facilities in Facility Group 2 or higher. In the unlikely event that significant GRE behavior develops in Facility Group 2 tanks, they will be moved to Facility Group 1 (main text of the FSAR, Appendix K). Therefore, Tank 241-AY-102 will remain assigned to Facility Group 2 unless large spontaneous GRE behavior is observed as a result of WRSS or any other waste transfers to this tank. If large spontaneous GRE behavior is anticipated or observed, the GRE behavior can be at least partially mitigated by removal of the supernatant liquid. Removal of the supernatant liquid mitigates GREs by reducing waste buoyant displacements and increases the tank dome space available for dilution of the released gas.

The equipment, materials, and work practices associated with this project were evaluated by the FGEAB to verify that the equipment and materials used in and around Tank 241-AY-102 are in compliance with the Ignition Source Control Sets #1 and #2 as detailed in TSR AC 5.10 (HNF-SD-WM-TSR-006). The FGEAB evaluation of the equipment, materials, and work practices associated with this project determined that the applicable Ignition Source Control Sets could

be satisfied in all cases by implementing several design modifications. The required design modification will be verified to have been implemented during Operational Readiness Review.

Comprehensive compliance with the applicable Ignition Source Control Sets not only minimizes the potential for an ignition source following a steady state gas release, but also minimizes the potential for an ignition source following a GRE. This control implementation provides an additional level of safety in order to prevent a flammable gas deflagration even if a large GRE were to occur. However, a large GRE is not expected to occur during or following WRSS operation. These expectations are based on the following information.

- LA-UR-97-1330, *Discussion of Flammable Gas Issues for Project W-320*, states that since Tank 241-AY-102 does not contain any organic complexants and is very dilute in terms of nitrates and nitrites, the volume of retained gas in the sludge following the transfer should be small (retained gas void fraction is estimated to be less in Tank 241-AY-102 than currently exists in Tank 241-C-106).

- Because the retained gas void fraction is expected to be low, and the neutral-buoyancy void fraction is estimated to be > 20%, episodic releases (rollovers) are not expected in Tank 241-AY-102 (LA-UR-97-1330, Appendix B).

- Because the makeup of Tank 241-AY-102 will be principally Tank 241-C-106 sludge and GRE behavior is not observed in Tank 241-C-106, GRE behavior is not anticipated in Tank 241-AY-102.

The implementation of the main text of the FSAR, Appendix K control strategy during WRSS operation in Tank 241-AY-102 provides adequate control to prevent a flammable gas deflagration as a result of a GRE, even though a GRE is not expected to occur.

3.4.2.8.3 Controls. This section summarizes the adequacy of existing controls for the implementation of WRSS operations, and summarizes any required new controls.

Safety Structures, Systems, and Components. Because of the open status of the USQ and the technical uncertainties associated with the flammable gas safety issue, it is assumed that installed equipment that performs a critical safety function to prevent or mitigate risk from flammable gas deflagrations merits a safety class designation. Additional analysis provided by the final safety analysis report or in support of safety issue resolution and USQ closure may provide refinement to this approach. As indicated in the FSAR, the ventilation safety function is designated as Safety Class. The new ventilation system to be utilized on Tank 241-C-106, therefore, is designated safety class. There are no unique new safety functions needed or provided by WRSS operations, and therefore the safety SSCs as stated in the main text of the FSAR remain applicable. The SSCs credited with managing risk from flammable gas deflagrations are repeated in Table 3.2.4.8-1.

Technical Safety Requirement Controls. The fundamental control strategy for all affected facilities is contained in the TSRs (HNF-SD-WM-TSR-006). WRSS operations relies on these TSRs for management of flammable gas hazards. There are no unique new safety requirements needed for, or provided by, WRSS operations, and therefore the TSRs remain applicable. The TSRs credited in the FSAR for managing risk from flammable gas deflagrations are repeated in Table 3.4.2.8-2.

Defense in Depth. There are unique and specific Defense-in-Depth measures that apply to the risk management of the flammable gas hazard for WRSS operations. These are included in the Process Control Plan, which is described in Section 2.5. Key Defense-in-Depth items are listed in Table 3.4.2.8-3.

Relative to managing risk from GREs in Tank 241-C-106 during sluicing, the Process Control Plan includes monitoring the headspace concentrations in Tank 241-C-106 and stopping sluicing if concentrations exceed 25% of the LFL.

Relative to managing risk from the ignition of GREs during operation of the WRSS, flammable gas concentrations will be monitored in Tank 241-AY-102 and WRSS will be stopped if concentrations exceed 25% of the LFL.

Relative to managing future GRE behavior in Tank 241-AY-102, the Process Control Plan collects data in order to avoid making Tank 241-AY-102 into a tank that experiences large episodic releases of flammable gas. The Process Control Plan requires baseline hydrogen concentration data from both tanks, and a series of stages where a transfer of waste is made. Monitoring occurs during a waiting period and a decision is made about whether another transfer stage should be done. In addition, a step-by-step contingency plan to remove the supernate out of Tank 241-AY-102 is included to mitigate GRE behavior if retained gas void fractions are estimated to approach neutral-buoyant void fractions.

Table 3.4.2.8-1. Safety Structures, Systems, and Components for Flammable Gas Deflagrations.

Structures, systems, or components	Safety classification		Safety function	Comments
	SC	SS		
Active ventilation	X	--	Maintains flammable gas concentrations in tank dome spaces, due to steady state releases, below 25% of the LFL	Applies to Tanks 241-C-106 and 241-AY-102
Primary tank leak detection system	X	--	Provides indication that corrective action is required to avoid accumulation and deflagration of waste gas in the annulus space	--

LFL = lower flammability limit.
SC = Safety-Class.
SS = Safety-Significant.

Table 3.4.2.8-2. Technical Safety Requirement Controls for Flammable Gas Deflagrations.

Control	Safety function	Comments
DST and AWF Tank Ventilation Systems	Prevents the accumulation of flammable gases due to steady-state releases and reduce the time at risk due to a gas release event	Flow must be verified OR flow monitoring must be performed OR pressure monitoring must occur
SST Ventilation Systems - Active	Applies to Tank 241-C-106 during transfer operations because an active ventilation system is required to remove accumulations of flammable gases produced during activities	Flow must be verified OR flow monitoring must be performed OR pressure monitoring must occur
Primary Tank Leak Detection System	Provides indication that corrective action is required to avoid accumulation and deflagration of waste gas in the annulus space	--
Flammability controls	A program will be established, implemented, and maintained to manage flammable gas hazards	During the performance of WRSS transfer operations there is the possibility of flammable conditions developing as a result of waste disturbing activities
Ignition controls	A program will be established, implemented, and maintained to manage potential ignition sources that can initiate a fire or flammable gas deflagration	Ignition controls for the annulus includes leak detection systems
Flammable gas monitoring	A program will be established, implemented, and maintained to monitor flammable gas concentrations to prevent deflagrations	
Emergency Preparedness - Response procedures	A program will be established, implemented, and maintained to ensure that emergency response plans are developed to direct facility actions in the event of a deflagration/detonation	--
HEPA filter controls - Periodic radiation surveillance - Replacement based on accumulation	Reduce consequences from a possible HEPA filter failure by limiting the inventory available for release.	--

AWF = aging waste facility.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
LFL = lower flammability limit.
SST = single-shell tank.
TWRS = Tank Waste Remediation System.
WRSS = Waste retrieval sluicing system.

Table 3.4.2.8-3. Defense-in-Depth Controls for Flammable Gas Deflagrations.

Control	Safety function	Comments
Monitor dome pressure in Tank 241-C-106 and Tank 241-AY-102 during sluicing	To determine if gas release events are occurring	A positive pressure increase indicates a release
Periodic video monitoring of the waste in Tank 241-AY-102	Foaming can cause enhanced retention of flammable gases. In addition, the foam could cause the high-level detector to function introducing an intermittent spark source	--
Measure background concentrations in both tanks for 3-4 weeks prior to sluicing	To determine the baseline generation rates and types of flammable gases in the tanks	Supports the Process Control Plan
Monitor the ventilation flow rates in both tanks during and after sluicing	This is used to help determine how much flammable gas is released versus how much gas is retained	Supports the Process Control Plan
Monitor level growth and use barometric pressure evaluation after sluicing	This determines whether Tank 241-AY-102 will become a tank that undergoes gas release events (often called rollovers)	Supports a decision on whether the contingency plan for removal of supernate from Tank 241-AY-102 if evaluation of conditions indicates a potential for rollover needs to be implemented
Flammable gas monitoring during sluicing	Determines if release events are occurring and provides evidence of gas retention	Stopping transfer activities between Tank 241-C-106 and Tank 241-AY-102 immediately if the concentration of flammable gas is > 25% of the LFL and transfer operations are in progress provides protection for the worker, minimizes activities that can produce an ignition source, and ensures the sluicing operation remains safe
HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h)	Limit inventory available for release and limit dose rate to workers in the vicinity of the filters	--

HEPA = high-efficiency particulate air (filter)
LFL = lower flammability limit.

3.4.2.9 Organic Solvent Fire. This section evaluates risks associated with the presence of separable-phase organic solvents in Tank 241-AY-102 and Tank 241-C-106 during and after WRSS operations. Both tanks have been identified as potentially containing a separate organic solvent phase capable of sustained burning (WHC-SD-WM-CN-032, *Analysis of Consequences of Postulated Solvent Fires in Hanford Site Waste Tanks*). If a separable organic liquid phase exists or is created by sluicing and is subsequently ignited, energy sufficient to release hazardous materials from the tanks could be liberated.

The analysis for an organic solvent fire contained in WHC-SD-WM-CN-032 is almost entirely applicable to Tank 241-AY-102 and Tank 241-C-106. The ventilation rate considered is 0.047 m^3/s (100 cfm). Therefore, the following sections are based on the analysis in WHC-SD-WM-CN-032 with modifications only to the extent necessary for their application to sluicing of Tank 241-C-106. The type of organic material involved in this accident is bis(2-ethylhexyl) phosphate instead of the tri-butyl phosphate (TBP) and normal paraffin hydrocarbon analyzed in the main text.

This analysis also closely follows that found in Section 3.4.2.4 of the main text. When the discussions between Section 3.4.2.4 of the FSAR overlap with the discussions in this analysis, only a summary is presented here.

WHC-SD-WM-CN-032 evaluates the frequency and consequences of the following three basic fire scenarios.

- **Pool Fires**—Pools are a layer of solvent floating on top of liquid waste or a layer that is trapped in a depression on top of solid waste. Neither Tank 241-AY-102 nor Tank 241-C-106 currently has a solid layer on top of the waste, but the analysis bounds such a possibility. The solids layer might occur on top of the waste if, for example, Tank 241-C-106 were to lose water and expose the solids at the bottom of the tank. The organic solvent pool has an area greater than 1 m^2 (10.8 ft^2).

- **Puddle Fires**—Puddles are 1 m^2 (10.8 ft^2) or less in area and would exist only in a depression in a solid waste surface. A puddle could occur in Tank 241-C-106 if the water layer were lost.

- **Wick-Stabilized Fires**—A wick-stabilized fire configuration would be a sludge or salt cake permeated with solvent. As the solvent burned, the sludge or salt cake would act as a wick. This case applies only to Tank 241-C-106 if the water layer in the tank were lost.

In addition to the accident scenarios identified in WHC-SD-WM-CN-032, the hazards analysis documented in Section 3.3 identifies several accident sequences specific to Tank 241-AY-102, Tank 241-C-106, and WRSS operations. The dominant sequences include the creation of a separable organics phase as a result of pumping and sluicing operations and subsequent ignition of the separated organic solvent. Less likely event sequences include inadvertently allowing the solids to become exposed and the organic components subsequently igniting.

The possibility of an organic solvent pool resulting in significant headspace flammability concerns is addressed in WHC-SD-WM-CN-032. The conclusion from WHC-SD-WM-CN-032 is that the low-volatility compounds in the waste pose little flammable vapor hazard, even if a separable organics phase forms. The organophosphates found in Tank 241-C-106 are bounded, in terms of volatility, by the organophosphates assumed in WHC-SD-WM-CN-032. Therefore, a flammable vapor deflagration resulting from formation of a separable organics phase in Tank 241-AY-102 or Tank 241-C-106 is not evaluated as a separate event.

3.4.2.9.1 Scenario Development. Four cases from WHC-SD-WM-CN-032 were found to bound organic solvent fires for sluicing operations.

- **Case G**—Bounding radiological accident for a single-shell tank fire (Tank 241-C-106).
- **Case K**—Bounding radiological accident for a double-shell tank fire (Tank 241-AY-102).
- **Case H**—Bounding toxicological accident for a single-shell tank fire (Tank 241-C-106).
- **Case L**—Bounding toxicological accident for a double-shell tank fire (Tank 241-AY-102).

The letter designator for each "case" is taken from the spreadsheet calculations in WHC-SD-WM-CN-032. The designators are maintained throughout this analysis to ease cross-referencing to the source document.

Scenarios Without Controls

- **Initiators**—An evaluation of potential initiators, including results from testing laboratories, is given in WHC-SD-WM-CN-032. For the cases involving pool and puddle fires, the only initiators with sufficient energy to cause ignition are lightning strikes and vehicle fuel fires. However, a wick-stabilized fire was found to require less energy to initiate and less energy to maintain the necessary conditions for combustion. For a wick-stabilized fire, initiators include hot metal from cutting torches, but not sparks or slag from welding; lightning strikes; and vehicle fuel fires.

  A flammable gas deflagration is also a potential initiator to an organic solvent fire in a tank. However, the consequences of a flammable gas deflagration (Section 3.4.2.8) are evaluated as a separate accident and applicable controls have already been developed for them.

- **Bounding Radiological and Toxicological Wick-Stabilized Fire in Single-Shell Tank, Case Q-**WHC-SD-WM-CN-032 indicates that solvent could intrude into the underlying sludge or salt cake in a single-shell tank following salt well pumping of drainable liquids from a tank. This condition also applies to Tank 241-C-106 during sluicing operations if the water is inadvertently drained from the tank by the slurry pump, or makeup cooling water is not provided. Exposed solids saturated with solvent could burn like a candle using the solids as a wick. The burning surface would slowly increase and could eventually cover approximately 40 m^2 (431 ft^2).

- **Bounding Radiological Single-Shell Tank Fire, Case G-**WHC-SD-WM-CN-032 indicates that in this scenario a pool of solvent is postulated to burn on the waste surface of an actively ventilated single-shell tank. The active ventilation system results in more radioactive material being exhausted from the tank, even after the fire is extinguished, and applies to Tank 241-C-106.

- **Bounding Radiological Double-Shell Tank Fire, Case K-**WHC-SD-WM-CN-032 indicates that a puddle fire (1 m^2 [10.8 ft^2]) is bounding for radiological releases from double-shell tanks (e.g., Tank 241-AY-102). A puddle fire assumes that the solvent collects in a small area on a solids surface. Tank 241-AY-102 does not have a known solids layer on top of the liquid layer, but the supernate in Tank 241-AY-102 could be almost completely removed following cessation of WRSS operations. In that case, inadvertent exposure of the solids in Tank 241-AY-102 would be more likely. Therefore, Case K is retained as the bounding case for Tank 241-AY-102.

- **Bounding Toxicological Single-Shell Tank Fire, Case H-**WHC-SD-WM-CN-032 indicates that this case is a passively ventilated pool fire with the large vent path model (9.5cm [3.75in.]) orifice and a 1.27m (50in.) orifice. The large vent path results in the toxic material in the headspace being rapidly ejected from the tank. Because toxicological guidelines are based on concentration, this case produces the largest toxicological consequence.

- **Bounding Toxicological Double-Shell Tank Fire, Case L-**WHC-SD-WM-CN-032 indicates that a pool fire (210 m^2 [2,260 ft^2]), an active ventilation system, and a large vent path (1.27m [50in.]) orifice and a 0.24m (9.6in.) orifice is bounding for this case. This case applies to all double-shell tanks, including Tank 241-AY-102. The large vent path results in the toxic material in the headspace being rapidly ejected from the tank. Because toxicological guidelines are based on concentration, this case produces the largest toxicological consequence.

Accident Frequencies Without Controls. The accident frequency without controls is assigned based on the frequency of the initiating event. For an organic solvent fire in Tank 241-AY-102 or Tank 241-C-106, the accident frequency is the sum of the frequencies of lightning strikes, vehicle fuel

fires, and the presence of hot metal from cutting torches. WHC-SD-WM-CN-032 shows that these are the only potential ignition sources that also have sufficient energy to start a fire.

- **Lightning**—The frequency of lightning strikes is determined in WHC-SD-WM-CN-032 as 3×10^{-5} per year per tank. This frequency applies directly to WRSS operations.

- **Vehicle Fuel Fire**—WHC-SD-WM-CN-032 determined that the frequency of a vehicle collision with an aboveground structure is 7×10^{-5} per tank per year. This frequency applies directly to WRSS sluicing operations.

- **Flame or Torch Cutting**—Flame or torch cutting on a tank or its attachments (i.e., a riser or a ventilation duct) where hot chunks of metal could fall to the waste surface is not a common activity. For the sluicing operations, no more than five flame or torch cutting operations per year per tank are expected, excluding the initial facility modifications. The basic human error probability of 1×10^{-2} is assumed in estimating the likelihood of dropping hot metal into a tank during a cutting operation. The resulting frequency of an event during a cutting activity is then

  $$(5) \times (1 \times 10^{-2}) = 5 \times 10^{-2} \text{ per year per tank.}$$

  The only case where hot metal from a cutting operation could initiate a fire is for the wick-stabilized condition. The probability of igniting solvent-permeated sludge is estimated at 1×10^{-1} (WHC-SD-WM-CN-032). The probability of draining Tank 241-C-106 to obtain an exposed solids layer is taken to be 1×10^{-2} for human error to inadvertently drain the tank and not correct the loss of water condition. Therefore, the overall frequency without controls of having a wick-stabilized solvent fire resulting from torch cutting is

  $$(5 \times 10^{-2}) \times (1 \times 10^{-1}) \times (1 \times 10^{-2}) = 5 \times 10^{-5} \text{ per year per tank.}$$

  Although WHC-SD-WM-CN-032 indicates that hot metal from cutting torches would not initiate a fire in a double-shell tank (Tank 241-AY-102), the possibility of exposing the solids layer in Tank 241-AY-102 must be considered. The supernate in Tank 241-AY-102 could be substantially reduced following cessation of sluicing operations. This configuration increases the likelihood of inadvertently exposing the solids layer. Furthermore, inclusion of the frequency of hot metal as an initiator does not alter the conclusions of the frequency analysis. The frequency category is the same with or without the frequency of the hot metal initiator.

- **Overall Frequencies**—For Tank 241-AY-102 and Tank 241-C-106, the sum of the frequencies for lightning, vehicle fuel fire, and torch cutting scenarios is the overall frequency of an organic solvent fire. This frequency is
  $(3 \times 10^{-5}) + (7 \times 10^{-5}) + (5 \times 10^{-5}) = 1.5 \times 10^{-4}$ per tank per year, times one tank (241-AY-102 or 241-C-106), for a frequency of

1.5×10^{-4} per year for either tank. These frequencies fall into the range of "unlikely" (10^{-4} to 10^{-2} per year) for determining risk evaluation guidelines.

Note that if the torch-cutting scenario is excluded from the frequency for Tank 241-AY-102, the overall frequency would be 1×10^{-4} per year, which still falls within the "unlikely" category.

Scenarios With Controls. The controls specified in this analysis eliminate two of the three possible initiators: vehicle fuel spills and flame cutting. The scenario with controls is, therefore, an organic solvent fire initiated by a lightning strike.

Frequencies With Controls. The frequency bin for the accidents without controls is "unlikely." The multiple control strategy for protection of fuel and prevention of ignition sources eliminates vehicle fuel fires and flame cutting as initiators. Failure of these controls is considered a beyond design basis event. Only lightning remains, with an initiating event frequency of 3×10^{-5} per year. For both tanks this results in a frequency designation of "extremely unlikely" for the accident scenarios with controls.

3.4.2.9.2 Source Term Development. The source terms from an organic solvent fire in Tank 241-AY-102 or Tank 241-C-106 are based on the source term models developed in WHC-SD-WM-CN-032.

The radiological material inventory for ventilation system components is summarized in HNF-SD-WM-CN-099. Of the three material inventories from the fire, only the HEPA filter source term is different than that calculated in WHC-SD-WM-CN-032. The different material inventory for the HEPA filters is discussed below.

HNF-SD-WM-CN-099 also lists the toxicological material inventory. Of the toxicological material inventories, only phosphorous pentoxide (P_2O_5) differs from that calculated in WHC-SD-WM-CN-032. Because of recent test data on the organic content of Tank 241-C-106, the assumptions pertaining to the types and quantities of organophosphates are different from those in WHC-SD-WM-CN-032. The material inventory calculations (emission factor) for the solvent smoke in this analysis address the new P_2O_5 inventory.

Filters. The air filter material inventories for the bounding ventilation systems for Tanks 241-AY-102 and 241-C-106 are taken from HNF-SD-WM-CN-099. The values in WHC-SD-WM-CN-032 are not appropriate because the difference in ULDs results in different filter loadings. The filter loadings are calculated from radiation readings near the surface of the filter housings (based on the filter change-out requirements), and different ULDs comprise different mixtures of isotopes. Selecting different ULDs results in altering the isotopic distribution on the filters and, subsequently, the radiological loadings on the filters.

HNF-SD-WM-CN-099 reports air filter loadings and subsequent inventory released following an overpressure event for both tanks and the various possible ventilation configurations.

The bounding HEPA filter material releases (based on the liquid/solid split discussed in Section 3.4.1) from HNF-SD-WM-CN-099 are as follows:

- Tank 241-C-106, 1.91×10^{-1} L; 296-C-006 system
- Tank 241-AY-102, 3.66×10^{-2} L; 241-A-702 system.

These releases are based on pressure failure of the filters, which bounds temperature failure (HNF-SD-WM-CN-099). These inventories are used in Table 3.4.2.9-1 to calculate dose consequences.

Solvent Smoke. The inventories arising from the solvent smoke (combustion products) are taken from WHC-SD-WM-CN-032. The radiological inventories are as follows:

- Case G, Tank 241-C-106; 4.38 kg (9.66 lb) of Tank 241-C-106 tank waste
- Case K, Tank 241-AY-102; 13.2 kg (29.1 lb) of Tank 241-AY-102 tank waste.

These inventories are used in Table 3.4.2.9-1 to calculate dose consequences.

The toxic materials produced by the organic solvent fire are modeled in WHC-SD-WM-CN-032 as CO, NO_2, and P_2O_5. These materials represent the predominant combustion species that can be expected to form when hydrocarbon liquids and organophosphates are burned.

The inventories for CO and NO_2 are appropriate for a fire in either Tank 241-C-106 or Tank 241-AY-102 and are used from WHC-SD-WM-CN-032 without modification. The inventory for P_2O_5 in WHC-SD-WM-CN-032 is based on the combustion, and subsequent emission factor, of TBP found in Tank 241-C-103. Recent test data documented in HNF-SD-WM-TI-756, *Chemical and Chemically Related Issues Associated with Sluicing Tank C-106 Waste to Tank AY-102*, indicates that Tank 241-C-106 contains a significant amount of bis(2-ethylhexyl) phosphate. Therefore, a new emission factor must be calculated for the P_2O_5. The method used to calculate the new emission factor is identical to that used in WHC-SD-WM-CN-032.

The stoichiometry for the oxidation of bis(2-ethylhexyl) phosphate is

$$C_{16}H_{35}O_4P + 24\ O_2 = 16\ CO_2 + 17.5\ H_2O + 0.5\ P_2O_5.$$

Using molecular weights of 322.48 g/mol for bis(2-ethylhexyl) phosphate and 142 g/mol for P_2O_5, the mass ratio of P_2O_5 to bis(2-ethylhexyl) phosphate is 0.22. HNF-SD-WM-TI-756 indicates that a minimum of 82% (by mass) of the solvent is made up of organophosphate compounds, but does not list the composition of the remaining 18%. Because the remaining 18% of the solvent could be organophosphate compounds, it is assumed that 100% by mass of the solvent is organophosphates. While this assumption seems overly conservative, a reduction of 18% in the calculated toxicological consequences has no impact on the conclusions reached in this analysis. The emission factor is, therefore, 0.22 kg P_2O_5 formed per kilogram of solvent burned.

The emission factor calculated based on the Tank 241-C-106 waste is bounding for Tank 241-AY-102 because few organophosphate hazards are expected from Tank 241-AY-102 waste.

Aqueous Boil-Off. The radiological inventory arising from the aqueous waste are taken from WHC-SD-WM-CN-032 for the bounding cases and are as follows:

- Case G, Tank 241-C-106; 0.368 kg (0.81 lb) of Tank 241-C-106 tank waste
- Case K, Tank 241-AY-102; 0.333 kg (0.73 lb) of Tank 241-AY-102 tank waste.

These inventories are used in Table 3.4.2.9-1 to calculate dose consequences. The toxicological inventories from the aqueous boil-off and tank headspace are used as modeled in WHC-SD-WM-CN-032.

3.4.2.9.3 Consequence Analysis. The consequence analysis is taken from WHC-SD-WM-CN-032 except for modifications for the ULDs, waste densities, and new P_2O_5 emission factor.

The different ULDs arise from the difference between the operations used as the basis of WHC-SD-WM-CN-032 and those to be performed in sluicing. In WHC-SD-WM-CN-032, it was assumed that no mixing occurred and that the tanks are in essentially a quiescent or static condition. This is not true for sluicing operations, where active mobilization and transport of Tank 241-C-106 solids and potential mobilization and transport of Tank 241-AY-102 solids will occur. Therefore, the ULDs listed in Section 3.4.1 are used in this analysis.

WHC-SD-WM-CN-032 also assumed a waste density of 1 kg/L when multiplying inventories (mass) by ULDs (dose per unit volume). The wastes in Tank 241-C-106 and Tank 241-AY-102 have a density of greater than 1 kg/L. The waste densities of 1.27 kg/L (10% solids and 90% liquids) and 1.41 kg/L (33% solids and 66% liquids) are used in this analysis for fires in Tank 241-AY-102 and Tank 241-C-106, respectively. These densities are used to convert the appropriate ULDs to a mass basis.

Table 3.4.2.9-1 shows the consequences for the cases without controls. Consequences with controls are shown in Table 3.4.2.9-2. The case without controls corresponds to the worst-case frequencies of the bounding fire. The case with controls corresponds to a frequency reduction to "extremely unlikely." The values presented in Table 3.4.2.9-2 are validated in HNF-SD-WM-CN-099, Attachment 6.

The remaining parameters, the breathing rate, and the onsite and offsite atmospheric dispersion factors are taken from WHC-SD-WM-CN-032.

3.4.2.9.4 Comparison with Guidelines. Tables 3.4.2.9-1 and 3.4.2.9-2 compare the accident consequences (without and with controls) to the appropriate risk evaluation guidelines. As can be seen from Tables 3.4.2.9-1 and 3.4.2.9-2, all offsite consequences (radiological and toxicological with

and without controls) are below offsite evaluation guidelines. The table also shows that all onsite consequences (radiological and toxicological with and without controls) are above the onsite evaluation guidelines.

3.4.2.9.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirements.

Safety Structures, Systems, and Components. No Safety-Class or Safety-Significant structures, systems, and components have been identified in this analysis.

Technical Safety Requirement Controls. Controls that act to prevent (reducing the likelihood) or mitigate the consequences of an organic solvent fire are provided in Table 3.4.2.9-3. The TSRs include ignition controls to prevent igniting an organic pool, transfer controls, emergency preparedness, and HEPA filter controls.

Defense-in-Depth. Defense-in-Depth controls are identified in Table 3.4.2.9-4. These include vehicle positioning spotters, tank farm fences, and HEPA filter replacement.

Table 3.4.2.9-1. Summary of Consequences and Frequencies for Organic Solvent Fire Without Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Organic Solvent Fire in Tank 241-C-106	7.1 E-01 7.1 E+01	5.0 E-02 (5.0 E+00)	5.9 E-04 5.9 E-02	5.0 E-03 (5.0 E-01)	20.4	1	0.22	1	Unlikely
Organic Solvent Fire in Tank 241-AY-102	1.8E-01 1.8E+01	5.0 E-02 (5.0 E+00)	1.5 E-04 1.5 E-02	5.0 E-03 (5.0 E-01)	20.0	1	0.22	1	Unlikely

SOF = sum-of-fractions.

Table 3.4.2.9-2. Summary of Consequences and Frequencies for Organic Solvent Fire With Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Organic Solvent Fire in Tank 241-C-106	7.1 E-01 (7.1 E+01)	1.0 E-01 (1.0 E+01)	5.9 E-04 (5.9 E-02)	4.0 E-02 (4.0 E-00)	20.4	1	0.22	1	Extremely Unlikely
Organic Solvent Fire in Tank 241-AY-102	1.8 E-01 (1.8 E+01)	1.0 E-01 (1.0 E+01)	1.5 E-04 (1.5 E-02)	4.0 E-02 (4.0 E+00)	20.4	1	0.22	1	Extremely Unlikely

SOF = sum-of-fractions.

Table 3.4.2.9-3. Technical Safety Requirement Controls for Organic Solvent Fires. (2 sheets)

Control	Safety function	Comments
Ignition Controls with the following key elements:		--
- Vehicle access within the tank farms shall be limited to vehicles whose fuel systems are protected from damage caused by potential collisions with tank structures	Prevents vehicle fuel system damage in the event of collisions with tank structures within the tank farms. Outside the tank farms where vehicle access can not be controlled, prevent vehicle access to tank structures	
- Physical barriers shall restrict vehicle access to those aboveground structures outside of tank farm boundaries that can direct liquids into waste tanks. Only vehicles with protected fuel systems shall be allowed within barriers		
- Speed limit controls		
- Stop intrusive activities in Tank 241-AY-102 and 241-C-106 when lightning is identified within a 80.5 km (50-mile) radius of the tank farm	Pieces of hot metal from flame cutting may be capable of igniting salt cake or sludge that has entrained organic solvent in it	
- Secure equipment in lowest position (e.g., lay down equipment elevated above the tanks and lower crane boom) if lightning is identified within 80.5 km (50 miles) of the tank farm		
- If flame cutting is performed in a location where debris from the cutting could fall on the waste surface in a tank, a device that is capable of catching and holding hot metal debris from the cutting shall be inserted between the cutting operation and the waste surface. This does not apply to sparks or slag from welding		
Transfer Controls with the following key elements:		--
- All waste transfers shall be evaluated to ensure that the waste transfer does not create an organic solvent hazard outside the FSAR safety envelope	Ensures that waste transfers do not create an organic solvent hazard outside the safety envelope established by the FSAR (i.e., prevent creation of a new tank with an organic solvent hazard unless the required organic solvent controls are extended to the tank)	
Emergency Preparedness with the following key element:		--
- Response procedures	Mitigates the consequences of a fire	

Table 3.4.2.9-3. Technical Safety Requirement Controls for Organic Solvent Fires. (2 sheets)

Control	Safety function	Comments
HEPA Filter Controls with the following key elements: - Periodic radiation survey to monitor HEPA filter loading - HEPA filter replacement per change-out criteria (i.e., ≤ 2 mSv/h [200 mrem/h]) - 241-AZ-702 HEME replacement per change-out criteria (8 mSv/h (800 mrem/h) - Periodic radiation survey to verify that 296-C-006 HEME/HEMF dose contribution is ≤ 1 mSv/h (100 mrem/h) at location of radiation detector that monitors the HEME/HEMF - Replacement of the 241-AZ-702 HEGA before the upstream HEPA filter has been replaced 20 times, or upon indication of degraded HEPA filter performance	Reduces consequences from a possible HEPA filter failure by limiting the inventory available	Applies to all HEPA filters and prefilters in the ventilation system
- Aerosol test upon installation (AWF 241-AZ-702) - Periodic aerosol test (AWF 241-AZ-702)	HEPA filter efficiency testing protects the HEGA filter source term assumption in the analysis	Applies to HEPA filters upstream of the HEGA filters

HEGA = high-efficiency gas adsorber
HEME = high-efficiency mist eliminator
HEMF = high-efficiency metal filter
HEPA = high-efficiency particulate air (filter).

Table 3.4.2.9-4. Defense-in-Depth Controls for Organic Solvent Fire.

Control	Safety function	Comments
Vehicle positioning spotters	Spotters provide additional level of control in positioning cranes/ vehicles	Reduces probability of analyzed accident
Tank farm fences	Provide line of demarcation within which Ignition Control Program key elements related to vehicle fuel systems must be met	Fence gates are typically closed and locked
HEPA filter replacement typically performed at 1 mSv/h (100 mrem/h)	Limits inventory available for release, limits dose rate to workers in vicinity of the filters	Doses from HEPA filters were minimal compared to the overall doses

HEPA = high-efficiency particulate air (filter).

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3.4.2.10 In-Tank Fuel Fire/Deflagration. This accident addresses the possibility that a combustible fuel is inadvertently added to either Tank 241-AY-102 or Tank 241-C-106 during or after sluicing operations. This scenario is the same as in Section 3.4.2.5 of the main text of the FSAR except that the material risk can include AWF solids. Even though increased consequences could occur, the control strategy is prevention. The controls are not specifically derived from the consequences and would not be changed by variations in the magnitude of the calculated consequences.

3.4.2.10.1 Scenario Development. In assessing the results of fuel spills into tanks, two possible scenarios are considered. The first scenario is a pool fire in which the fuel burns on the surface of the waste (Section 3.4.2.9, Organic Solvent Fire). The second scenario is a headspace deflagration in which vaporized fuel causes the headspace volume to reach the lower flammability limit, and the vaporized fuel is ignited (Section 3.4.2.8, Flammable Gas Deflagration). The difference between the two scenarios is the physical state of the fuel when ignition occurs.

Accident Scenarios Without Controls. The fuel spills are initiated by vehicle accidents and by propylene glycol spills into the tank. The vehicle accident would be an impact into an above grade structure (e.g., a riser) and the subsequent spill of the vehicle fuel into the structure. Because many of the aboveground tank structures have penetrations into the tank, the fuel is assumed to leak into the tank and also spill into the pits. The case where the spill is contained (and catches fire) in the aboveground structure is addressed in Section 3.4.2.4 (Fire in Contaminated Area). The maximum amount of vehicle fuel available in an accident is 227 L (60 gal) (i.e., the capacity of the largest fuel tank on any vehicle that enters the tank farms). Some of the spilled fuel could enter the waste tank through the damaged structure, while some of the fuel would vaporize as the fuel drained into the tank. Section 3.4.2.5.1 of the main text of the FSAR describes the vehicle accident scenario.

The propylene glycol spills could be initiated by a failure associated with either the pit or process chiller. The pit chiller is associated with the Tank 241-AY-102 pump pit and is designed to provide cool air to the pit to remove heat generated by the pump. The process chiller is associated with the ventilation systems of Tank 241-C-106. Before sluicing, the process chiller will be used to precool the waste and minimize the possibility of releasing steam from the waste after sluicing operations begin. After sluicing operations have begun, the process chiller will be used on the recirculation line of the new ventilation system as part of the moisture removal system to prevent the formation of fog in the tank.

The propylene glycol from either chiller would not present a significant fire or deflagration hazard in the tank. Propylene glycol is present in the chillers as a solution in water (46% propylene glycol and 54% water). Therefore, the possibility that a propylene glycol spill results in a fire inside either Tank 241-AY-102 or Tank 241-C-106 is not addressed further.

Accident Frequency Without Controls. The frequency category assigned is "extremely unlikely" based on the analysis in Section 3.4.2.4.

Accident Scenario With Controls. The multiple control strategy specified in Section 3.4.2.10.5 prevents the accident by controlling the fuel and ignition sources. Because the accident is prevented by the specified controls, no release scenarios are postulated for the case with controls. The failure of the multiple control strategy is considered a beyond design basis event.

Accident Frequency With Controls. No release scenarios are postulated assuming success of the credited controls. Therefore, no accident frequency is developed for this case.

3.4.2.10.2 Source Term Analysis.

Accident Source Term Without Controls. The source term for the vehicle fuel pool fire is bounded by the source term calculated for the organic solvent pool fire in Section 3.4.2.9 and is not repeated here.

Accident Source Term With Controls. No release scenarios are postulated assuming success of the credited controls; therefore, no source term is developed for this case.

3.4.2.10.3 Consequence Analysis. As discussed in the scenario development, the potential radiological and toxicological consequences associated with a vehicle fuel spill into a tank are bounded by the consequences of an organic solvent pool fire consequences presented in Section 3.4.2.9 and are outlined in Tables 3.4.2.9-1 and 3.4.2.9-2.

3.4.2.10.4 Comparison with Guidelines. It can be seen from Table 3.4.2.9-2 that the consequences of a pool fire are outside all onsite evaluation guidelines. However, the pool fire is within all offsite evaluation guidelines.

3.4.2.10.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirements.

Safety Structures, Systems, and Components. No Safety-Class or Safety-Significant structures, systems, and components have been identified to prevent or mitigate this accident.

Technical Safety Requirement Controls. Because the potential consequences identified for this accident exceed evaluation guidelines, TSR controls have been developed. The controls specified in Section 3.4.2.9.5 for the organic solvent fire are designed to prevent the inadvertent spill of vehicle fuel into a tank, provide emergency response if necessary, and limit the release from the high-efficiency particulate air filters. These controls apply to both a fuel fire and deflagration.

To avoid repeating controls and possible inconsistencies, the reader is referred to Section 3.4.2.9.5 for the TSR controls for this accident.

Defense-in-Depth. As with the TSR controls, several features that provide Defense-in-Depth are listed in Section 3.4.2.9.5.

3.4.2.11 Tank Bump. A tank bump could occur if operations related to the tanks produce any of the following conditions without compensating measures being taken.

- Removal of supernate from a tank and the resulting reduction in liquid level will reduce the hydrostatic pressure in the sludge layer and consequently decrease the saturation temperature of the interstitial solution (primarily concerns Tank 241-C-106).
- Increasing the heat load in a tank by adding insoluble solids to Tank 241-AY-102 and/or operating high power pumps.
- Increase of the sludge layer thickness either by fluffing of the current sludge or adding additional sludge (concerns Tank 241-AY-102).
- Inadequately cooling the tank for an extended period (concerns both tanks).

The first three conditions may occur during the WRSS transfer of material from Tank 241-C-106 to Tank 241-AY-102. The fourth condition could occur as the result of ventilation system failure or operational error. The presence of an organic oil film on the top of the supernate layer, due to mobilization of the organics currently dispersed in the waste, could impede evaporative cooling of the tank.

Tank 241-C-106 is one of several SSTs with the proper initial conditions conducive to a tank bump. Tank 241-C-106 contains 746,000 L (197,000 gal) (about 1.75 m [69 in.]) of soft sludge with a total heat load estimated at 38.8 kW (132,400 Btu/h) (as of June 1994) (HNF-SD-W320-ER-004, *Project W-320 SAR and Process Control Thermal Analysis*). The total heat load and the heat load distribution determine the peak temperature in the sludge. If this peak sludge temperature exceeds the local saturation temperature, the potential for a tank bump will increase. Tank 241-C-106 is on the High Heat Watch List and must receive periodic water additions to maintain the waste temperatures within allowable limits. Currently, forced ventilation with added water to promote thermal conductivity and evaporative cooling is used for heat removal.

Tank 241-AY-102, a double-shell tank, contains 121,000 L (30,000 gal) (about 305 mm [12 in.]) of sludge and 3.1 million L (812,000 gal) of supernate for a total waste depth of about 9.1 m (30.0 ft). The estimated heat load of Tank 241-AY-102 is 13.2 kW (45,000 Btu/h) (HNF-SD-W320-ER-004).

The waste transferred into Tank 241-AY-102 will add to that tank's heat load and cause an increase in the sludge temperatures. In addition, the sludge from Tank 241-C-106 will probably not settle back immediately to its original volume, but will initially remain "fluffed" to some greater volume and depth. This increased volume will increase the distance over which heat transfer must take place and further increase the temperature in the sludge. The amount of fluffing (the fluff factor) to be expected is uncertain. A fluff factor of 2 is being assumed as bounding (HNF-SD-W320-ER-004). Thermal analyses have been performed for waste addition to Tank 241-AY-102 to confirm adequate heat removal capability. Analysis results indicate that

waste temperatures will remain below saturation for waste transfers of up to 0.6 m (2 ft). The analysis assumes 4.3 m^3/min (150 ft^3/min) flow to the cooling channels under the tank floor, and operable primary ventilation (these assumptions are valid for both 241-A-702 and 241-AZ-702). After the first campaign to transfer 0.6 m (2 ft) of sludge from Tank 241-C-106, temperatures will not reach their new steady-state values for some time (about 300 days for 0.6 m (2 ft) of sludge transfer) (HNF-SD-W320-ER-004). Real-time temperature data on the tank contents will be entered into a thermal model in the form of an initial temperature history to project thermal response of the sludge. The results will be used to calibrate the model, establish hold times between transfers, and further evaluate cooling requirements for sludge transfers.

The analysis presented here uses a mixture of AWF solids and AWF liquids to develop consequences. A similar mixture of SST solids and SST liquids would have a much lower ULD, thus consequences from an SST tank bump are bounded by the tank bump in Tank 241-AY-102. Therefore, for purposes of establishing the need for controls, only analysis specific to Tank 241-AY-102 is performed.

3.4.2.11.1 Scenario Development. The WRSS accident scenario assumes that heat removal is insufficient to maintain acceptable operating temperatures and that saturation temperature has been reached. This condition is postulated to have been reached as a result of any one or a combination of the four conditions discussed in Section 3.4.2.11.

The analysis uses the following assumptions. Details of the analysis and scenario choice are described in HNF-SD-WM-CN-098, *Consequences of a Postulated Tank Bump Related to Project W-320*.

- In the tank bump analysis (WHC-SD-WM-CN-022), 1.45 m (4.75 ft) of sludge was assumed to have been transferred from Tank 241-C-106 to Tank 241-AY-102, producing a total sludge depth of 3.35 m (11 ft) in Tank 241-AY-102 (fluff factor of 2). The total pool depth was assumed to be maintained at 9.1 m (30 ft).

- For loss of ventilation, a "best estimate" temperature profile (corresponding to the thermal model for 1.45 m [4.75 ft] of sludge and a fluffing factor of 2) was assumed for the sludge layer corresponding to conditions leading to an initial bump caused by inadequate cooling (loss of primary and annulus ventilation) for the heat load over an extended period.

- Only saturated sludge becomes involved in a tank bump. Therefore, the severity of the tank bump is directly related to the volume of saturated sludge. The tank sludge is expected to first reach saturation temperature in the bottom center of the tank. The fraction of sludge that is saturated in this situation is much less than 1. In this case, where the tank is a subject of ongoing operations and is constantly monitored, a tank bump is assumed to be initiated when such a temperature profile exists.

- The vent path configuration that allowed the greatest aerosol release and therefore produced the greatest consequence to onsite and offsite receptors was used.

- No credit was taken for condensation of steam in the supernate layer overlying the sludge.

Accident Scenario Without Controls. For the accident scenario without controls, it was postulated that active ventilation would be lost for an indefinite period. The temperature of the tank waste near the bottom of the tank was modeled to exceed local saturation temperature.

Accident Frequency Without Controls. The frequency of a tank bump without controls was categorized as "anticipated."

Accident Scenario With Controls. The controls selected for the tank bump scenario are preventive and are presented in Section 3.4.2.11.5. The controls prevent tank waste from reaching saturation temperatures, thereby precluding a tank bump.

Accident Frequency With Controls. With the controls identified in Section 3.4.2.11.5, the accident is assumed to be prevented.

3.4.2.11.2 Source Term Analysis. The Tank 241-AY-102 waste conditions were modeled with the GOTH thermal hydraulics computer code, a transient computer program used to model multi-phase flow (WHC-SD-WM-CN-022). The GOTH code presented the mass of waste released (the release fraction and inventory at risk are included in the code). The waste types assumed for radiological dose consequence calculations were AWF tank liquids and solids. The waste types assumed for toxicological consequences were double-shell tank liquids (the toxicological sum-of-fractions for double-shell tank liquids includes AWF liquids) and double-shell tank solids (the toxicological sum-of-fractions for double-shell tank solids includes AWF solids). These are bounding assumptions for a release due to a steam bump in either Tank 241-AY-102 or Tank 241-C-106.

Accident Source Term Without Controls. GOTH model estimates showed that for the worst case tank vent configuration, a tank bump in Tank 241-AY-102 would eject 35.4 kg (78 lbm) of solids and 280 kg (620 lbm) of liquids directly out of the pit drains along with 180 kg (400 lbm) of steam over about 3 seconds (WHC-SD-WM-CN-022). Because this is such a short-duration release, the steam release would initially form a cloud over the release point with the waste material suspended as an aerosol. The loading of this much waste material in this amount of steam would amount to more than a kilogram per cubic meter. Even with some turbulent mixing with air, this is far too great a load to be sustained for even a short time. The material would rapidly fall out of the cloud until the air loading decreased to some short-term sustainable value. The GOTH simulation also shows 770 kg (1700 lbm) of steam issuing from the tank vent at the same time the release from the pit occurs. This magnitude of pressure pulse will easily blow out the filters (HEPA, HEGA and HEME) in the ventilation system. No credit was taken for cover blocks being in place because they would have little effect on the material released.

The maximum sustainable loading of an aerosol mist in air is normally assumed to be 100 mg/m^3 (6.23x10^{-6} lb/ft^3) (ANSI N46.1, *American National Standard - Guidance for Defining Safety-Related Features of Nuclear Fuel Cycle Facilities*). However, because the air loading here is for a fast transient condition until turbulent mixing with the surrounding air and enough evaporation of the water portion of the liquid release can occur, 10 times this value (1 g/m^3) (6.23x10^{-5} lb/ft^3) is assumed for conservatism. For the WRSS accident, all the transportable aerosol that could affect a downwind receptor is assumed to be carried by the released steam at a transient loading of 1 g/m^3 (6.23x10^{-5} lb/ft^3).

The maximum total steam release for any scenario considered was 950 kg (2100 lbm). Assuming the liquid-solid ratio described above (280 kg [620 lbm] liquid and 35.4 kg [78 lbm] solids), the net transportable releases are 9.63 x 10^{-2} L (2.54 x 10^{-3} gal) of solids and 1.17 L (0.31 gal) of liquids (HNF-SD-WM-CN-098). The 1 g/m^3 (6.23x10^{-6} lb/ft^3)initial loading includes the water portion of the liquid waste component that would rapidly evaporate during transport leaving only the dissolved solids. Therefore, in this case, the usual maximum air loading of 100 mg/m^3 (6.23x10^{-6} lb/ft^3) at the receptor cannot be used to assume additional fallout.

The analysis showed the tank headspace pressure to reach a peak of about 28 kPa gauge (4.1 psig) in Tank 241-AY-102 (WHC-SD-WM-CN-022). More available headspace and lower hydrostatic head would result in a lower peak pressure in Tank 241-C-106 than Tank 241-AY-102.

The pressure pulse of 28 Kpa gauge (4.1 psig) is approximately 10 times the minimum pressure required for high-efficiency particulate air filter blow out. Therefore, the filters (HEPA, HEME, and HEGA) in the AY/AZ farm ventilation systems should be expected to fail during a tank bump. Thus, the consequences of the tank bump are increased by the dose contribution from filter blow out and subsequent unfiltered release. However, the dose contribution of filter blow out and unfiltered release is insignificant compared to the dose consequences of the tank bump itself. For example, the 241-A-702 ventilation system represents the bounding case for Tank 241-AY-102 (refer to Sections 3.4.2.2 and 3.4.2.3). For the 241-A-702 system, the combined onsite consequence of 2.1 E-02 Sv for the filter failure and unfiltered release is two orders of magnitude lower than the 1.9 Sv onsite consequences of a tank bump. In addition, the initial headspace air with its normal loading of waste material is assumed to be displaced out of the tank by the steam release. The dose contribution resulting from this effect is negligible compared to the dose consequences of the bump itself (WHC-SD-WM-CN-043, *Tank Bump Consequence Analysis*).

Accident Source Term With Controls. No source term with controls was derived because the accident controls are preventative.

3.4.2.11.3 Consequence Analysis. The onsite and offsite dose consequences and toxicological exposures were determined using the method discussed in Section 3.4.1.

Analysis Results.

Consequences Without Controls. The radiological and toxicological consequences of this release are presented in Table 3.4.2.11-1.

Consequences With Controls. No consequences with controls were derived because the accident controls are preventative.

3.4.2.11.4 Comparison to Guidelines. Table 3.4.2.11-1 compares the tank bump consequences to risk guidelines. Onsite consequences without controls for both radiological and toxicological exposure are above risk guidelines. Offsite radiological consequences are also above risk guidelines. Therefore, to protect the onsite worker and members of the public from both radiological and toxicological hazards of a tank bump, the event must be controlled.

Note that increasing the amount of sludge transferred beyond the 1.45 m (4.75 ft) assumed in the bump simulation from WHC-SD-WM-CN-022 that was used as the basis of this analysis would increase the severity of the bump and the consequent releases. The scenario analyzed here already produces consequences above the onsite and offsite boundary risk guidelines. Increasing the amount of sludge transferred and hence increasing the potential severity of the accident would, therefore, have no effect on the conclusions.

3.4.2.11.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems, and Components. Because both the onsite and offsite guidelines are exceeded, Safety-Class structures, systems, and components are required (Table 3.4.2.11-2).

The primary and annulus ventilation systems for Tank 241-AY-102 remove a major portion of the heat generated in the primary tank. The safety function provides the means to maintain tank waste below local steam saturation temperature. The safety function of both these systems is to maintain the tank waste temperatures below the saturation temperature. The ventilation system for Tank 241-C-106 removes heat from the waste and its safety function is also to maintain the tank waste temperatures below the saturation temperature.

Technical Safety Requirement Controls. The TSR controls selected to prevent tank bumps are listed in Table 3.4.2.11-3. These controls establish tank waste temperature limits, and ensure that waste transfers do not create in-tank conditions conducive to bump initiation.

Tank 241-C-106. Tank waste temperature limits are set for Tank 241-C-106 to prevent the waste in the tank from reaching saturation temperatures. The temperature limits will be lowered as WRSS operations proceed, since the hydraulic head, and thus the saturation temperature, is reduced from waste transfer.

The liquid level in Tank 241-C-106 will be maintained at a pre-determined level for the first two increments (defined as 0.3 m of sludge) of waste transfer, to avoid affecting the sub-cooling provided by the hydraulic head of

the liquid in the tank. The control of the liquid level in Tank 241-C-106 can not be monitored using the ENRAF liquid level instrument because this instrument will be shut down during sluicing operations to avoid damage by the sluice stream. Therefore, the control uses the lower liquid level sensor on the submersible slurry pump. The minimum liquid cover/hydraulic head control requirement will be eliminated after the first sluicing campaign as discussed in HNF-SD-W320-ER-004.

Tank 241-AY-102. To prevent the transfer of heat generating sludge to Tank 241-AY-102 beyond its cooling capacity, a step-wise transfer of waste is required. Waste will be transferred in three campaigns, each consisting of two transfer increments of 0.3 m (1 ft.). Each transfer increment will be followed by a hold period to monitor waste parameters and thermal response. Transfer increments can comprise one or several batches of waste. The sluicing batch durations will be limited by two factors: (1) the mass flow meter totalizer reading (estimated volume of sludge transferred), and (2) a maximum time duration established based on mass flow meter instrument detection level. These two values will be established in the WRSS process control plan. The values may be subsequently modified based on WRSS operational experience.

During the monitoring period between transfer increments, the volume of Tank 241-C-106 sludge transferred to Tank 241-AY-102 will be calculated using ENRAF densitometer density profile data and Tank 241-AY-102 grab samples analysis results. This estimate will be compared with the mass flow meter totalizer readings. The monitoring period duration may also be extended until adequate confidence is established in the estimated sludge volume/heat load transferred.

The sludge volume transferred from Tank 241-C-106 to Tank 241-AY-102 is monitored in real time using the mass flow meter located in pit 241-AY-02A. This solids volume transferred is used to estimate the approximate heat load transferred. After each sluicing campaign, the heat load transfer monitoring is accomplished by performing a heat balance on each of the two tanks to refine the thermal analysis baseline and verify that subsequent sluicing operations can be accomplished safely.

Defense-in-Depth. Existing prevention and mitigation features support Defense-in-Depth as shown in Table 3.4.2.11-4.

Table 3.4.2.11-1. Consequences of a Tank Bump Assuming No Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Tank Bump in 241-AY-102	1.9 E+00 (1.9 E+02)	5.0 E-03 (5.0 E-01)	1.6 E-03 (1.6 E-01)	1.0 E-03 (1.0 E-01)	3,900	1	0.11	1	Anticipated

SOF = sum-of-fractions.

Table 3.4.2.11-2. Safety Structures, Systems, and Components for Tank Bumps.

Control	Safety classification		Safety function	Comments
	SC	SS		
Tank 241-AY-102 primary ventilation system	X	--	Provides the means to maintain tank waste below local saturation temperature	If saturation temperatures are reached a tank bump could occur
Tank 241-AY-102 annulus ventilation system	X	--	Prevents Tank 241-AY-102 from reaching the saturation temperature	If saturation temperatures are reached a tank bump could occur
Tank 241-C-106 ventilation system	X	--	Provides the means to maintain tank waste below local saturation temperature	If saturation temperatures are reached a tank bump could occur

SC = Safety-Class.
SS = Safety-Significant.

Table 3.4.2.11-3. Technical Safety Requirement Controls for Tank Bumps. (2 sheets)

Control	Safety function	Comments
SST Waste Temperature Controls with the following tank waste temperature limit: For Tank 241-C-106, ≤ 205 °F (96 °C)	Ensures that tank waste temperatures at which a tank bump or steam release event could occur are not reached	The specific waste temperature limit for Tank 241-C-106 applies prior to sluicing operations
DST and AWF Tank Waste Temperature Controls with the following tank waste temperature limits: For Tank 241-AY-102, ≤ 195 °F (91 °C), for all waste levels OR ≤ 195 °F (91 °C) in the top 4.6 m (15 ft) of the waste AND ≤ 215 °F (102 °C) in the waste below 4.6 m (15 ft)	Ensures that tank waste temperatures at which a tank bump or steam release event could occur are not reached	The specific waste temperature limits for Tank 241-AY-102 applies prior to, during, and after sluicing operations
Tank 241-AY-102 Annulus Ventilation System - Operability	Ensures operability of the Tank 241-AY-102 annulus ventilation system	Applies to Tank 241-AY-102 after 0.6 m (2 ft) of sludge from Tank 241-C-106 has been transferred
Transfer Controls with the following key elements: - Incremental waste transfer with material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation - All waste transfers shall be evaluated to ensure that the waste transfer does not create a tank bump hazard outside the FSAR safety envelope	Ensures that conditions in Tank 241-AY-102 remain within analyzed envelope at all times Ensures that the waste transfer does not create a tank bump hazard outside the safety envelope (i.e., prevent creation of a new tank with a tank bump hazard unless the required tank bump controls are extended to the tank)	During the monitoring period, volume of Tank 241-C-106 transferred will be calculated using the ENRAF densitometer and Tank 241-AY-102 grab samples analysis results The sludge transferred from Tank 241-C-106 is monitored real time using the mass flow meter on the transfer line
Process Instrumentation and Measuring and Test Equipment with the following key element: - Equipment must be calibrated and properly maintained	Ensures instrumentation used to monitor temperature, tank levels, and transfer line flow is maintained	--
Ventilation Controls with the following key element: - Provide adequate cooling capacity for Tank 241-AY-102, through the primary and annulus ventilation systems, after 0.6 m (2 ft.) of sludge is transferred into the tank	Ensures that adequate cooling capacity is available to keep waste in Tank-241-AY-102 from reaching saturation temperature for each sluicing campaign	--

Table 3.4.2.11-3. Technical Safety Requirement Controls for Tank Bumps. (2 sheets)

Control	Safety function	Comments
Tank 241-AY-102 Primary Ventilation System	Provides adequate cooling capacity in Tank 241-AY-102 in conjunction with Annulus Ventilation System	Applies to Tank 241-AY-102 after 0.6 m (2 ft) of sludge from Tank 241-C-106 has been transferred
Tank 241-C-106 Waste Temperature Controls: - Predict saturation temperatures at the bottom of Tank 241-C-106. Use predicted height of the waste throughout the incremental transfer and periodically monitor the waste temperature	Ensures that tank waste temperatures at which a tank bump or steam release event could occur are not reached	--
- During the first two 0.3 m (1.0 ft) transfer increments, the liquid level established before start of each sluicing increment will be maintained throughout the increment	Prevents a steam flash in Tank 241-C-106 resulting from loss of hydraulic head	

AWF = aging waste facility.
DST = double-shell tank.
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 3.4.2.11-4. Defense-in-Depth Controls for Tank Bumps.

Control	Safety function	Comments
The airlift circulators in Tank 241-AY-102 will be disabled prior to the start of sluicing operations	Prevents inadvertent transfer of heat generating materials to Tank 241-C-106 and prevents ALC initiation of tank bump in Tank 241-AY-102	Transfer of large amounts of sludge to Tank 241-C-106 via the sluice line could increase the heat load in Tank 241-C-106 to greater than the analyzed range, possibly causing a tank bump in Tank 241-C-106
Communications between the Tank 241-C-106 and Tank 241-AY-102 control trailers will be maintained during sluicing operations	Coordinates operations at the two tanks and to detect flow imbalances or other unexpected conditions	--
Pump pit and sluice pit cover blocks (including removable plugs) will be in place prior to any sluicing operations and prior to enabling of the sluice or slurry pumps	Provides containment and confinement function in the event of a tank bump or spray leak within the pit, and limit onsite and offsite radiological and toxicological exposures	Camera installation through the cover plug camera port is allowed
The transfer pumps associated with the sluice and slurry lines must be administratively locked out except as necessary for actual sluicing operations and maintenance	Prevents inadvertent initiation of sluice or slurry flow which could result in a sludge configuration leading to tank bump conditions	Unexpected operation of a transfer pump when the transfer system is not in a proper lineup for sluicing operations could lead to an accidental release or injury to personnel
Emergency response plan/procedures	Protects onsite personnel and facility workers from unnecessary radiological and toxicological exposure in the event of a tank bump	--

ALC = air lift circulator.

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3.4.2.12 Liner Breach Caused by Steam Between the Steel Liner and Concrete Shell in Tank 241-C-106. A liner breach caused by steam under the liner can cause a rapid steam pressurization of the tank headspace, similar to that caused by a tank bump. A liner breach is a safety concern because of the potential for a release of aerosolized waste into the environment and/or an insult to the environment from tank leakage.

Water could get between the steel liner of Tank 241-C-106 and the concrete shell by four methods. These include water in the concrete itself, spillage during liner filling, rainfall during construction, or a leak. Water from the concrete, from spillage, or from rainfall, is assumed to have vaporized in the 1970s, when the tank temperatures were at their highest.

During sluicing operations, a stream of supernate may be directed at the carbon steel tank liner. This supernate jet could strike an area of the tank liner that has been weakened by corrosion, thus causing a leak. Other leak possibilities exist (they are listed in the WRSS hazard analysis [see Section 3.2]), but the same consequences are yielded. Raw water or supernate could leak under the bottom of the liner and the grout that covers the asphalt layer over the concrete base of the tank. This liquid could become trapped if the liner were to expand during a temperature increase. The heated asphalt under the liner provides another method of entrapment.

The current measured temperature in Tank 241-C-106 is about 63 °C (145 °F). Thermal modeling indicates that the maximum temperature in the bottom center of Tank 241-C-106 is about 109 °C (228 °F). Before sluicing, the tank will be chilled to about 107 °C (224 °F) (HNF-SD-W320-ER-004). The saturation temperature of water is pressure dependent. Hydrostatic head (i.e., the pressure caused by the weight of the waste) for the total waste height (including sludge) increases local pressure and, therefore, local saturation temperature. At the current level of waste, the saturation temperature needed under the liner to create steam is about 110 °C (230 °F). The saturation temperature of water at atmospheric pressure is 100 °C (212 °F). Waste temperature rising above the saturation temperature would create a steam bubble between the liner and the concrete base of the tank. A sufficiently energetic steam bubble could breach the liner and possibly initiate a tank bump. This liner breach would eject steam containing contamination into both the atmosphere and the soil.

The tank bump scenario is specifically addressed in Section 3.4.2.11; the supporting documents for that analysis are WHC-SD-WM-CN-022 and WHC-SD-WM-CN-043. The tank bump scenario covers the response of steam travelling through waste in more detail. The response of steam created by a liner breach would be similar to the bump.

Drying waste will experience a temperature peak caused by decreased conductivity, but the waste will eventually cool down as radioactive isotopes decay. If enough waste is removed, the remaining waste temperatures will remain below the saturation temperature of water, eliminating the possibility of a liner breach.

Water entrapment under the liner is only a concern in single-shell tanks. Tank 241-C-106 is a SST containing 746,000 L (197,000 gal) (about 1.75 m [69 in.]) of soft sludge with a total heat load estimated at 38.8 kW (132,400 Btu/h) as of June 1994. This tank is on the high heat watch list and must have periodic water additions to maintain the waste temperatures within allowable limits by means of evaporative cooling using active ventilation.

On January 28, 1965, a steam release event occurred in Tank 241-A-105. After the event, it was determined that the bottom of the steel liner was displaced from the concrete pad and bulged upward to a maximum of 2.6 m (8.5 ft). It was determined that the cause of the event was an amount of liquid between the liner and concrete reached the saturation temperature, converted to steam, and pushed the liner upward. Subsequently, this displacement caused the liner to fail and leak some amount of waste to the space between the liner and the concrete (Bander et al. 1994, *Assessment of Possibility of Deformation of the Bottom Steel Liner of Tank 241-C-106*).

3.4.2.12.1 Scenario Development. Engineered heat removal methods are implemented when heat removal by natural conduction to the soil is insufficient to maintain acceptable operating temperatures. The most common heat removal method is active ventilation of the tank headspace. An initiating event is the result of equipment failures or operational errors that result in impaired heat transfer from the sludge to the supernate or heat transfer from the supernate to the tank ventilation system. The other initiating event is operational errors that increase the heat generation capacity of the waste to above the heat removal capacity of the tank.

Tank waste temperature begins to rise when the engineered heat removal mechanism (e.g., active ventilation) is lost or certain operational errors occur. The rate of the temperature increase depends on the heat generation rate and the quantity of waste involved.

The following assumptions were made to ensure conservative results (HNF-SD-W320-CN-004, *Consequence Analysis of a Liner Breach Due to Steam Under the Liner*).

1. A total of 1.25 m (4.1 ft) of sludge has been transferred from Tank 241-C-106 to Tank 241-AY-102 with a total sludge depth of 0.79 m (2.6 ft) left in Tank 241-C-106. This value was chosen based on analysis discussed in HNF-SD-W320-ER-004, which shows that without ventilation, 0.79 m (2.6 ft) of dry waste in Tank 241-C-106 will result in temperatures above saturation. Less remaining waste would result in lower temperatures; however, temperature models would be necessary to determine what level of waste would yield temperatures below saturation.

2. A small amount of liquid (just under 26.5 L [7 gal]) is trapped under the liner, turns to steam, and expands the liner until just before breaching. If the steam cools, a 1400 ft^3 void is created under the liner (Bander et al. 1994).

3. Water fills the void completely.

4. The tank reaches the saturation temperature of water and the trapped water under the liner turns to steam and breaches the liner. A differential pressure of 22.1 kPa (3.2 psi) will breach the liner. This pressure differential could be created by the presence of about 26.5 L (7 gal) of water under the liner that is converted to steam (Bander, et al. 1994).

5. The liner breach causes a pressure drop. Saturation temperatures drop with the pressure drop and a certain amount of liquid under the liner flashes to steam and is released out of the liner breach. This amount can be determined using energy conservation.

6. All steam released is assumed to be involved in the accident, with no effect from condensation. Condensation would have a minimal effect because the supernate is at approximately the same temperature as the sludge.

7. If a liner breach occurred during sluicing or before dry-out of the waste, the consequences would be lower than if the event happens after sluicing is finished and the remaining waste material has dried out. This is because the moist waste would have a greater density, and consequently the source term would be lowered.

8. The worst case source term is 100% dry solids, with the maximum amount of water trapped under the liner. The waste moisture content and level have little effect on the consequences.

Accident Scenario Without Controls. For the accident scenario without controls, the temperature of water trapped under the liner of Tank 241-C-106 was postulated to rise above local saturation.

Accident Frequency Without Controls. The frequency without controls of a liner breach was categorized as "anticipated" in the hazards analysis.

Accident Scenario With Controls. The controls selected for the liner breach scenario are preventive and are presented in Section 3.4.2.12.5. These controls prevent the water trapped beneath the liner of Tank 241-C-106 from reaching saturation temperatures, thereby precluding the liner breach event. Should a rising temperature trend be detected, potential heat sources (e.g., pumps) would be eliminated and waste cooling techniques (e.g., ventilation, water addition) would be restored or initiated.

Accident Frequency With Controls. With the controls identified for the liner breach scenario in Section 3.4.2.12.5, the accident is prevented.

3.4.2.12.2 Source Term Analysis. The amount of steam released into Tank 241-C-106 during both the liner breach and the resultant steam flash was calculated to find the entrained waste release. The waste types assumed for radiological dose consequence calculations were single-shell tank solids. The waste types assumed for toxicological consequences were SST solids.

Accident Source Term Without Controls. A liner breach in Tank 241-C-106 would release 0.47 L (0.12 gal) of respirable solids (HNF-SD-W320-CN-004). The entire volume of steam created is assumed to be released during the event.

As noted previously, the release of steam from under the liner is similar to a tank bump event. Therefore, the source term model used in HNF-SD-W320-CN-004 is based on the tank bump calculations in WHC-SD-WM-CN-043 and WHC-SD-WM-CN-022 (Section 3.4.2.11).

Damage to the ventilation system filters should be expected during a liner breach event. The dose contributions of filter blow out and subsequent unfiltered release are added to the dose consequences of the steam release itself. The contribution of the filter blow out and unfiltered release are included in the consequences presented in Table 3.4.2.12-1, and are quantified in Section 3.4.2.2. and 3.4.2.3.

Accident Source Term With Controls. No source term with controls was derived because the accident controls are preventive.

3.4.2.12.3 Consequence Analysis. The onsite and offsite dose consequences and toxicological exposures were taken from HNF-SD-W320-CN-004.

Analysis Results.

Consequences Without Controls. The radiological and toxicological consequences of this release are presented in Table 3.4.2.12-1.

Consequences With Controls. No consequences with controls were derived because the accident controls are preventive.

Key Parameters and Assumptions. A major assumption includes the transportable and respirable releases. The transportable (able to reach a receptor at least 100 m downwind) and respirable source term for this accident was formulated by assuming all the steam issuing from the tank to be carrying a short-term transient air loading (1 g/m^3) of waste material (HNF-SD-W320-CN-004).

3.4.2.12.4 Comparison to Guidelines. Table 3.4.2.12-1 compares liner breach consequences to risk guidelines. Onsite consequences without controls for both radiological and toxicological exposure are above risk guidelines. Offsite radiological consequences are also above risk guidelines. To protect the onsite worker from both radiological and toxicological hazards of a liner breach, the event must be controlled.

3.4.2.12.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls.

Safety Structures, Systems, and Components. No safety structures, systems, and components were identified in this analysis.

Technical Safety Requirement Controls. The TSR controls selected to prevent a liner breach are listed in Table 3.4.2.12-2. These controls establish tank waste temperature limits, ensure operability of tank waste

temperature monitoring instrumentation, and ensure that waste transfers do not create in-tank conditions conducive to liner breach initiation. It should be noted that AC 5.26 provides a more restrictive temperature control on Tank 241-C-106 than is imposed by LCO 3.3.1. This is primarily because the sluicing operation will lower the local saturation temperature through removal of hydraulic head. In addition, an element has been added to the Administrative Controls (AC 5.26) to require a recovery plan if the temperature is exceeded.

Defense-in-Depth. Existing prevention and mitigation features support Defense-in-Depth, as shown in Table 3.4.2.12-3.

Table 3.4.2.12-1. Consequences of a Liner Breach Assuming No Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose*	Risk guideline	Calculated dose*	Risk guideline	Calculated SOF*	Risk guideline	Calculated SOF*	Risk guideline	
Liner Breach	5.4 E+00 (5.4 E+02)	5.0 E-03 (5.0 E-01)	4.4 E-03 4.4 E-01	1.0 E-03 (1.0 E-01)	2.6 E+04	1	8.2 E-01	1	Anticipated

SOF = sum-of-fractions.

* Note: The radiological and toxicological dose is based on consequences identified in 98-TWR-025, Contract No. DE-AC06-96RL13200 - Addendum To Safety Evaluation Report (SER) For Project W-320, Tank 241-C-106 Sluicing (Letter from J. D. Wagoner, RL, to R. D. Hanson, FDH), dated September 25, 1998.

Table 3.4.2.12-2. Technical Safety Requirement Controls for Liner Breaches.

Control	Safety function	Comments
SST Waste Temperature Controls with the following key element (prior to start of sluicing): - Temperature ≤ 205°F	Ensures that tank waste temperature monitoring system is operable and that temperatures at which a liner breach event could occur are not reached	Temperatures must be maintained below those that could result in creation of steam under the liner
Tank 241-C-106 Waste Temperature Controls with the following key element: - Establish temperature controls that are < T_{sat} for existing tank conditions (during and after sluicing)	Ensures that tank waste temperature monitoring system is operable and that temperatures at which a liner breach event could occur are not reached	The specific waste temperature limits will depend on the amount of waste remaining in Tank 241-C-106, since T_{sat} under the liner varies with pressure. Temperatures must be maintained below those that could result in creation of steam under the liner
Transfer Controls with the following key element: - All waste transfers will be evaluated to ensure that the waste transfer does not create a liner breach hazard outside the FSAR safety envelope	Ensures that waste transfers do not create a liner breach hazard outside the safety envelope established by the FSAR (i.e., prevent creation of a new tank with a liner breach hazard unless the required liner breach controls are extended to the tank)	--
Process Instrumentation and Measuring and Test Equipment with the following key element: - Equipment must be calibrated and properly maintained	Ensures instrumentation used to monitor temperature, tank levels, and transfer line flow is maintained	--

AWF = Aging Waste Facility.
DST = double-shell tank.
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 3.4.2.12-3. Defense-in-Depth Controls for Liner Breaches.

Control	Safety function	Comments
Active ventilation or other heat removal mechanisms will be maintained	Maintains sludge and supernatant temperatures below the required control levels for tanks with a potential for a liner breach	--
Pump pit and sluice pit cover blocks (including removable plugs) will be in place whenever the conditions for initiation of a liner breach are present (i.e., known leaking liner, active ventilation system down indefinitely)	Provides containment and confinement function in the event of a liner breach	WHC-SD-WM-CN-043 quantifies the reduction of a tank bump, similar to a liner breach, in consequences provided by cover blocks
Emergency response plan/ procedures	Protects onsite personnel and facility workers from unnecessary radiological and toxicological exposure in the event of a liner breach	--
A material balance will be performed after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation	Ensures that the introduction of tank solids into the sluice line is ≤ 10%	An inadvertent deviation of Tank 241-C-106 conditions outside the analyzed envelope could result in a liner breach
Syphon protection is provided on the slurry distributor and the submersible sluice pump discharge line within Tank 241-AY-102	Prevents establishing a syphon when slurry pumps or sluice pumps are shut down	A syphon, if established, could drain back from Tank 241-AY-102 to Tank 241-C-106 and could result in overfilling Tank 241-C-106, allowing liquid to leak under the liner
Material balance including level monitoring to identify leakage into the liner	Tank 241-AY-102 level measurement and slurry line mass flow measurement	--
Raw water is metered	Used in coordination with material balance and 241-AY-102 level monitoring, detects large raw water leakages	--
Communication between Tank 241-C-106 and Tank 241-AY-102 control trailers will be maintained during sluicing operations	Coordinates operations at the two tanks and detects flow imbalances or other unexpected conditions (e.g., power failure)	--
Sluicing controls	Sluicing controls are in the process control plan. During the early stages of sluicing, the sluice stream will not be directed at the waste near the walls	During the later stages of sluicing, the sluice stream will be directed toward the wall to ensure effective recovery of the Tank 241-C-106 waste
Design feature - The stiff hose is engineered to maintain integrity	Prevents sluicer hose from breaking off and causing liner breach	--
Design feature - Positive mechanical stops are provided to limit nozzle travel to 115° vertically (0° reference is the nozzle pointed straight down)	Prevents the sluice stream from impinging on an area above the steel liner. Prevents sluice from leaking into the liner from top of liner	--

WHC-SD-WM-CN-043, 1996, Tank Bump Consequence Analysis, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

3.4.2.13 Subsurface Leak Remaining Subsurface. This accident category refers to low-energy subsurface leaks that remain subsurface and are not visually detected. A subsurface leak that forms a surface pool and is visually detectable is analyzed in Section 3.4.2.14. The analyzed leak is similar to the subsurface leak remaining subsurface scenario analyzed in the main text of the FSAR. However, the presence of the berm over the transfer lines in the WRSS makes the worst case leak geometry different from that described in Section 3.3.2.4.7 of the main text of the FSAR. The direct dose from waste in the berm is much larger than the direct doses for below ground waste calculated in the main text, which is primarily caused by the long path through the soil that attenuates the direct radiation. The shielding provided by the soil is not as great as in the WRSS analysis. Secondary factors that also changed doses compared to those in the main text were a larger transfer flow rate for WRSS and a different waste for the source term for WRSS (Section 3.4.1).

Possible causes of a subsurface leak identified in the hazard analysis include the following:

- Failure of an encased transfer line during sluicing operations (caused by corrosion or aging)
- Excavation accident that damages a waste transfer line
- Leak from a cracked or broken pump or valve or a related transfer pit failure
- Structural failure of a tank wall or bottom.

Tank structural failure could result in a large subsurface leak, but the subsurface plume would have no immediate consequences to facility workers or offsite receptors because of the large amount of soil shielding above the liquid in the tanks; therefore, this scenario was not analyzed. Leaks into a transfer pit are analyzed in Section 3.4.2.16. Excavation accidents are analyzed in Section 3.4.2.17. Therefore, failure of an encased waste transfer line was chosen as the worst case subsurface leak and is analyzed in the following subsections.

3.4.2.13.1 Scenario Development. The worst case subsurface leak remaining subsurface accident scenario is a subsurface leak from a waste transfer line during WRSS operations. The following assumptions are used to calculate dose consequences for the scenario with and without controls.

- The leak occurs in the slurry line because the heavy solid loading will make doses higher in the slurry line than in the sluicing line.
- The burial depth of the slurry transfer line varies depending on location, but the worst consequences are obtained if the leak occurs near Tank 241-C-106 where the line is buried just below the surface and is bermed.
- The berm near Tank 241-C-106 is 0.76 m (2.5 ft) high and 2.44 m (8 ft) wide.

- The leak remains below the surface (not visually detectable) and no airborne radioactive or toxic materials are released.
- The total radiological dose to the onsite receptor is comprised of direct (line of sight), skyshine, and associated bremstrahlung radiation components for 12 hours, which is consistent with the method presented in the main text of the FSAR (Section 3.4.1.1.3).
- Uncontaminated soil cover of 152.4 mm (6 in.) remains as shielding over the leak area.
- Leaking waste completely saturates a region of the soil around the leak site.
- The soil void fraction is 40%.
- The soil density is 1.6 g/cm^3 (100 lb/ft^3).
- The slurry line waste density is 1.4 g/cm^3 (87 lb/ft^3).
- The worst case leak geometry is a disk representing a leak into the soil under the berm or a rectangular region saturating a section of the berm to within 152.4 mm (6 in.) of the surface.

Accident Scenario Without Controls. The following parameters were used in the accident scenario without controls.

- The transfer line flow rate is 28.4 L/s (450 gpm).
- A leak rate of 5% of the total flow (a higher leak rate would become the subsurface leak resulting in a pool [Section 3.4.2.14] or the spray leak from an underground waste transfer line [Section 3.4.2.17]).
- The duration of the leak is assumed to be 12 hours (maximum sluicing batch duration).
- The source term is two parts AWF tank liquids and one part AWF tank solids (Section 3.4.1 for the radionuclide composition of these sources) corresponding to the worst case slurry line source term discussed in Section 3.4.1.

Accident Frequency Without Controls. The frequency category for a subsurface leak accident without controls is "anticipated." Pipeline failures occurred during earlier operations and are documented in the Hanford Site occurrence reporting database.

Accident Scenario With Controls. The accident scenario with controls is the same as that without controls except that the solids loading in the source term is assumed to be 90% solids from Tank 241-C-106 (instead of 100% solids from Tank 241-AY-102). The source term is 2 parts SST liquid, 18 parts AWF tank liquid, 9 parts SST solid, and 1 part AWF tank solid. (See Section 3.4.1 for a discussion of the mitigated [or with controls] source term.)

Accident Frequency With Controls. The frequency of a pipe failure resulting from aging or corrosion is reduced to "unlikely" by taking credit for the encasement as a second and independent barrier to corrosion or aging induced failure. The failure rate for the primary transfer line is estimated to be 3.3×10^{-9} leaks/m/h (1×10^{-9} leaks/ft/h) (WHC-IP-0690, *Safety Analysis and Regulation Manual*). The length of transfer pipe is 0.5 km (0.3 mi). This gives a 1.4×10^{-2}/yr failure rate for the primary pipe. The failure rate for both primary and secondary pipes is assumed to be lowered to place the overall frequency in the "unlikely" category.

3.4.2.13.2 Source Term Analysis. The source term calculations for this event are documented in HNF-SD-WM-CN-104, *Calculation Notes for an Underground Leak which Remains Underground*.

Source Term Without Controls. The total volume of material released in the assumed 12-hour leak is 60,570 L (16,000 gal). The worst case geometry was found to be a saturated length of the berm because of the increased direct dose from waste in the berm compared to an underground "disk" model. The mixture of isotopes present in the release without controls is presented in HNF-SD-WM-CN-104. No airborne radioactive or toxic materials are released because the leak is subsurface.

Source Term With Controls. The total volume of material released and worst case geometry in the scenario with controls is the same as for the scenario without controls. The mixture of isotopes present in the release with controls is discussed in HNF-SD-WM-CN-104 and reflects a smaller percentage of AWF tank solids loading, as discussed in Section 3.4.1.

3.4.2.13.3 Consequence Analysis. This section presents the dose consequences associated with the radiation field created by the subsurface leak. For each assumed geometry, radiation dose rates are calculated for the onsite receptor (a receptor located at 100 m [328 ft] from the leak point). Line-of-sight and bremstrahlung and skyshine dose rate contributions were calculated using the ISO-PC (WHC-SD-WM-UM-030, *ISO-PC Version 1.98 - User's Guide*) and MICROSKYSHINE (Grove 1987, *MICROSKYSHINE*) computer codes, respectively. Details of the calculations are presented in HNF-SD-WM-CN-104. The worst case geometry with controls and without controls was found to be a saturated section of the berm. The receptor dose starts after the full subsurface plume has been created. The dose to the offsite receptor is insignificant because of the large distance between the source and receptor.

Consequence Without Controls. Dose to the onsite receptor is 0.011 Sv (1.1 rem) in the scenario without controls. No significant toxicological consequences or offsite radiological consequences would occur (Table 3.4.2.13-1).

Consequences With Controls. Dose to the onsite receptor in the accident scenario with controls is 0.01 Sv (1.0 rem). No significant toxicological consequences or offsite radiological consequences would occur (Table 3.4.2.13-2).

3.4.2.13.4 Comparison With Guidelines. The dose to the onsite receptor in the scenario without controls, 0.011 Sv (1.1 rem), is above the onsite risk

guideline (0.005 Sv [0.5 rem]) for an "anticipated" event. The dose to the onsite receptor with controls, 0.01 Sv (1.0 rem), is below the onsite risk guideline (0.05 Sv [5 rem]) for an "unlikely" event. No significant toxicological consequences or offsite radiological consequences would occur.

3.4.2.13.5 Summary of Safety Classification and Technical Safety Requirement Controls. Safety classification, TSR controls, and Defense-in-Depth features for the subsurface leak accident are summarized in the following paragraphs.

Safety Structures, Systems, and Components. The secondary piping is credited as a Safety-Significant component that provides a redundant leak barrier that reduces the likelihood of a leak resulting from corrosion or aging. The transfer leak detection systems and tank level detection systems (shown in Table 3.4.2.13-3) have also been designated as Safety-Significant for protection of the facility worker.

Technical Safety Requirement Controls. Technical Safety Requirement controls are in place to prevent or mitigate a subsurface leak. Table 3.4.2.13-4 summarizes these controls. The TSRs include excavation controls, transfer controls, encasement seal loop controls, transfer leak detection systems, and transfer pump administrative lock controls.

Defense-in-Depth. Table 3.4.2.13-5 summarizes the Defense-in-Depth features applicable to the subsurface leak accident. Defense-in-Depth controls include pressure/leak testing, operator training, operating procedures, seismic shutdown switches and emergency response.

Table 3.4.2.13-1. Summary Consequences and Frequencies for a Subsurface Leak Remaining Subsurface Without Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Subsurface Leak Remaining Subsurface	1.1 E-02 (1.1 E+00)	5.0 E-03 (5.0 E-01)	N/A	1.0 E-03 (1.0 E-01)	N/A	1	N/A	1	Anticipated

N/A = not applicable.
SOF = sum-of-fractions.

Table 3.4.2.13-2. Summary Consequences and Frequencies for a Subsurface Leak Remaining Subsurface With Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Subsurface Leak Remaining Subsurface	1.0 E-02 (1.0 E+00)	5.0 E-02 (5.0 E+00)	N/A	1.0 E-02 (1.0 E+00)	N/A	1	N/A	1	Unlikely

N/A = not applicable.
SOF = sum-of-fractions.

Table 3.4.2.13-3. Safety Structures, Systems, and Components for Subsurface Leaks Remaining Subsurface.

Structure, system, or component	Safety classification		Safety function	Comments
	SC	SS		
Waste transfer pipe-in-pipe encasement	--	X	Ensure that a leak in the primary waste transfer system piping is directed to a waste transfer-associated structure	Mitigates frequency of leaks
Transfer leak detection systems	--	X	Detects leaks in transfer-associated structures and activates an alarm, leading to operator shutdown of the transfer	Prevents/mitigates significant facility worker hazard
Tank level detection systems	--	X	Provide indication of tank waste level to support performance of periodic material balance during waste transfers to detect leaks or misroutes	Prevents/mitigates significant facility worker hazard

SC = Safety-Class.
SS = Safety-Significant.

Table 3.4.2.13-4. Technical Safety Requirement Controls for Potential Subsurface Leaks Remaining Subsurface.

Control	Safety function	Comments
Transfer Leak Detection Systems	Detects leaks in transfer-associated structures and activates an alarm, leading to operator shutdown of the transfer	Ensure leak detector alarms are operable during transfer
Transfer Controls with the following key elements: - Material Balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation - Configuration management: control of jumper and valve configuration - Establish communications between 241-C-106 and 241-AY-102 control room during sluicing operations - Transfer path verification - independent route verification during transfer setup	Prevent/mitigate significant facility worker hazard	--
Encasement Seal Loop Controls with the following key element: - Ensure the encasement seal loop valves are not in the closed position	Ensure that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure	--
Excavation control	Prevents pipe rupture caused by excavation activities	See Section 3.4.2.17
Transfer Pump Administrative Lock Controls	Eliminate motive force for unplanned transfers	--

Table 3.4.2.13-5. Defense-in-Depth Controls for Subsurface Leaks Remaining Subsurface.

Control	Function	Comments
Pressure/leak testing of transfer route before material transfer	Provides a greater level of assurance of transfer line integrity before actual transfer of waste	Enhanced NDE used for final welds
Operator training	Operations of facilities are performed by Hanford Site experienced crews with specific training in these activities	--
Operating procedures	Operations are performed to approved plant operating procedures	--
Emergency response plan/ procedures	Plans and procedures are in place to respond to emergency conditions	--
Seismic shutdown switches	Shut down transfer pumps upon detection of a seismic event	--

NDE = nondestructive examination.

3.4.2.14 Subsurface Leak Resulting in a Pool. A subsurface leak resulting in a pool accident is analyzed in Section 3.4.2.8 of the FSAR main text. This analysis is different than that presented in the main text of the FSAR because the flow rate of the WRSS pumps is greater than the flow rate used in the FSAR, and the waste composition is different.

The specific hazardous conditions that can result in waste leaks directly to the soil surface are identified in the hazard analysis. A leak from the transfer line could result in washing away of the soil berm and the formation of a pool. The line could be uncovered by localized flooding and subsequently failed by corrosion or stress. In addition, an excavation accident could result in a break of a line and the formation of a pool.

3.4.2.14.1 Scenario Development. A breach of the slurry transfer line was selected as the bounding, representative accident for detailed analysis. Because an unconstrained pipe break permits waste to flow at 41 L/s (650 gpm), the scenario produces the largest surface pool. Local flooding is assumed to uncover the line during transfer operations, the line is breached, and the waste spills directly on the ground.

The unmitigated scenario assumes that the leak is detected after 7 hours, any onsite personnel are evacuated immediately, and the leak cannot be stopped until the pumping is terminated after 12 hours. This accident scenario was qualitatively assigned a frequency of "anticipated" (1 to 10^{-2}/year). The frequency was based on the tank farms operational history. The occurrence reporting database has documented previous related pipe failures.

The mitigated accident scenario assumes that the spilled slurry content is different from the unmitigated slurry because it more realistically reflects the average mixed content of Tank 241-AY-102 (Section 3.4.1). The operator more promptly detects the leak, the pump is turned off, and any onsite personnel are immediately evacuated. The frequency of the mitigated accident scenario is taken to be the same as the unmitigated accident scenario.

3.4.2.14.2 Source Term Analysis. The composition, ULD, and sum-of-fractions for the slurry mixtures used in this analysis are detailed in Section 3.4.1. Details of the supporting source term calculations are documented in HNF-SD-WM-CN-110, *Consequences of a Radioactive Surface Pool Resulting From Waste Transfer Operations Between Tanks 241-C-106 and 241-AY-102.*

The waste is assumed to flow onto the ground at the maximum capacity of the pump, 41 L/s (650 gpm). Therefore, in 12 hours, 12 x 60 x 60 x 41 = 1,771,600 L (468,000 gal) are spilled onto the ground. Soil conditions are assumed to be such that the growing pool remains a free-standing liquid for 12 hours. This maximizes the spread of the pool and creates the largest surface area available for aerodynamic resuspension by the wind. A "spreading factor" (i.e., surface area of soil affected divided by the spill volume) equal to 8.7 per linear foot is used in this analysis, consistent with WHC-SD-WM-CN-049, *Calculation Notes for Surface Leak Resulting in Pool, TWRS FSAR Accident Analysis.* A final pool size of 127 m (417 ft) radius and area of 5.06×10^4 m^2 (5.45×10^5 ft^2) is calculated to form.

A resuspension flux (from DOE-HDBK-3010-94, equal to 2×10^{-10} kg/m^2) is used to estimate the rate that aerosols are generated by the wind. The waste density is 1.4 kg/L, so 1.4×10^{-10} L/m^2-s is generated by the wind while the pool is liquid. The unmitigated aerosol amount released during these 12 hours is 0.156 L. The peak release rate, 7.2×10^{-6} (L/s), occurs at the end of pool formation.

After the transfer pump is shut off, the waste will soak into the soil, leaving entrained salts and entrained solids behind as surface contamination. The contaminated soil is assumed to be immediately available as dry soil for resuspension by the wind. The respirable release fraction, 8.4×10^{-5}, is taken from Section 3.2.4.4 in DOE-HDBK-3010-94. This release takes place in the 12- to 24-hour period. The unmitigated amount of contaminated soil that is resuspended during these 12 hours is 148.7 L (39 gal). The peak release rate, 2×10^{-3} (L/s), occurs at the onset of soil resuspension. Note that the offsite consequences will be dominated by the material resuspended from the contaminated soil phase.

As a limiting case to determine the maximum available operator response time, without consequences exceeding risk guidelines, a detection time of 43 minutes was used to calculate mitigated consequences. This corresponds to 106,000 L (28,000 gal) of material released. Actual operator response time is expected to be significantly less than 43 minutes. In this case, the pool only grows to a radius of 31 m (102 ft) and reaches a final surface area of 3.03×10^3 m^2. The amount of material released during pool formation is limited to 3.4×10^{-2} L at a peak rate of 4.3×10^{-7} (L/s). The amount of material released as contaminated soil is less than 0.9 L (0.2 gal), at a peak rate of 1.2×10^{-5} (L/s).

3.4.2.14.3 Consequence Analysis. Table 3.4.2.14-1 summarizes the consequences of spills without control and Table 3.4.2.14-2 summarizes the consequences of spills with controls. The unmitigated scenario at a worst case composition has a ULD equal to 5.6×10^5 Sv/L, a sum-of-fractions multiplier (onsite) equal to 1.3×10^4 s/L, and a sum-of-fractions multiplier (offsite) equal to 68 s/L. The mitigated scenario uses a reasonable mixture of the liquid and solid source terms in Tank 241-C-106 and Tank 241-AY-102 and has a smaller ULD equal to 1.2×10^5 Sv/L, a sum-of-fractions multiplier (onsite) equal to 1.9×10^4 s/L, and a sum-of-fractions (offsite) multiplier equal to 40 s/L.

The radiological dose consequences without controls are 3.0 Sv (3.0×10^2 rem) for the onsite receptor, which includes shine from the growing pool, and 8.0×10^{-1} Sv (8.0×10^1 rem) for the offsite receptor. The toxicological sum-of-fractions are 0.09 and 0.13 for the onsite and offsite receptors, respectively.

The radiological dose consequences with controls are 1.3×10^{-2} Sv (1.3 rem) for the onsite receptor, which includes shine from the growing pool, and 1.0×10^{-3} Sv (1.0×10^{-1} rem) for the offsite receptor. The toxicological sum-of-fractions are 8.3×10^{-3} and 5.0×10^{-4} for the onsite and offsite receptors, respectively.

3.4.2.14.4 Comparison to Guidelines. Table 3.4.2.14-1 provides the radiological and toxicological consequences of the accident scenario without controls. The radiological onsite and offsite consequences without controls are well above the risk guidelines. The toxicological sum-of-fractions for the risk guidelines is less than 1 (within risk guidelines) for both the onsite and offsite receptors.

Table 3.4.2.14-2 shows the results of the accident scenario with controls. The radiological onsite dose consequence is above the risk guideline; however, the offsite dose consequence meets the risk guideline. The toxicological sum-of-fractions for the risk guidelines is less than 1 (within risk guidelines) for both the onsite and offsite receptors.

3.4.2.14.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. Tables 3.4.2.14-3 and 3.4.2.14-4 summarize the safety structures, systems, and components and TSR controls selected to prevent and mitigate subsurface leaks from the transfer lines used in the operations involving Tank 241-C-106 and Tank 241-AY-102. For each control, the safety function required is described. Clarifying comments are provided as necessary.

Safety Structures, Systems, and Components. For pipe-in-pipe encased transfer lines, the encasements were designated Safety-Class. The safety function of the encasements is to contain and route waste leaked from the primary line back to transfer structures (e.g., process pits). The transfer line leak detection system has been designated as Safety-Class to prevent pit overflows during transfers. The system prevents pit overflows by alarming and alerting operators to shut down the transfer pump.

Tank level detection systems were designated as Safety-Significant to support the performance of periodic material balances during transfers. Material balances are important to back up leak detectors and limit the amount of waste that can be released to the environment.

Technical Safety Requirement Controls. A transfer leak detection system control is required to stop the transfer if a leak is found, and to prevent transfer-associated structures from overflowing.

A waste transfer control program was developed to limit the potential consequences of leaks from subsurface transfer lines. Material balances are required as part of the transfer control program to limit the volume of waste potentially leaked to the soil column (without surfacing) as a backup detection for leaks into encased lines that drain back to transfer structures containing Safety-Class pit leak detectors. Material balances are required to be performed after each sluicing batch of 12 hours maximum duration during the transfer. The material balances are especially important; over an extended period, the skyshine from pools smaller than those analyzed in the representative accident can give integrated doses approaching the evaluation guideline for the onsite receptor. Other key elements of the waste transfer control program include configuration management and independent route verification during transfer. These key elements are required to prevent misroutes into potentially compromised transfer lines.

Establishing communication between the Tank 241-C-106 and Tank 241-AY-102 control rooms during transfers is another key element of the transfer control. Detection of a leak allows for the transfer to be stopped to minimize the amount of leakage. Table 3.4.2.14-4 describes the TSR controls for subsurface leaks resulting in pools.

A TSR control also is necessary to ensure that the appropriate emergency response procedures are implemented when a surface waste pool is detected. Emergency response plans for a waste leak shall include response procedures with a graded approach based on the magnitude of the leak to protect the offsite public, onsite worker, and facility worker (e.g., transfer termination, leakage containment and removal, and site evacuation).

Defense-in-Depth. Table 3.4.2.14-5 summarizes hardware and existing tank farm procedures that provide Defense-in-Depth protection against leaks from buried or bermed transfer lines. These include a walkdown of the transfer lines, encasement leak detectors, seismic shutdown switches, and flow rate monitoring.

Table 3.4.2.14-1. Summary of Consequences and Frequencies for Subsurface Leak Resulting in a Pool without Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite*		Offsite**		Onsite*		Offsite**		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Subsurface leak resulting in a pool	3.0 E+00 (3.0 E+02)	5.0 E-03 (5.0 E-01)	8.0 E-01 (8.0 E+01)	1.0 E-03 (1.0 E-01)	0.09	1	0.13	1	Anticipated

*Exposure time of 7 hours.
**Exposure time of 24 hours.
SOF = sum-of-fractions.

Table 3.4.2.14-2. Summary of Consequences and Frequencies for Subsurface Leak Resulting in a Pool with Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite*		Offsite*		Onsite*		Offsite*		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Subsurface Leak Resulting in a Pool	1.3 E-02 (1.3 E+00)	5.0 E-03 (5.0 E-01)	1.0 E-03 (1.0 E-01)	1.0 E-03 (1.0 E-01)	8.3 E-03	1	5.0 E-04	1	Anticipated

*Exposure time of 43 minutes, which is longer than expected response time.
SOF = sum-of-fractions.

Table 3.4.2.14-3. Safety Structures, Systems, and Components for Subsurface Leaks Resulting in Pools.

Control	Safety classification		Safety function	Comments
	SC	SS		
Waste transfer pipe-in-pipe encasement	X	--	Ensure that a leak in the primary waste transfer system piping is contained and directed to a waste transfer-associated structure	See controls for surface leak resulting in pools
Transfer leak detection systems	X	--	Detects leaks in transfer-associated structures and activates an alarm, leading to operator shutdown of the transfer	Ensure leak detector alarms are operable during transfers
Tank level detection systems	--	X	Provide indication of waste level to support performance of periodic material balances during waste transfers to detect waste leaks or misroutes	Applicable to Tanks 241-C-106 and 241-AY-102

SC = Safety-Class.
SS = Safety-Significant.

Table 3.4.2.14-4. Technical Safety Requirement Controls for Subsurface Leaks Resulting in Pools.

Control	Safety function	Comments
Transfer leak detection systems	Detects leaks in transfer-associated structures and activates an alarm, leading to operator shutdown of the transfer	Ensure leak detector alarms are operable during transfers
Transfer Controls with the following key elements:		--
- Establish communication between control rooms for Tank 241-C-106 and Tank 241-AY-102 during sluicing operations	Stops transfer to limit the volume of waste leaked	
- Material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation	Detects waste transfer line leaks and misalignments; limit volume of waste leaked	
- Configuration management	Prevents misalignments	
- Independent route verification during transfer setup	Prevents misrouting	
Emergency Preparedness with the following key element:	Mitigates consequences to onsite personnel	--
- Response procedures		

Table 3.4.2.14-5. Defense-in-Depth Controls for Subsurface Leaks Resulting in Pools.

Control	Safety function	Comments
Walkdowns are performed once/shift to detect surface leaks from transfer line	Provides backup to material balance for leaks that might surface	--
WRSS pipe-encased transfer lines are equipped with encasement leak detectors	Detect leak during transfer, provide backup to pit leak detection	Can also be used as Safety-Class substitute for pit leak detection
Monitor flow rate	Provides evidence of a leak. If flow data indicates leakage, stop the transfer and determine the cause	Necessary for material balance
Seismic shutdown switches	Shut down transfer pumps upon detection of a seismic event	

WRSS = Waste retrieval sluicing system.

3.4.2.15 Surface Leak Resulting in a Pool. A subsurface leak resulting in a pool is analyzed in Section 3.4.2.7 of the FSAR main text. This analysis is different than that analyzed in the FSAR main text because the pump flow rate of the WRSS pumps is higher than that used in the FSAR, and the waste composition is different. The consequences of this accident are bounded by the subsurface leak resulting in a pool analyzed in Section 3.4.2.14 of this addendum.

3.4.2.15.1 Scenario Development. The breach of the slurry transfer line was selected as the bounding representative accident for detailed analysis of surface pools. Because an unconstrained pipe break permits waste to flow at 41 L/s (650 gpm), the subsurface-originating leak produces the largest surface pool in 12 hours (Section 3.4.2.14).

Surface-originating leaks, such as an overflow of the pit with its cover block on, would constrain the waste flow to less than 28.4 L/s (450 gpm) and a smaller surface pool would form within the 12 hours.

The frequency category of the accident without controls is determined on the basis of the likelihood of the initiating event. Tank farm operating experience indicates that waste leaks into process pits are "anticipated" events. Between 1972 and 1996, the occurrence reporting database includes five accounts of waste being misrouted through compromised transfer paths into process pits. The frequency of the accident with controls is the same as the accident without controls.

3.4.2.15.2 Source Term Analysis. See Section 3.4.2.14.2.

3.4.2.15.3 Consequence Analysis. Surface leak consequences are bounded by the consequences postulated for subsurface leaks (Section 3.4.2.14.3).

3.4.2.15.4 Comparison to Guidelines. See Table 3.4.2.14-1 in Section 3.4.2.14.

3.4.2.15.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. Tables 3.4.2.15-1 and 3.4.2.15-2 summarize the safety structures, systems, and components and TSR controls selected to prevent or mitigate surface pool leaks throughout the TWRS. For each safety structure, system, and component and TSR control, the safety function required is described in Chapter 4.0 of this addendum.

Technical Safety Requirement Controls. Technical safety requirement controls are listed in Table 3.4.2.15-2 and detail relating to their safety function are listed in HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, and Section 5 of this addendum. A key element for communications between the control locations for Tank 241-AY-102 and Tank 241-C-106 was added to AC 5.12, Transfer Controls, to mitigate this accident.

Defense-in-Depth Controls. Table 3.4.2.15-3 identifies the Defense-in-Depth controls.

Table 3.4.2.15-1. Safety Structures, Systems, and Components for Surface Leak Resulting in Pool.

Control	Safety classification		Safety function	Comments
	SC	SS		
Transfer leak detection system	X	--	Detects leaks in transfer-associated structures and activates an alarm, leading to operator shutdown of the transfer	Ensure leak detector alarms are operable during transfers
Transfer System Covers	--	X	Limit release of aerosols generated by splatter inside the pit*; limit shine and skyshine dose to onsite receptor	Pit structure and covers provide confinement safety function. Pit structure also required to support the pit covers
Tank level detection systems	--	X	Supports periodic material balances during transfers	See material balance TSR AC (next table)
Primary tank leak detection system	X		Provides indication of infiltration into the annulus of Tank 241-AY-102	--
Transfer line pipe in pipe encasement	X	--	Provide secondary confinement for leaks from primary line; route leak from primary line back to process pit*	--
Back flow preventers	--	X	Prevent back flow of waste	Safety significant to prevent general contamination of service water supply systems, e.g., the tanker truck

*Includes valve pits, central and feed pump pits, sluice pits, leak detection pits, annulus pump pits, flush pits, catch tank pump pits, diversion boxes, vault pits, vent station nozzle pit.

AC = Administrative Control.
SC = Safety-Class.
SS = Safety-Significant.
SST = single-shell tank.
TSR = Technical Safety Requirement.

Table 3.4.2.15-2. Technical Safety Requirement Controls for Surface Leak Resulting in Pool.

Control	Safety function	Comments
Transfer system covers	Limit release of aerosols generated by splatter inside the pit; limit shine and skyshine dose to onsite receptor	Ensures pits physically connected to transfer route are covered during transfers
Transfer Leak Detection Systems	Detects leaks in transfer-associated structures and activates an alarm, leading to operator shutdown of the transfer	Ensure leak detector alarms are operable during transfers
Primary Tank Leak Detection System	Ensures primary tank leak detection systems on tanks physically connected to the transfer route are operable to detect misroutes into the annulus of Tank 241-AY-102	--
Transfer Controls with the following key elements:		
- Material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation	Provides confirmation of analysis assumptions	
- Configuration management: control of jumper and valve configuration	Prevents misroutes of waste and prevents jumpers from being grossly misaligned or from falling off during transfers	High flow rate leaks into pits can overflow the pits before transfer pumps can be manually shut down after leak detector alarm activates (if pit drain plugged)
- Establish communications between 241-C-106 and 241-AY-102 control room during sluicing operations	Detects a waste transfer line leak; limits volume of waste leaked	
- Cap/blank nozzles when not in use	Prevents leak through open nozzles	
- Vehicle restrictions around transfer lines	Ensures that the transfer line is protected from vehicle collisions that could result in a loss of integrity of the primary and encasement pipes	
Emergency Preparedness with the following key element: - Response procedures	Provides response procedures to mitigate structure overflow.	--
Excavation Control Program	Prevents pipe rupture caused by excavation activities.	See Section 3.4.2.17
Transfer Pump Administrative Lock Controls with the following key element: - The administrative lock of a waste transfer pump is demonstrated by removing and securing the motive force from the pump (e.g., electrical power, steam, water, or air)	Eliminate motive force for unplanned transfers	--
Transfer System Cover Removal Controls	Ensure structures physically connected to the transfer route are covered during transfers and provide compensatory measures for cover removal during transfers	--

Table 3.4.2.15-3. Defense-in-Depth Controls for Surface Leak Resulting in Pool.

Control	Safety function	Comments
Tank farms are visually surveyed by operators at least once a day	Surveys are performed to check for general problems (e.g., animal or water intrusion, etc.)	Surveys will detect surface pools of waste due to all causes. Surveys provide backup detection to leak detectors and material balances of water
Pit drains, where open	Allow leak to drain back to storage or catch tank; prevents overflow of pit to soil surface	High capacity pit drains are designed to accommodate maximum flow from the line
Encasement leak detectors	Detect leaks from primary line; limit leak volume	Redundant to interfacing pit leak detectors
Backflow preventers	Prevent backflow	--
Material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation	Limit duration of pool release	Material balances are typically performed by comparing level changes in the source and receipt tanks. The material balances will eventually discover the discrepancy caused by the pool leak
Seismic Shutdown switches	Shut down transfer pumps upon detection of a seismic event	--

3.4.2.16 Spray Leak from Structure. Only one spray leak accident related to WRSS operations has not been previously considered in the safety documentation for the main text of the FSAR that is needed for WRSS analysis. This is an accident associated with the sluice line and slurry line flush connections located in pits over Tank 241-AY-102 (the highest elevation in the system). These connections are 5.1 cm (2 in.) diameter (nominal) pipes directed vertically upward under removable plugs in the pit cover blocks. The flush connections are normally closed by blanked jumper-type connectors. The flush line spray leak without controls assumes that the blank connector and the removable plug in the pit cover block have been removed so that the maximum system flow is directed vertically out the open 5.1 cm (2 in.) line into the air above the pit. The spray scenario with controls assumes that the removable plug is in place and the flow is directed against the underside of the pit cover block. Analysis has shown that maximum flow from the connection is not sufficient to lift the 159 kg (350 lb) removable plug.

3.4.2.16.1 Scenario Development. Two bounding accident scenarios have been chosen to represent the range of flush connector spray leaks that could occur in the sluice and pump pits over Tank 241-AY-102 during WRSS operations. These scenarios were analyzed for both the sluice line (high flow rate, low solids content) and the slurry return line (lower flow, high solids content) to determine worst case radiological and toxicological consequences. Details of the scenario development and analysis can be found in HNF-SD-WM-CN-102, *Radiological and Toxicological Consequences of a Worst-Case Spray Leak Related To Project W-320*.

Accident Scenario Without Controls. For the accident scenario without controls, the pit cover plug over the flush connection was assumed to be removed and the stream was assumed to be directed vertically upward. A slurry line release from pump pit 241-AY-02A and a sluice line release from sluice pit 241-AY-02E were evaluated to determine the worst case. Both flush connections are nominal 5.1 cm (2 in.) Schedule 40 pipe with an inside diameter of 5.25 cm (2.067 in.). In the case of the sluice line, the pump was assumed to be very close to the open flush connection and to be running at maximum speed (3056 rpm) with no discharge head. The maximum flow rate under these conditions is 41.0 L/s (650 gpm) with a discharge velocity of 19.9 m/s (65.3 ft/s) at the flush connection.

For the slurry line returning from Tank 241-C-106, the flush connection was assumed to be elevated 10.7 m (35.10 ft) higher than the slurry pump and the material was assumed to traverse about 600 m (656 yd) of pipe run. The flush connection actually is very close to but at a higher elevation than the slurry distribution nozzles in Tank 241-AY-102. The flow from the flush connection is therefore expected to be about the same as the normal 22.1 L/s (350 gpm) flow rate for the slurry line. For this analysis, however, the flow was conservatively assumed to be 28.4 L/s (450 gpm), or about 6.3 L/s (100 gpm) above the expected flow rate. The corresponding flow velocity from the flush connection was estimated to be 13.8 m/s (45.3 ft/s). Consistent with previous spray release analyses in the main text, the flush connection release was assumed to continue unabated for 24 hours.

Accident Frequency Without Controls. The accident frequency without controls is assigned based on the frequency of the initiating event. In this case, the initiating event is the failure or absence of the blank connector that closes off the flush connection. This causes a pressurized spray release during a transfer. The initiating event frequency is considered to be "anticipated" (1 event/year - 1.0×10^{-2} events/year) consistent with Section 3.4.2.9.1 of the main text of the FSAR.

Accident Scenario With Controls. The conditions for the release scenario with controls are the same as assumed for the scenario without controls except that the removable plug in the pit cover block over the flush connection was assumed to be in place. A slurry line release in pump pit 241-AY-02A and a sluice line release in sluice pit 241-AY-02E were evaluated to determine the worst case. Consistent with WHC-SD-WM-CN-048, *Calculation Notes in Support of TWRS FSAR Spray Leak Accident Analysis*, the impact of the stream on the underside of the pit cover was assumed to saturate the air in the pit to the maximum sustainable air loading of 100 mg/m^3 (ANSI N46.1). The direct aerosol release was then assumed to be carried with the air displaced from the pit while the pit fills with slurry.

After the pit fills, the spray release ends and the slurry spreads over the ground above the pit as a pool. Pool releases are covered in Sections 3.4.2.14 and 3.4.2.15 and are outside the scope of this scenario. Pits 241-AY-02A and 241-AY-02E are equipped with 152mm (6in.) high-capacity drains emptying directly into Tank 241-AY-102. These drains are designed to handle the maximum flow from an open transfer line. In addition, both pits are equipped with leak detectors that alarm before the liquid reaches the levels of the high-capacity drains. For purposes of this bounding analysis, the high-capacity drains were assumed to be blocked and no credit was taken for the leak detectors. Because a negative pressure is maintained in the pits via the drains to Tank 241-AY-102, the consequences with the drains open would be far less severe.

Accident Frequency With Controls. The accident with controls frequency category is "anticipated." No safety structures, systems, and components or TSR controls are credited with reducing the likelihood of the initiating event.

3.4.2.16.2 Source Term Analysis. The method and detailed calculations used to determine the airborne aerosol release volumes in the accident analyses without and with controls are documented in HNF-SD-WM-CN-102. The following sections summarize the source term analyses.

Source Term Without Controls. Based on the total solids and liquids in both tanks, the solid and liquid components of the slurry circulating in both directions between Tank 241-C-106 and Tank 241-AY-102 in the sluice line and slurry line were determined to have the following best estimate compositions:

- **Liquids**—10% SST liquids and 90% AWF tank liquids
- **Solids**—90% SST solids and 10% AWF tank solids.

The sluice supernate being pumped from Tank 241-AY-102 to Tank 241-C-106 was assumed to contain 10% solids and 90% liquids, while the slurry being pumped back from Tank 241-C-106 was assumed to contain 33% solids and 67% liquids.

Two sources of aerosolization were evaluated: direct production by edge shear during slurry flow out of the nozzle and instability/shear stress at the surface of the liquid during the fall from its maximum height and impact on the ground (assumed to be a hard surface). The passage of the falling material through the air creates airflow patterns and turbulence that aid in suspension of the slurry. The sluice supernate and slurry return flows were investigated to determine the worst case.

The direct spray releases from the nozzle and from the pool formed on the ground were found to be negligible compared to the respirable releases produced by the fall and impact of the stream after reaching maximum height above the pit cover. The respirable aerosol release produced by the fall and impact of the liquid stream was calculated using the method recommended in DOE-HDBK-3010-94. Neglecting effects of air resistance, a vertical stream with an initial velocity of 19.9 m/s (65.3 ft/s) can reach a height of 20.2 m (66.3 ft). The airborne release fraction of slurry falling and impacting on a hard surface from a height of 20.2 m (66.3 ft) was determined to be 1.18×10^{-3}. As recommended in DOE-HDBK-3010-94 for this type of release, the respirable fraction was assumed to be one. The resulting respirable release rate is 4.84×10^{-2} L/s (0.77 gpm). The corresponding 12- and 24-hour respirable releases are 2.09×10^{3} L (552 gal) and 4.18×10^{3} L (1,100 gal).

Source Term With Controls. In the accident with controls, the pit cover provides an impaction surface that prevents aerosols from jetting directly into the atmosphere. The covers also create a relatively stagnant air volume that fosters agglomeration and rainout of aerosols within the pit. Aerosol removal also occurs as the result of condensation on the pit walls and the underside of the cover blocks. Aerosol is further removed from any air expelled from the pit through the cover block gaps because the leakage paths are tortuous and provide additional surfaces for impingement and condensation.

It was assumed (consistent with WHC-SD-WM-CN-048) that the impact of the stream on the underside of the pit cover saturates the air in the pit to the maximum sustainable air loading of 100 mg/m^3 (ANSI N46.1). The direct aerosol release is then carried with the air displaced from the pit as the pit fills with slurry. No credit was taken in this bounding analysis for the leak detectors or the 1.5 cm (6 in.) diameter high-capacity drains in the pits. Note that once the pit fills and overflows, the slurry will form a pool on the ground above. The releases from such a pool are addressed in Sections 3.4.2.14 and 3.4.2.15.

The sluice line flush connection is in pit 241-AY-02E with inside dimensions of 2.4 m x 1.8 m x 2.1 m (8 ft x 6 ft x 7 ft) giving an interior volume of 9.5 m^3 (336 ft^3). The total volume displaced while the pit is filling with slurry is this volume plus an additional 35% from heating of the air in the pit and addition of water vapor up to 100% relative humidity (WHC-SD-WM-CN-048). The total air volume displaced from the pit through crevices and small openings is then 12.8 m^3 (452 ft^3), implying a slurry aerosol release of 1.28 g (2.82×10^{-3} lbm). Using the sluice supernate

density (1.27 g/cm^3 [75.5 lbm/ft^3]) the equivalent slurry volume was calculated to be 1.01 x 10^{-3} L (2.67 x 10^{-4} gal). At a slurry addition rate of 41.0 L/s (65.2 gpm) or 4.10 x 10^{-2} m^3/s (1.45 ft^3/s), the pit will fill in 232 seconds or 3.86 minutes. No credit was taken for pit volume occupied by piping and machinery. The slurry aerosol release rate resulting from volume displacement is then 4.35 x 10^{-6} L/s (6.92 x 10^{-5} gpm).

The slurry line flush connection is in pit 241-AY-02A, which has inside dimensions of 3.7 m x 2.4 m x 1.5 m (12 ft x 8 ft x 5 ft) giving an interior volume of 13.6 m^3 (480 ft^3). The total volume displaced while the pit is filling with slurry is this volume plus an additional 35% from heating of the air in the pit and addition of water vapor up to 100% relative humidity (WHC-SD-WM-CN-048). The total air volume displaced out of the pit through crevices and small openings is 18.4 m^3 (650 ft^3), implying a slurry aerosol release of 1.84 g (4.06 x 10^{-3} lbm). Using the return slurry density (1.41 g/cm^3 [88.0 lbm/ft^3]), the equivalent slurry volume was calculated to be 1.30 x 10^{-3} L (3.43 x 10^{-4} gal). At a slurry addition rate of 28.4 L/s (452 gpm) or 2.84 x 10^{-2} m^3/s (1.00 ft^3/s), the pit will fill in 479 seconds or 7.98 minutes. No credit was taken for pit volume occupied by piping and machinery. The slurry aerosol release rate resulting from volume displacement is then 2.71 x 10^{-6} L/s.

3.4.2.16.3 Consequence Analysis. The onsite and offsite inhalation dose consequences and toxicological exposures were determined using the method discussed in Section 3.4.1. (See HNF-SD-WM-CN-102 for the detailed dose calculations.) The radiological and toxicological consequences for the accident scenarios without and with controls are summarized in Tables 3.4.2.16-1 and 3.4.2.16-2, respectively.

For the flush connection spray leak without controls, the sluice line release was found to be more limiting with the dose to the onsite receptor determined to be 150 Sv (15,000 rem) (50-year committed effective dose equivalent). The dose to the offsite receptor was found to be 0.21 Sv (21 rem). The toxicological sum-of-fractions for the onsite and offsite receptors were found to be 620 and 0.87, respectively.

For the flush connection spray leak with controls, the slurry return line release was found to be more limiting with the dose to the onsite receptor determined to be 1.8 x 10^{-3} Sv (0.18 rem). The dose to the offsite receptor was found to be 1.6 x 10^{-6} Sv (1.6 x 10^{-4} rem). The toxicological sum-of-fractions for the onsite and offsite receptors were found to be 5.8 x 10^{-2} and 1.1 x 10^{-4}, respectively.

Key Parameters and Assumptions—Accident Analysis Without Controls. The consequences for the accident scenario assuming no controls were calculated conservatively. The sensitivity of the analysis results to key parameters and assumptions used in the analyses are addressed in this section.

1. **Waste Flow Rate**—Maximum flow rate from the sluice line with the flush connection open was assumed to be 41.0 L/s (650 gpm) (maximum pump flow with no discharge head). Maximum flow rate from the slurry line with the flush connection open was assumed to be 28.4 L/s (450 gpm) (normal flow rate plus 6.29 L/s [100 gpm]). This

flow rate is considered to be very conservative for the slurry line because of the elevation of the flush connection above the slurry pump and the much longer run of pipe involved. The flow rate from the flush connection determines the upward flow velocity, hence the height to which the stream of liquid will rise before falling back to earth. The dominant release mechanism here is the aerosolization of the slurry by instability/shear stress at the surface of the liquid during the fall from maximum height and the effects of ground impact (assumed to be on a hard surface).

2. **Slurry Mixes and Unit Liter Doses**—Based on the amounts of the various waste components in Tank 241-C-106 and Tank 241-AY-102, the radiological ULDs and toxicological unit sum-of-fractions were based on a best estimate composition for the liquid and solid components of the sludge being circulated between the two tanks. In the sluice stream or the slurry stream, the liquid component was assumed to be 10% SST liquid and 90% AWF tank liquid while the solid component was assumed to be 90% SST solids and 10% AWF tank solids. The sluice stream from Tank 241-AY-102 to Tank 241-C-106 was assumed to be 10% solids and 90% liquids, while the slurry stream from Tank 241-C-106 to Tank 241-AY-102 was assumed to be 33% solids and 67% liquids. These are both maximum expected values for the amount of solids. Based on the sluice line composition (limiting from a release consequence point of view), using the ULD for pure AWF tank components increases the consequences by about a factor of 4. This would not be realistic, however, because uniformly mixing the contents of Tank 241-AY-102 would produce a slurry with only about 4% AWF tank solids.

3. **Release Mechanisms**—The dominant release mechanisms for the scenario without controls are the processes associated with the fall and impact of the slurry from the maximum height reached by the liquid stream issuing from the flush connection. These processes were modelled as recommended in DOE-HDBK-3010-94. Also as recommended, the respirable fraction for the aerosol release was assumed to be one. Releases from direct aerosolization at the exit nozzle were found to be negligible.

4. **Accident Duration**—The spray leak accident without controls is assumed to continue undetected for 24 hours. The total respirable aerosol release is directly proportional to the assumed accident duration. However, changing wind direction, wind speed, and atmospheric stability results in a logarithmically decreasing χ/Q' as a function of time. The decreasing χ/Q' value somewhat offsets the increase in release quantity over increasing accident durations. Therefore, the 24-hour dose to the offsite receptor was found to be only a factor of 2.6 times larger than for a 2-hour release at the same leak rate. The onsite receptor is assumed in the accident analysis to be exposed during the first 12 hours of the accident. The 12-hour onsite dose was found to be only 66% larger than the dose for a 2-hour exposure.

Key Parameters and Assumptions—Accident Analysis With Controls. The analysis with controls has the same sensitivities to accident duration and assumed solids content as the analysis without controls. Key parameters to which the analysis with controls is sensitive are discussed as follows.

- **Aerosol concentration of air expelled from the pit**—In the accident analysis with controls, the air displaced from the pit is assumed to be limited in aerosol concentration to a value of 100 mg/m^3 (6.24×10^{-6} lbm/ft^3), comparable to fog. The fog value provides an upper bound for the analysis. The dose is proportional to the assumed aerosol concentration.

- **Temperature and humidity change**—The analysis assuming controls estimates an initial volumetric expansion of the pit air based on a temperature and humidity change from -1 °C (30 °F), 15% relative humidity to 49 °C (120 °F), 100% relative humidity. From psychometric charts, the volume expansion results in a pit air exchange equal to 35% of the pit volume. This volume expansion is conservative because the initial temperature of the pit at the start of the spray leak would normally be much higher than -1 °C (30 °F) and the final pit air temperature was set equal to the maximum expected waste temperature (i.e., no heat transfer into the walls of the pit was assumed).

- **Leak flow rate**—For this type of release, the covered pit would fill very quickly, limiting the total spray release to the waste entrained in the air displaced from the pit. The direct radiological consequences of the spray release are therefore independent of the leak flow rate. The maximum release rate, and therefore the toxicological consequences are proportional to the leak flow rate. In the scenario with controls, the slurry stream would normally be expected to return to Tank 241-AY-102 via the high capacity 15.2 cm (6 in.) drain in the pit producing very little release. For this analysis, however, the pit drain was assumed to become plugged. Once the pit fills and runs over, the accident becomes a surface pool release (analyzed in Section 3.4.2.17).

3.4.2.16.4 Comparison with Guidelines. The accident doses and toxicological exposures without and with controls are compared with the offsite and onsite risk guidelines in Tables 3.4.2.16-1 and 3.4.2.16-2. The accident radiological doses without controls are above both the offsite and onsite evaluation guidelines. Both offsite and onsite doses from the spray leak assuming controls are shown to be well below the risk guidelines.

The toxicological sum-of-fractions is well over one for the accident without controls at the onsite receptor location. The toxicological consequences therefore exceed the onsite risk guidelines. The offsite toxicological consequences for the accident without controls are below risk evaluation guidelines. The toxicological sum-of-fractions for the accident with controls is well below one, hence well below the risk guidelines, for both the onsite and offsite receptors.

3.4.2.16.5 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. No changes in Safety structures, systems, and components and no new TSR controls are required for this accident (Tables 3.4.2.16-3 through 3.4.2.16-5).

Safety Structures, Systems, and Components. Table 3.4.2.16-3 summarizes the safety structures, systems, and components selected to prevent or mitigate the spray leak from a structure. These include the transfer system covers, backflow preventers, the pipe-in-pipe encasements, and the stack CAM and interlock.

Technical Safety Requirement Controls. The TSRs selected to prevent or mitigate the spray leak from a structure include the transfer system cover controls; the ventilation stack CAM interlock system on 241-A-702, 241-AZ-702, 296-P-16, and 296-C-006 Ventilation Systems; transfer controls; the encasement seal loop controls; the transfer pump administrative lock controls; and the transfer system cover removal controls.

Defense-in-Depth. The Defense-in-Depth controls to prevent or mitigate the spray leak from a structure encompass service testing of repositioned jumpers, process pit and vault pit leak detectors, material balance, encasement leak detectors, isolation valves, seismic shutdown switches, and backflow preventers.

Table 3.4.2.16-1. Summary of Consequences and Frequencies Without Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Spray leak from flush connection	1.5 E+02 (1.5 E+04)	5.0 E-03 (5.0 E-01)	2.1 E-01 (2.1 E+01)	1.0 E-03 (1.0 E-01)	620	1	0.87	1	Anticipated

SOF = sum-of-fractions.

Table 3.4.2.16-2. Summary of Consequences and Frequencies With Controls.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Spray leak from waste transfer system	1.8 E-03 (1.8 E-01)	5.0 E-03 (5.0 E-01)	1.6 E-06 (1.6 E-04)	1.0 E-03 (1.0 E-01)	0.052	1	1.1 E-04	1	Anticipated

SOF = sum-of-fractions.

Table 3.4.2.16-3. Safety Structures, Systems, and Components for Spray Leaks.

Control	Safety classification		Safety function	Comments
	SC	SS		
Transfer system covers	X	--	Knockdown spray, limit release of aerosols to the atmosphere	Waste transfer-associated structure covers are also a mitigative feature for other accidents and provide radiation protection (i.e., shielding) for facility workers
Backflow preventers in service water system connections to the waste transfer system	--	X	Prevent contamination of the service water system, e.g., the tanker truck, via backflow of waste into service water line, e.g., the hose	The hazardous condition of concern is a spray leak, a rupture of the tanker truck, or simply exposure of the workers
Transfer line pipe-in-pipe encasement	X	--	Confine leak from the primary piping and ensure that a leak is directed to the encasement leak detection system	The pipe-in-pipe encasement shall be designed to withstand the design basis earthquake and high wind
Stack CAM and interlock to exhaust fan (241-A-702, 241-AZ-702, 296-P-16, and 296-C-006 Ventilation Systems)	X	--	Ensure exhaust fan is shut down should exhaust HEPA filters break through (Prevent unfiltered release from occurring for more than 10 minutes)	Aerosol-laden air could eventually saturate the HEPA filters, resulting in their failure

CAM = continuous air monitor.
HEPA = high-efficiency particulate air (filter).

Table 3.4.2.16-4. Technical Safety Requirement Controls for Spray Leaks.

Control	Safety function	Comments
Transfer system covers	Operable covers mitigate spray leak by knocking down/confining the spray. This control ensures covers are operable when the waste transfer-associated structure is physically connected to the waste transfer piping during waste transfer	An exception is allowed if the waste transfer-associated structure is separated by two locked valves and continuous monitoring for spray leaks is provided
Ventilation stack CAM interlock system	Ensures interlock is operable during transfers out of the facility and during tank farm transfers through routes physically connected to the unloading facility	--
Transfer Controls with the following key elements: - Configuration management shall be applied to waste transfer routes - The waste transfer route configuration shall be independently verified prior to transfers - Use of vehicle restrictions around transfer lines	Configuration management and independent verification of waste transfer routes serves to prevent mistransfers Ensure that the transfer line is protected from vehicle collisions that could result in a loss of integrity of the primary and encasement pipes	--
Encasement Seal Loop Controls with the following key element: - Encasement valve on encasement drain line will not be closed	Ensure that if the primary pipe leaks during waste transfer, the encasement will drain to the waste transfer-associated structure	Control prevents pressurizing encasement risers which could result in abovegrade spray release
Transfer Pump Administrative Lock Controls	Eliminate motive force for unplanned transfers	To address spray leaks that may occur during inadvertent waste transfer pump starts, either the waste transfer-associated covers will be operable or the waste transfer pump(s) physically connected to waste transfer-associated structures will be locked out
Transfer System Cover Removal Controls	Provide compensatory measures for cover removal during transfers	--

Table 3.4.2.16-5. Defense-in-Depth Controls for Transfer System Spray Leaks.*

Control	Safety function	Comments
Repositioned jumpers are in service tested during initial sluicing. Cameras lowered through penetrations in the cover block are used to verify initial jumper integrity during the leak test	Reduce the likelihood of a spray leak from a failed or misaligned jumper	--
Process pit and vault pit leak detectors	Limit duration of spray release. The liquid fraction of the release will drain past the leak detector	Leaks that produce low flow rates of liquid may not be detected
Material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation	Limit duration of spray release	Material balances are typically performed by comparing level changes in the source and receipt tanks and adjusting for line holdup. The material balances will eventually discover the discrepancy caused by the spray leak
Encasement leak detectors	Ensure transfer pump is shutdown upon detection of leak from primary transfer pipe. Prevents pressurization and potential spray leak from test riser	--
Isolation valves; manual valve is closed to isolate the flush system when not in use	Prevent backflow of waste into the raw water supply	Isolation valves are not effective at preventing backflows during flushing operations as the valves will be open
Backflow preventers	Prevent backflow of waste into the raw water supply	--
Seismic shutdown switches	Shut down transfer pumps upon detection of a seismic event	

*Some of the controls in this list may be determined to be Safety-Class or Safety-Significant for other accidents.
CAM = continuous air monitor.

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3.4.2.17 Spray Leak from an Underground Waste Transfer Line. This analysis addresses the potential of WRSS operations to break an underground transfer line before or during sluicing operations. This accident is different than that originally analyzed in Section 3.4.2.10[1] of the main text of the FSAR because the pump flow rate of the WRSS pumps is higher than that used in the FSAR and the waste composition is different. Although the consequences of an underground transfer line failure are developed in other WRSS accident analyses, unique event sequences are identified in this analysis. The need for controls applicable to these unique event sequences is also identified.

3.4.2.17.1 Scenario Development. The accident scenarios for spray leaks from an underground transfer line are described in the main text of the FSAR.

Other event initiators identified in the hazard analysis in Section 3.3 include a seismic event and light aircraft crash. The excavation activity is the dominant initiator because the consequence analyses are already bounding and the likelihood of an excavation error is greater than a seismic event or an aircraft crash.

An impact to a transfer line could result in two basic release scenarios: a spray leak and formation of a surface pool. The formation of a surface pool is addressed in Sections 3.4.2.14 and 3.4.2.15, and spray leaks are addressed in Section 3.4.2.16. The source terms and consequences in those sections are bounding for the possible releases postulated in this event. Comparing the consequences of (and recovery from) a surface pool and a spray leak shows that the spray leak is bounding over the surface pool. Therefore, the consequences in this analysis are taken from the consequences of a spray leak from an aboveground structure. The possible formation of a surface pool is not considered further.

The bounding frequency category assigned to this event is "anticipated." This frequency is assigned in the main text of the FSAR to excavation impacts to underground waste transfer lines and applies to the transfer lines associated with Tank 241-C-106 sluicing operations.

3.4.2.17.2 Source Term Analysis. The source term for this event is bounded by the source term calculated in the main text and in Section 3.4.2.16.

3.4.2.17.3 Consequence Analysis. The consequences for this event are bounded by the consequences calculated in the main text and in Section 3.4.2.16. The consequences are mitigated or prevented for the scenario with controls.

3.4.2.17.4 Comparison to Guidelines. The consequences calculated in the main text and in Section 3.4.2.16 for a spray leak without controls exceed the onsite and offsite radiological risk guidelines and the onsite toxicological risk guidelines, and require controls. The consequences are mitigated or prevented for the scenario with controls.

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[1]The information originally contained in this section was incorporated in Sections 3.4.2.7, 3.4.2.8, and 3.4.2.9 of the FSAR.

3.4.2.17.5 Summary of Safety-Class Structures, Systems, and Components and Technical Safety Requirements.

Safety Structures, Systems, and Components. No safety structures, systems, and components have been identified for this event.

Technical Safety Requirement Controls. Table 3.4.2.17-1 lists the controls relied on to prevent impacts to the underground transfer lines. In addition to the preventive controls, a mitigative control is listed as a key element in Table 3.4.2.17-1. The TSRs selected are excavation controls to prevent damaging the transfer line and transfer controls to protect the transfer line integrity.

Defense-in-Depth. The Defense-in-Depth controls for this event are listed in Table 3.4.2.17-2. The Defense-in-Depth controls are barriers to restrict access to the transfer line, seismic shutdown switches, and transfer controls.

Table 3.4.2.17-1. Technical Safety Requirement Controls for Spray Leak from Underground Waste Transfer Lines.

Control	Safety Function	Comments
Excavation Controls with the following key elements		---
- An excavation permit shall be required where waste transfer lines exist	Prevents leaks in waste transfer lines caused by excavation activities by ensuring: • Excavation activities are not inadvertently performed near waste transfer lines • Excavation activities are carefully controlled when required near waste transfer lines	
Waste transfers are prohibited through lines uncovered by excavation activities unless compensatory controls are established	Prevents transfers through waste transfer lines that are uncovered by excavation activities that could cause worker radiation doses exceeding limits established by the radiation protection program	
Waste transfers shall not be conducted in transfer lines located within approximately 5 m (15 ft) of ongoing excavation activities	Prevents leaks in waste transfer lines caused by excavation activities by ensuring that excavation activities are not performed near waste transfer lines during waste transfers	
Prior to initiation of an excavation activity, identify emergency response actions and establish communications between the excavation site and operations personnel to ensure immediate shutdown of waste transfers when leakage is indicated	Mitigates waste transfer leaks caused by excavation activities by prompt shutdown of the waste transfer pump	
Encased pipe outside of the tank farm boundaries shall be identified with permanent aboveground labels	Prevents leaks in waste transfer lines caused by excavation activities by ensuring that excavation activities are not inadvertently performed near waste transfer lines outside of tank farms	

Table 3.4.2.17-2. Defense-in-Depth Controls for Spray Leak from Underground Waste Transfer Lines.

Control	Safety Function	Comments
T-bars and chains	Restrict access to transfer lines	--
Material balance after each sluicing batch of 12 hours maximum duration during transfer operations, including total material transferred and solids loading calculation	Prevents a leak from a transfer line by monitoring the flow through the lines	A small leak, such as a spray leak, is difficult to detect by the material balance equipment
Seismic shutdown switches	Shut down transfer pumps upon detection of a seismic event	

3.4.2.18 Natural Phenomena. The following natural phenomena events were identified in the hazard analysis: seismic events, ice storms, rainfall, local flooding, volcanic activity, and high winds/dust devils. These phenomena are initiators for several of the accidents analyzed in detail in Section 3.4.2. They do not pose any unique accident scenarios different from those in Section 3.4.2 or the main text of the FSAR.

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3.4.3 Beyond Evaluation Basis Accidents

The results of an assessment of beyond evaluation basis accidents analyzed to provide a perspective of the residual risk associated with tank farm operations (including WRSS) is provided in the main text of the FSAR. Beyond valuation basis accidents are not analyzed specific to WRSS.

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CHAPTER 4.0
SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

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CHAPTER 4.0
SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

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4.0 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

4.1 INTRODUCTION

The purpose of this chapter is to provide details on structures, systems, and components (SSCs) utilized by Project W-320 that are necessary for Waste Retrieval Sluicing System (WRSS) activities to satisfy accident consequence guidelines, provide Defense-in-Depth, and aid in ensuring worker safety. Descriptions of the attributes required (1) to support the safety functions identified in the hazard and accident analyses, and (2) to support subsequent derivation of the Technical Safety Requirements (TSRs), are provided.

4.2 REQUIREMENTS

The following lists the current standards, regulations, and U.S. Department of Energy (DOE) orders that establish the requirements in support of safety analysis and design.

- DOE 5480.28, *Natural Phenomena Hazard Mitigation*[1] (1994)
- DOE 6430.1A, *General Design Criteria*[2] (1989)
- HP-SDC-4.1, *Standard Architectural-Civil Design Criteria*[3] (1988)

The existing WRSS SSCs that are designated as Safety-Class and Safety-Significant in this addendum, were not designed and constructed to meet Safety-Class criteria.

An engineering analysis was performed for each Safety Class and Safety Significant system of the WRSS to ensure that it is able to perform its safety function. The results of this evaluation are provided in HNF-2050, *Project W-320 Safety Class and Safety Significant Equipment Engineering Evaluation.* The engineering analysis defined the project strategy for meeting the system safety functions(s) and evaluated the system compliance with safety design requirements. The evaluation includes failure modes and effects analysis, allowed outage times and operational attributes and critical characteristics. The evaluation discusses the results of the reliability analyses for the Tank 241-AY-102 primary and annulus ventilation systems and Tank 241-C-106 primary ventilation system. The evaluation provides the basis for

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[1]DOE 5480.28 was canceled by DOE N 251.4 and DOE O 420.1. As of July 2, 1996, the new orders were not transmitted for compliance; therefore, compliance with DOE 5480.28 is required by clause I-97(a).

[2]Non safety-related portions of DOE 6430.1A will be phased out/canceled upon meeting the implementation conditions of DOE O 430.1. The portions of DOE 6430.1A related to nuclear safety for nonreactor nuclear facilities are canceled by DOE O 420.1. As of July 2, 1996, the new orders were not transmitted for compliance; therefore, compliance with DOE 6430.1A is required.

[3]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., FDH Procedures (e.g., HNF-PRO-XXX).

establishing the spare parts requirements for the Safety Class and Safety Significant systems. Acceptance and operational testing is underway, and will demonstrate, where practical, that safety functions and requirements can be met.

4.3 SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS

This section provides information about the Safety-Class SSCs identified in Chapter 3.0 "Hazard Evaluations and Accident Analyses." Table 4-1 provides a summary list of those SSCs. Details of each Safety-Class SSC correlating to the information in Table 4-1 follow.

4.3.1 Annulus Ventilation System (Tank 241-AY-102)

The annulus ventilation system of Tank 241-AY-102 is identified as a Safety-Class SSC for the tank bump (Section 3.4.2.11 "Tank Bump") accident scenario and is credited as Safety Significant for the unfiltered release (Section 3.4.2.3 "Unfiltered Release") accident scenario.

4.3.1.1 Safety Function. The safety function of the Tank 241-AY-102 annulus ventilation system is to provide adequate cooling to prevent the sludge or supernate in the tank from reaching the local saturation temperature in the scenarios of Sections 3.4.2.3 and 3.4.2.11.

4.3.1.2 System Description. The Tank 241-AY-102 annulus ventilation system draws outside air into the tank annulus area, where heat being conducted through the tank inner liner is absorbed, before the air is filtered and exhausted to the environment.

The annulus space in Tank 241-AY-102 is ventilated by a dedicated, independent ventilation system. A portion of the annulus ventilation system has been blocked to increase the under-floor flow rate. If needed, any combination of an increased vacuum exhaust fan, an inlet system blower, and an inlet system chiller may be installed to enhance the cooling capacity of the annulus ventilation system and meet the cooling requirements of the tank. Cooling requirements depend on thermal analysis of the actual transferred waste conditions (i.e., volume, fluffing factor, and tank temperature response). A supporting SSC is the electrical system that supplies power to the ventilation fans.

4.3.1.3 Functional Requirements. The annulus ventilation system shall maintain a flow rate to control tank waste temperature within the following limits:

≤195 °F (91 °C), for all waste levels

OR

≤195 °F (91 °C) in the top 4.6 m (15 ft) of the waste

AND

≤215 °F (102 °C) in the waste below 4.6 m (15 ft)

Tank waste temperatures must be controlled below those temperatures that could lead to waste boiling, steam generation, overpressurization conditions, and unfiltered releases.

4.3.1.4 System Evaluation.

Performance Criteria: To meet its safety function, the annulus ventilation system must provide the sufficient cooling capacity to maintain waste temperatures below the limits described above. Under analyzed base case conditions, the system will require a flow rate capability of 61 m^3/min (2150 ft^3/min) and provision of 4 °C (40 °F) inlet air (HNF-SD-W320-ER-004, *Project W-320 SAR and Process Control Thermal Analysis*). Final determination will be made based on data from the first sluicing campaign.

Analytical results (HNF-SD-W320-ER-004) for worst-case thermal transients indicate that the maximum allowable outage time of this system is 25 days.

System Evaluation: The Tank 241-AY-102 annulus ventilation system is existing and operational. This system was evaluated, as described in Section 4.2, to determine any needed functional upgrades and/or requirements for spares. The system may be upgraded, as described in Section 4.3.1.2, if required for increased cooling capacity. Designs for new equipment upgrades will be performed to DOE 6430.1A criteria.

During WRSS operations, the operability of the annulus ventilation systems shall be verified at a surveillance frequency of 10 days.

4.3.1.5 Controls (TSRs).

The assumption in the analyses presented in Sections 3.4.2.3 and 3.4.2.11 is that the annulus ventilation system provides adequate cooling capacity to ensure that the Tank 241-AY-102 waste saturation temperatures are not exceeded for the potential tank bump and unfiltered release.

4.3.2 Primary Tank Ventilation System (241-AY-102 & 241-C-106)

The primary ventilation systems of Tanks 241-AY-102 and 241-C-106 are identified as Safety-Class SSCs for the flammable gas deflagration

(Section 3.4.2.8) accident scenario, and the tank bump (3.4.2.11) accident scenario and are credited as Safety-Significant for the unfiltered release (3.4.2.3) accident scenario.

4.3.2.1 Safety Function. The safety functions of the primary ventilation systems of Tanks 241-AY-102 and 241-C-106 are to (1) dilute gases released from the waste in a chronic (steady state) manner such that flammable gas concentrations in tank dome spaces remain below 25% of the lower flammability limit (LFL) and (2) to help remove heat to maintain the tank waste temperatures below the saturation temperature. Another safety function of the Tank 241-C-106 primary system is to cool the tank and prevent a steam release by eliminating thermal saturation zones.

4.3.2.2 System Description. The primary ventilation systems of Tanks 241-AY-102 and 241-C-106 draw outside air into the tanks, mixing and displacing the flammable gases produced by the waste. The air/gas mixture is then removed from the tanks, filtered to remove radioactive particulates, and exhausted to the environment.

Specifically, the Tank 241-C-106 ventilation system (296-C-006) is a combination recirculation and exhaust system. The ventilation system serves to (1) cool the tank, and (2) dilute flammable gas generated in the sludge, which discharges a thoroughly decontaminated ventilation stream to the atmosphere. The recirculation portion of the system is used to provide the needed cooling. The exhaust portion of the system maintains headspace below flammable conditions.

An older heating, ventilating, and air-conditioning (HVAC) system (296-P-16) also serves Tank 241-C-106. The older system will be maintained in an operational standby status as a backup system for cooling Tank 241-C-106. Its main function, however, will be to subcool Tank 241-C-106 waste before initiation of sluicing to reduce the potential for a steam release event during the retrieval activity and to provide a high flow exhaust system to support Tank 241-C-106 open riser maintenance activities.

The primary ventilation system (241-A-702) of Tank 241-AY-102, serves to (1) cool the tank, (2) maintain the tank at a negative pressure while discharging a decontaminated ventilation stream to the atmosphere, and (3) dilute flammable gas generated in the sludge. A backup ventilation system is also available for the 241-A-702 ventilation system. The supporting SSC is the electrical system that provides power to the ventilation fans.

The 241-AZ-702 ventilation system, which will replace the 241-A-702 system, uses separate systems for cooling and/or confinement and for exhausting (Figure 2-9). However, 241-AZ-702 and the existing ventilation system (241-A-702) both rely on evaporative cooling to maintain waste temperatures. The exhaust system contains HEPA filtration and stacks similar to the existing design. A separate recirculating system is added for cooling and confinement. This additional system greatly reduces the amount of air vented out the stack. The 241-AZ-702 system will have three operating modes available: recirculation, high heat, and by-pass.

4.3.2.3 Functional Requirements. The active primary ventilation systems of Tanks 241-AY-102 and 241-C-106 shall prevent the accumulation of flammable gases from steady-state releases by (1) providing a minimum flow rate, and (2) limiting a loss of ventilation upset to a timeframe where gases cannot build to more than the LFL. Definition of 25% LFL is provided in Appendix K, "Flammable Gas Hazards and Controls in the Hanford Waste Storage Tanks and Waste Transfer Facilities," of the FSAR main text.

The primary active ventilation system on Tank-C-106 (296-C-006 or 296-P-16) must also provide sufficient cooling capacity to maintain the waste below 96 °C (205 °F).

4.3.2.4 System Evaluation.

Performance Criteria: To meet its safety function, the primary ventilation system must maintain flammable gas concentrations in tank dome spaces below 25% of the LFL. The minimum flow rate to maintain the headspace below 25% of the LFL has been evaluated in (HNF-SD-WM-CN-114) *Calculation Note: Project W-320 Primary Ventilation Air Flow Requirements for Mitigation of Steady State Flammable Gas Concentrations in the Headspaces of Tanks 241-C-106 and 241-AY-102* for both tanks. For Tank 241-C-106, this flow rate is 2.7E-02 m^3/min (0.74 ft^3/min), using an upper bound hydrogen generation rate of 0.19 m^3/day (6.7 ft^3/day). For Tank 241-AY-102, this flow rate is 8.3E-02 m^3/min (2.95 ft^3/min), using an upper bound hydrogen generation rate of 0.75 m^3/day (26.9 ft^3/day).

The 296-P-16 system must provide 4 °C (40 °F) inlet air through the air inlet station to pre-cool the waste below saturation temperatures (HNF-SD-W320-ER-004).

The Tank 241-AY-102 system must provide 14.2 m^3/min (500 ft^3/min) at 24 °C (76 °F), as noted in HNF-SD-W320-ER-004.

Following sluicing, the 296-P-16 system must maintain any remaining waste in Tank 241-C-106 below saturation temperature (Section 3.4.2.12, "Liner Breach Due to Steam Between the Steel Liner and Concrete Shell in Tank 241-C-106"). This function may not be required if enough waste material is removed from the tank.

System Evaluation: The Tank 241-AY-102 primary ventilation system is existing and operational. This system will be evaluated, as described in Section 4.2 above, to determine any needed functional upgrades and/or requirements for spares. The nominal flow rate of the 241-A-702 system, 17 m^3/min (600 ft^3/min), is more than adequate to maintain the headspace below 25% of the LFL. There is an existing backup ventilation system available for use in the event of a ventilation outage.

The 241-AZ-702 system has been constructed, but not yet operational. This system will also be evaluated, as described in Section 4.2. The nominal flow rate of the 241-AZ-702 system, 2.8 m^3/min (100 ft^3/min), is also more than adequate to maintain the headspace of Tank 241-AY-102 below 25% of the LFL.

The existing Tank 241-C-106 primary ventilation system (296-P-16) is operational. This system has been upgraded to meet flammable gas ignition control requirements (FSAR Appendix K). This system will be evaluated as described in Section 4.2. The nominal flow rate of the 296-P-16 system, 68 m^3/min (2400 ft^3/min), is more than adequate to maintain the headspace of Tank 241-C-106 below 25% of the LFL.

The new Tank 241-C-106 primary ventilation system (296-C-006) has been designed, constructed, and installed, but is not yet operational. This system was evaluated as described in Section 4.2. The nominal flow rate of the 296-C-006 system, 5.7 m^3/min (200 ft^3/min), is also more than adequate to maintain the headspace of Tank 241-C-106 below 25% of the LFL. When this system is operational, the 296-P-16 system will serve as a back-up system for both cooling and flammable gas dilution functions.

4.3.2.5 Controls (TSR). The assumption in the Sections 3.4.2.3, 3.4.2.8, and 3.4.2.11 accident analyses is that the ventilation systems are operable and operating during WRSS operations. The operability assumption includes (1) monitoring of the differential pressure across the ventilation system's HEPA filters, or (2) monitoring of the tank pressures, or (3) verification of the flow.

4.3.3 Primary Tank Leak Detection System (241-AY-102)

The primary tank leak detection system for Tank 241-AY-102 is identified as a Safety-Class SSC for the flammable gas deflagration accident (Section 3.4.2.8) and the surface leak resulting in pool accident (Section 3.4.2.15).

4.3.3.1 Safety Function. The safety function of the primary tank leak detection system is to provide an indication of leakage of waste to the annulus space of Tank 241-AY-102.

4.3.3.2 System Description. The primary tank leak detection system includes (1) conductivity probes that detect the presence of liquid in the tank annulus, and (2) a CAM that detects the presence of airborne radionuclides in the annulus ventilation exhaust stream.

4.3.3.3 Functional Requirements. The annulus conductivity probes must be able to detect a specified depth of waste in the bottom of the annulus, and must provide an audible alarm signal and an annunciator panel light upon the detection of waste.

If the conductivity probe is not in service, the annulus ventilation system's CAMs must operate continuously while the annulus ventilation system is operating, and must alarm when radiation levels exceeding a preset level are detected.

4.3.3.4 System Evaluation.

Performance Criteria: To meet their safety function, the primary tank leak detectors must be continuously operational or fail in a fail-safe mode (alarming). Liquid waste contact with the annulus leak detector will activate alarms and annunciator panel lights. The CAM will alarm if the radiation level exceeds a preset level. Failure of the CAMs will activate audible and visible alarms.

System Evaluation: The primary leak detectors on Tank 241-AY-102 are in place, and are operational, and were evaluated as described in Section 4.2. The operability of the liquid waste detectors must be verified by a system functional test prior to WRSS operations.

4.3.3.5 Controls (TSRs). The assumption in the Sections 3.4.2.8, "Flammable Gas Deflagration," and 3.4.2.15, "Surface Leak Resulting in a Pool," analyses is that the annulus liquid waste detectors are operable.

4.3.4 Transfer Line Pipe-in-Pipe Encasement

The transfer line pipe-in-pipe system, and specifically the encasement, has been designated as Safety-Class SSC for the subsurface leak resulting in a pool (Section 3.4.2.14), surface leak resulting in a pool (Section 3.4.2.15), and spray leak from structure (Section 3.4.2.16) scenarios, and is credited as Safety-Significant for the subsurface leak remaining subsurface (Section 3.4.2.13)scenario.

4.3.4.1 Safety Function. The safety function of the transfer line pipe-in-pipe system is to ensure that a leak in the primary waste transfer system piping will be contained and directed to a waste transfer-associated structure, where the leak will be detected, subsequently resulting in operator shutdown of the transfer operation.

4.3.4.2 System Description. The transfer line pipe is fabricated as a pipe within a pipe, with an inner or primary pipe that is surrounded by an encasement or secondary pipe. The encasement pipe forms a sloped annular drain channel, and any leaked waste from a primary pipe will flow by gravity from the leak site along this annular channel to a detector.

4.3.4.3 Functional Requirements. The transfer line pipe-in-pipe system shall contain and route the waste leaked from the primary pipe to a structure at which the leak can be detected. The encasement shall provide an unobstructed flow path to the structure.

4.3.4.4 System Evaluation.

Performance Criteria: To meet its safety function, the transfer lines must be capable of withstanding maximum system pressures, temperatures, and transients. It must withstand credible natural phenomena (i.e., high winds, earthquakes) and must not fail by corrosion for the life of the project.

System Evaluation: The WRSS transfer lines have been constructed and are ready for operation. The transfer lines are designed to Safety-Significant requirements per the U.S. Department of Energy, Richland Operations Office (RL), approved (HNF-SD-W320-FDC-001, *Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320*). The encased lines are provided with cathodic protection to reduce the possibility of corrosion failure, as well as seismic switches to trip the pumping systems in the event of a significant earthquake (0.1 g). The lines will only be used a total of 10-20 days over a 1-year period.

The transfer line leak accidents analyzed in Section 3.4.2 rely primarily on leak detection and operator shutdown of the transfer pumps to mitigate potential accident consequences. The transfer lines are assumed to fail in both the unmitigated and mitigated accident scenarios. An additional margin of safety is provided by the seismic shutdown switches which are credited as Defense-in-Depth. The seismic trip system will have setpoints that shut down the slurry pump, sluice pump, and booster pumps at ground accelerations less than the current Safety-Significant design seismic loads for the pipe-in-pipe system. If such an event were to occur, the pipe-in-pipe system would require engineering inspection and structural reanalysis prior to further use.

Considering the design of the system and its limited use, it is judged to meet its safety function. The drain path into the pit(s) from the annulus of the encased piping system shall be verified to be free of obstructions prior to the start of a waste transfer.

4.3.4.5 Controls (TSRs). The accident analyses presented in Sections 3.4.2.13, "Subsurface Leak Remaining Subsurface," through 3.4.2.16, "Spray Leak from Structure," assume that the encasement is unobstructed and operable before a waste transfer and remains operable throughout the WRSS operation. The operability assumption includes that the encasement seal loop valves are in their operating position.

4.3.5 Transfer Leak Detection Systems

The transfer leak detection systems, including leak detectors in interfacing pits and their alarms are identified as Safety-Class SSCs for the Subsurface Leak Resulting in a Pool (Section 3.4.2.14) and "Surface Leak Resulting in a Pool," Section 3.4.2.15 accident scenarios, and are credited as Safety-Significant for the "Subsurface Leak Remaining Subsurface" (Section 3.4.2.13) scenario.

4.3.5.1 Safety Function. The safety function of the transfer line leak detection system, and specifically the leak detectors in the pits, is to provide warning of liquid within the transfer line encasement, and routine waste accumulation to prevent transfer pits from overflowing as the result of equipment leaks.

4.3.5.2 System Description. The pits and transfer line encasements are provided with leak detectors located in the lowest part of the structures. The leak detectors have electrodes, at different electrical potentials, which are short-circuited by a conductive medium (i.e., liquid waste) and cause a

change in state of the monitoring circuitry. When liquid waste short-circuits the leak detector electrodes, an alarm is generated.

4.3.5.3 Functional Requirements. A leak detector must be capable of detecting a predetermined depth of liquid accumulation. The leak detection system is required to activate an alarm when a leak is detected.

4.3.5.4 System Evaluation.

Performance Criteria: To meet their safety function, leak detectors must be continuously operational or fail in a fail-safe mode (alarming). When the detectors are contacted by liquid waste, an alarm will activate, leading to operator shutdown of the transfer system.

System Evaluation: The leak detectors associated with the WRSS are installed and operational. These leak detectors have been modified to meet flammable gas ignition control requirements (FSAR Appendix K) and provide fail-safe alarm capability. The leak detectors were evaluated as described in Section 4.2. The operation of the leak detector and the associated alarm shall be verified prior to WRSS operations.

4.3.5.5 Controls (TSRs). The assumption in Sections 3.4.2.13, 3.4.2.14, and 3.4.2.15 is that the leak detector systems will be operable and operating during WRSS operations. The operability assumptions include ensuring (1) that the leak detection system is operational, and (2) that the alarm and control functions activated by the leak detector are routinely verified. The specific bases and controls protecting the operability assumptions are developed in Chapter 5.0.

4.3.6 Transfer System Covers

The transfer system covers are identified as Safety-Class SSCs for the spray leak from structure (Section 3.4.2.16) accident scenario, and are credited as Safety-Significant for the surface leak resulting in a pool (Section 3.4.2.15) scenario.

4.3.6.1 Safety Function. The safety function of the transfer system covers is to mitigate the effects of a spray release (i.e., knock down the spray) from the pressurized transfer line and limit the release of aerosols to the atmosphere. Transfer system covers also limit shine and skyshine dose to the onsite receptor.

4.3.6.2 System Description. The transfer system covers are concrete and have been positioned over the pits to form a barrier.

4.3.6.3 Functional Requirements. The transfer system covers must be capable of limiting the splatter of a spray release and mitigating the release of aerosols, as well as limiting shine and skyshine dose to the onsite receptor.

4.3.6.4 System Evaluation.

Performance Criteria: To meet their safety function, the transfer system covers must be in place, must be structurally sound for their design life, and must cover the pit openings such that an undiverted spray to the atmosphere is not possible.

System Evaluation: The transfer system covers are all currently installed and were evaluated as described in Section 4.2. The 241-C-06A and 241-C-06C cover blocks were recently upgraded due to structural concerns, and the 241-AY-02A pit cover block was designed to DOE 6430.1A criteria. The covers shall be verified to be in place during transfers.

4.3.6.5 Controls (TSRs). The Sections 3.4.2.15 and 3.4.2.16 accident analyses assume that the covers and cover assemblies will be operable prior to WRSS operations and will remain operable throughout the WRSS operation to provide a tortuous leak path for a spray leak.

Each time a transfer system cover is opened, the pit structure and its covers shall be visually inspected for damage and/or degradation in structural integrity. The exterior of the transfer system covers shall be visually inspected prior to WRSS operation to ensure that (1) covers are installed and operable, and (2) cover plugs are installed and operable.

4.3.7 Stack Continuous Air Monitor and Interlock to Exhaust Fan

The primary exhaust stack CAM, and interlock to the exhaust fan are identified as a Safety-Class SSC for the spray leak from structure (Section 3.4.2.16) accident scenario.

4.3.7.1 Safety Function. The safety function of the stack CAM interlock to the exhaust fan is to ensure that the fan will be shut down in the event of HEPA exhaust filters break through.

4.3.7.2 System Description. If the stack CAMs on the ventilation exhaust stack detect a predetermined radiation level, the interlock signals an alarm and transmits a signal to a relay that interrupts the electrical power to the exhaust fan motor.

Supporting SSCs include the electrical power for the CAM, the interlock, the alarm, any instrument cabinet heaters, and freeze protection for the CAM gas tubing.

4.3.7.3 Functional Requirements. The stack CAM must operate continuously while the exhaust systems are operating and must be capable of alarming and shutting down the exhaust fan when radiation levels above background are detected in the stack.

4.3.7.4 System Evaluation.

Performance Criteria: The stack CAMs shall operate continuously during ventilation system operation and shall actuate the alarm on failure. Interlocks shall be operational at all times the system is functional.

System Evaluation: The stack CAMs and interlocks are existing and operational on the operating exhausters associated with the WRSS. All WRSS-related stack CAMs and interlocks have been upgraded to meet flammable gas ignition control requirements (FSAR Appendix K). CAMs and interlocks will be evaluated as described in Section 4.2. The CAMs and interlocks shall be calibrated and verified to be operable prior to waste transfers. The interlocks must be ensured operable during transfers out of the facility and during tank farm transfers through routes physically connected to the unloading facility.

4.3.7.5 Controls (TSRs). The assumptions in the Section 3.4.2.16 accident analysis are that the CAMs with interlocks are provided on all ventilation stacks, and that the CAMs and their associated alarms and interlocks are operable and operating during and following a spray leak from the structure that results in damage to the HEPA filters. The operability function includes (1) the vacuum pump operates as designed, (2) isokinetic sampling conditions are maintained, (3) the CAMs accurately measure radionuclide levels in the sample, (4) the CAMs are properly set to actuate interlocks when high radionuclide levels are detected, (5) the interlocks perform as required, and (6) local and remote alarms, both visual and audible, are actuated by failure of the CAMs.

4.4 SAFETY-SIGNIFICANT STRUCTURES, SYSTEMS, AND COMPONENTS

This section provides information about the Safety-Significant SSCs identified in Chapter 3.0. Refer to Section 4.3 for the description of Safety-Significant SSCs that are also designated as Safety-Class SSCs with a common safety function. Table 4-2 provides a summary list of the Safety-Significant SSCs. Details of each unique Safety-Significant SSC, correlating to the information in Table 4-2, follow.

4.4.1 Stack Continuous Air Monitor Interlocks

The stack CAM interlocks are designated as Safety-Significant for the "HEPA Filter Failure Due to Exposure to High Pressure or High Temperature," Section 3.4.2.2 and "Unfiltered Release" (Section 3.4.2.3) accident scenarios.

4.4.1.1 Safety Function. The safety function of the stack CAM interlock systems for the accident scenarios presented in Sections 3.4.2.2 and 3.4.2.3 is to prevent the unfiltered ventilation system release from occurring for more than 10 minutes for the 241-A-702 (if returned to service), and 241-AZ-702 ventilation systems on Tank 241-AY-102, and for more than 10 minutes for the 296-C-006 and 296-P-16 ventilation systems on Tank 241-C-106.

4.4.1.2 System Description. The stack CAMs continuously monitor the exhaust air while the ventilation systems are in operation. The CAMs measure the radiation level in the exhaust stream and shut down (through an interlock) the appropriate ventilation system when a predetermined level is reached. The CAMs shall also activate an alarm or shut down the exhaust system in the event of CAM failure.

Supporting SSCs include the electrical power for the CAM, the interlock, the alarm, any instrument cabinet heaters, and freeze protection for the CAM gas tubing.

4.4.1.3 Functional Requirements. The stack CAMs must operate continuously while the exhaust systems are operating. The CAM interlocks are located some distance downstream of the filter location and are expected to be unaffected by the initiator of the HEPA filter failure. The ventilation stack CAMs shall be interlocked to the fans to ensure ventilation system shut-off within 10 minutes for the Tank 241-AY-102 and Tank 241-C-106 ventilation systems.

4.4.1.4 System Evaluation. The stack CAMs shall be calibrated prior to WRSS operations and periodically as required.

4.4.1.5 Controls (TSRs). The assumptions in the HEPA filter failure accident described in Section 3.4.2.2 and credited in Section 3.4.2.3 are that the CAMs are provided on all exhaust stacks, and that the CAMs and their associated alarms and interlocks are operable and operating. The operability assumptions include (1) vacuum pumps operate as designed, (2) isokinetic sampling conditions are maintained, (3) CAMs accurately measure radionuclides in the sample, (4) CAMs are properly set to actuate interlocks when high radionuclide levels are detected, (5) interlocks perform as required, and (6) local and remote alarms, both visual and audible, are actuated by failure of the CAMs.

4.4.2 Tank Level Detection System

The primary tank level detection systems are designated as Safety-Significant SSCs for the subsurface leak remaining subsurface (Section 3.4.2.13), subsurface leak resulting in a pool (Section 3.4.2.14), and surface leak resulting in a pool (Section 3.4.2.15) accident scenarios.

4.4.2.1 Safety Function. The safety function of the tank (primary) level measurement system is to provide measurements used in the performance of material balance calculations between transfer batches. The calculations are used to detect discrepancies during transfers to detect leaks or misroutes.

4.4.2.2 System Description. Each system includes at least one level detector, which may be a manual tape, an FIC gauge, an ENRAF gauge, or a set of dip tubes.

4.4.2.3 Functional Requirements. The level detection systems are required to measure tank waste levels and to transmit the data to local and/or remote level indicators.

4.4.2.4 System Evaluation. Tank level detection systems shall measure waste levels with an accuracy of ±1.3cm (±0.5in.) and will be verified operable prior to WRSS operations.

4.4.2.5 Controls (TSRs). The assumption in the Chapter 3.0 accident analyses is that the level monitoring systems will be operable and operating when they are needed to perform their safety function. The operability assumption includes (1) calibration of level detection instruments and indicators is properly performed and is kept current, and (2) level readings are taken and/or recorded at intervals that will allow early detection of leaks or misroutes into Tanks 241-C-106 and 241-AY-102. NOTE: The level detection system for Tank 241-C-106 will be raised during this operation.

4.4.3 Backflow Preventers

The backflow preventers for the slurry from Tank 241-AY-102 are identified as Safety-Significant SSCs for the surface leak resulting in a pool (Section 3.4.2.15) and spray leak from structure (Section 3.4.2.16) accident scenarios.

4.4.3.1 Safety Function. The safety function of the backflow prevention devices is to prevent back flow of waste into the service water system (e.g., tankers, trucks).

4.4.3.2 System Description. The backflow preventer consists of two valves that prevent backflow into the service water system. At the AY Farm, a temporary manual valve and check valve are added to the connection.

4.4.3.3 Functional Requirements. Backflow prevention devices shall be installed in accordance with the manufacturer's instructions. The rated pressure of the backflow preventer shall exceed the maximum pressure of the system in which it is installed.

4.4.3.4 System Evaluation. They shall be operated within their design limits (e.g., maximum operating pressure) as certified by the manufacturer.

4.4.3.5 Controls (TSRs). TSR controls are not required to ensure the functionality of backflow preventers (Section 5.3.3.3).

4.5 REFERENCES

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HNF-SD-WM-CN-114, 1997, *Calculation Note: Project W-320 Primary Ventilation Air Flow Requirements for Mitigation of Steady State Flammable Gas Concentrations in the Headspaces of Tanks 241-C-106 and 241-AY-102*, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-SD-W320-ER-004, 1998, *Project W-320 SAR and Process Control Thermal Analysis*, Rev. 1, Numatec Hanford Company, Richland, Washington.

HNF-SD-W320-FDC-001, 1998, *Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320*, Rev. 5, Fluor Daniel Hanford, Inc., Richland, Washington.

HPS-SDC-4.1, 1988, *Standard Architectural-Civil Design Criteria*, Westinghouse Hanford Company, Richland, Washington.

Table 4-1. Safety-Class Structures, Systems, and Components.

SSC	Accident(s)	Safety Functions	Functional Requirements	Operability criteria for TSRs
Annulus ventilation system (Tank 241-AY-102)	Tank Bump, Section 3.4.2.11.	Provides waste temperature cooling ability to maintain tank waste temperatures below local saturation temperature.	Provide annulus space ventilation flow for cooling of the waste in Tank 241-AY-102.	The operability of the annulus ventilation system shall be verified prior to sluicing and periodically thereafter.
Primary tank ventilation systems (Tank 241-C-106/ 241-AY-102)	Flammable Gas Deflagration, Section 3.4.2.8; Tank Bump, Section 3.4.2.11.	Maintain flammable gas concentrations below 25% of the LFL. Provides waste temperature cooling ability to maintain tank waste temperatures below local saturation temperature.	Maintain the ventilation flow rates as required by operational procedures. Provide ventilation flow for cooling.	Operability must be verified prior to WRSS operations.
Primary tank leak detection system	Flammable Gas Deflagration, Section 3.4.2.8; Surface Leak Resulting in a Pool, Section 3.4.2.15.	Provides indication that waste has leaked into the annulus space.	Detect a specified depth of waste in the annulus area and provide an audible alarm signal and annunciator panel light.	Operability must be verified prior to WRSS operations.
Transfer line pipe-in-pipe encasement	Subsurface Leak Resulting in a Pool, Section 3.4.2.14; Surface Leak Resulting in a Pool, Section 3.4.2.15; Spray Leak from Structure, Section 3.4.2.16.	Ensures that a leak in the primary waste transfer system piping is contained and directed to a waste transfer-associated structure.	Route the waste from the leaking primary pipe to the pit.	Shall be verified operable prior to WRSS operations.
Transfer leak detection system	Subsurface Leak Resulting in a Pool, Section 3.4.2.14;Surface Leak Resulting in a Pool, Section 3.4.2.15.	Detect leaks in transfer associated structures (pits).	Shall be capable of detecting leak and activating an alarm leading to operator shutdown of the transfer	Shall be verified operable prior to WRSS operations.
Transfer system covers	Spray Release from Structure, Section 3.4.2.16.	Mitigate the effect of a spray leak within the transfer pits. Limit release of aerosols generated by splatter inside the pit; limit shine and skyshine dose to onsite receptor.	The covers must be capable of limiting the splatter of a spray release and mitigating the release of aerosols.	Transfer system covers must be installed during waste transfers.
Stack CAM and interlock to exhaust fan 241-A-702/ 241-AZ-702 296-P-16/296-C-006)	Spray Leak From Structure, Section 3.4.2.16.	Shut down exhaust fan should exhaust HEPA filters break through.	Shall be capable of detecting a predetermined level of radiation in the exhaust stream and shut down the ventilation system.	Shall be calibrated and verified operable prior to WRSS operations.

CAM = continuous air monitor. HEPA = high-efficiency particulate air (filter). TSR = Technical Safety Requirement. WRSS = Waste Retrieval Sluicing System.

Table 4-2. Safety-Significant Structures, Systems, and Components. (2 sheets)

SSC	Accident(s)	Safety Functions	Functional Requirements	Operability Criteria for TSRs
Annulus ventilation system (Tank 241-AY-102)	Unfiltered release 3.4.2.3	Provides waste temperature cooling ability to maintain tank waste temperatures below local saturation temperature.	Provide annulus space ventilation flow for cooling of the waste in Tank 241-AY-102.	The operability of the annulus ventilation system shall be verified prior to sluicing and periodically thereafter.
Primary tank ventilation systems (Tank 241-C-106/ 241-AY-102)	Unfiltered Release 3.4.2.3	Provides waste temperature cooling ability to maintain tank waste temperatures below local saturation temperature.	Maintain the ventilation flow rates as required by operational procedures Provide ventilation flow for cooling	Operability must be verified prior to WRSS operations
CAM interlocks on ventilation systems (241-A-702/ 241-AZ-702/ 296-P-16/ 296-C-006)	HEPA Filter Failure, Section 3.4.2.2; Unfiltered Release, Section 3.4.2.3.	Shut down the ventilation system in the event that a HEPA filter fails, and prevent an unfiltered release to the atmosphere for more than a specified time.	Continuously monitor exhaust air while the ventilation system is in operation. Measure the radiation level in the exhaust stream and shut down the ventilation system when a predetermined level is reached. The CAMs shall also activate an alarm or shut down the exhaust system in the event of CAM failure.	CAMs shall be inspected and tested in accordance with existing Hanford Site procedures.
Tank level detection systems	Subsurface Leak Remaining Subsurface, Section 3.4.2.13; Subsurface Leak Resulting in a Pool, Section 3.4.2.14; Surface Leak Resulting in a Pool, Section 3.4.2.15.	Provide tank level indication to support material balance calculations between transfer batches.	Provide level readouts within a specified tolerance.	Shall be verified operable prior to WRSS operations.
Transfer leak detection systems	Subsurface Leak Remaining Subsurface, Section 3.4.2.13	Detect leaks in transfer associated structures (pits).	Shall be capable of detecting leak, and activating an alarm, leading to operator shutdown of the transfer.	Shall be verified operable prior to WRSS operations.
Transfer line pipe-in-pipe encasement	Subsurface Leak Remaining Subsurface, Section 3.4.2.13	Ensures that a leak in the primary waste transfer system piping is contained and directed to a waste transfer-associated structure.	Route the waste from the leaking primary pipe to the pit.	Shall be verified operable prior to WRSS operations.
Transfer system covers	Surface Leak Resulting in a Pool, Section 3.4.2.15	Limit release of aerosols generated by splatter inside the pit; limit shine and skyshine dose to onsite receptor	Pit structures and covers provide a mitigative safety function to limit releases.	Shall be in place during WRSS operations.

Table 4-2. Safety-Significant Structures, Systems, and Components. (2 sheets)

SSC	Accident(s)	Safety Functions	Functional Requirements	Operability Criteria for TSRs
Backflow preventers	Surface Leak Resulting in a Pool, Section 3.4.2.15; Spray Leak from Structure Section 3.4.2.16.	Safety-Significant to prevent general contamination of service water supply systems.	Backflow prevention devices shall be installed in accordance with the manufacturer's instructions. The rated pressure of the backflow preventer shall exceed the maximum pressure of the system in which it is installed.	Backflow prevention devices shall be functionally tested and shall be verified to be operating correctly.

CAM = continuous air monitor.
HEPA = high-efficiency particulate air (filter).
SSC = structure, system, and component.
TSR = Technical safety requirement.
WRSS = Waste Retrieval Sluicing System.

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CHAPTER 5.0

DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

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CHAPTER 5.0
DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

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5.0 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 INTRODUCTION

The necessary preventive and mitigative features determined to be essential for the Waste Retrieval and Sluicing System (WRSS) in Chapter 3.0 and from the designation of Safety-Class and Safety-Significant features in Chapter 4.0 of this Addendum are identified in this chapter. Information necessary for preparing the separate Technical Safety Requirement (TSR) document (HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*) required by DOE 5480.22, *Technical Safety Requirements*, is also provided in this chapter.

TSRs define acceptable conditions, safe boundaries, and management or Administrative Controls (ACs) that ensure safe operation of a nuclear facility and reduce the potential risk to the public and onsite workers from uncontrolled releases of radioactive or other hazardous material or from radiation exposures caused by inadvertent criticality (DOE 5480.22).

This chapter consists of summaries and references to pertinent sections of the main text of the FSAR and this Addendum that describe design and Administrative Control (AC) features needed to prevent or reduce the consequences of an accident specific to the WRSS. The Safety Limits (SLs), Limiting Control Settings (LCSs), Limiting Conditions for Operation (LCOs), Surveillance Requirements, ACs, and Design Features form the basis of the TSR document and provide the logical link between the TSRs and the main text of the FSAR and this Addendum.

This chapter includes the following:

- Qualitative and quantitative TSR selection criteria
- Operational modes that designate distinguishable facility configurations
- Derivation of minimum staffing levels for each operational mode
- Derivation discussion of the TSR controls selected
- A list of design features not covered by the TSRs
- Identification of TSR interfaces with other Tank Waste Remediation System (TWRS) and Hanford Site facilities and the controls
- Tables that link the hazard and accident analyses and the TSRs
- A table that provides cross-references to other chapters in this Addendum

5.2 REQUIREMENTS

The primary requirements specific for this chapter, the hazard and accident analyses, and the TSR document are included in DOE 5480.22 and DOE 5480.23, *Nuclear Safety Analysis Reports*.

5.3 TECHNICAL SAFETY REQUIREMENTS COVERAGE

5.3.1 Summary

The suite of TSRs for analyzed hazards/accidents for the WRSS operations is summarized in Table 5-1. This table lists TSR controls per the accident analyses in Chapter 3.0 and the evaluation of safety structures, systems, and components (SSCs) in Chapter 4.0, "Safety Structures, Systems, and Components," of this Addendum. It also provides a brief derivation basis for each control related to the specific accident. Table 5-1 is written to provide a road-map to the respective accident analysis section or to Section 5.5, "Technical Safety Requirement Derivation," where derivation details are arranged by TSR control.

The required TSR controls for the WRSS are necessary and prudent for public safety, significant Defense-in-Depth, significant worker safety, and for preventing and mitigating radiological and toxicological consequences.

Worker safety for the WRSS is covered by integrated safety management programs (e.g., HNF-SD-WM-HSP-002 *Tank Farms Health and Safety Plan* [HASP]). These safety programs described in the HASP reduce the likelihood and potential impacts of events and are covered by their respective regulatory and contractual systems of basic requirements. Therefore, these programs are not repeated as AC programs in the TSR document. A cross-reference to the other chapters in this Addendum is provided in Table 5-2. DOE 5480.22 requires the TSR document to include AC programs for nuclear criticality safety, organization and management (including minimum staffing), and occurrence reporting at a minimum.

5.3.2 Criteria

The Executive Summary and other appropriate sections of the FSAR main text discuss the control selection process from initial hazard analysis identification to selection of hardware or administrative programs for controls. The section below outlines the criteria that were considered in control selection. These criteria were also used for the WRSS.

5.3.2.1 Control Selection Criteria. The following elements were considered in selection of controls for the WRSS to the extent practical.

- **Contractor Management Directives, Policies, and Procedures**—Controls were not selected for environmental-only hazards unless the radiological or toxicological consequences exceed offsite or onsite

risk guidelines. Environmental controls for the WRSS are, however, discussed in Section 3.3.2.3.4 and listed in Table C-4 of this Addendum.

- **Analysis Assumptions**—Controls were selected to protect major assumptions that could be affected by an operating activity or equipment operation.

- **Sensitivity Analysis**—Controls were selected for less significant analysis assumptions if variability of the assumption significantly affected consequences.

- **Reliability**—Controls were selected for equipment systems that have demonstrated high reliability in the tank farm environment.

- **Optimization**—Controls were selected that could address multiple accidents to minimize implementation costs.

- **Priorities**—Controls were selected first, to prevent, then to mitigate; first, to involve passive systems, then actively engineered systems; and first, to use engineered controls, then administrative programs.

- **Practical Safety-Class/Safety-Significant Designation**—Controls were selected that would have value in being designated Safety-Class or Safety-Significant.

- **Risk Guidelines**—Controls were identified that would bring the frequency or consequences within acceptable risk guideline values when possible; the process was iterative and may require more than one control.

- **Conservatism**—Controls were selected to drive consequences further below risk guidelines for additional risk reduction.

- **Facility Worker Safety**—Controls were selected that would not significantly increase radiological or toxicological exposures to the facility worker.

- **Significant Defense-in-Depth**—Controls were selected from the suite of Defense-in-Depth items if they significantly minimized risk.

- **Operational Flexibility**—Controls were selected that minimized the need for additional operators or maintenance personnel.

- **Procedure Minimization**—Controls were selected that minimized the need for new or significantly modified operational or ACs.

- **Existing Hardware**—Controls were selected primarily for equipment systems that were in place.

- **Cost/Benefit**—Controls were selected, when new systems were needed, that minimized costs on a qualitative basis.

- **Impacts on TWRS Mission**—Controls were selected that minimized impact to characterization and stabilization activities.

- **Applicability/Consistency**—Controls were selected if they mirrored activities already in progress in the field.

5.3.3 Safety Structures, Systems, and Components Not Provided With Explicit Technical Safety Requirement Coverage

The Safety-Class and Safety-Significant SSCs for the WRSS that have not been provided with explicit TSR coverage include the WRSS Transfer System level detection, and backflow prevention. All other safety SSCs are provided with TSR coverage with an LCO or are included in an AC program. The bases for not providing TSR coverage are provided in the following paragraphs.

5.3.3.1 WRSS Transfer System. The WRSS transfer encasements are Safety-Class SSCs. There are no TSR controls for these safety SSCs, because they are passive Design Features, and their safety function is managed by configuration control processes. These SSCs were not credited as a control in the analysis but were identified as a key assumption in maintaining their encasements, directing leakage to leak detection systems. Leak detection systems are managed by the TSR control LCO 3.1.3, "Transfer Leak Detection Systems."

5.3.3.2 Tank Level Detection Systems. Tank level detection systems are Safety-Significant SSCs. There are no TSR controls for these safety SSCs because the accident analyses identified these as being needed only to support performance of material balance calculations during waste transfers according to AC 5.12, "Transfer Controls." Process and measuring and test equipment are further managed by AC 5.19, "Process Instrumentation and Measuring and Test Equipment."

5.3.3.3 Backflow Prevention. Backflow prevention devices are Safety-Significant. Requirements for backflow prevention devices are implemented by the Industrial Hygiene Program described in Chapter 8.0, "Hazardous Material Protection."

5.4 DERIVATION OF FACILITY MODES

5.4.1 Operational Modes

The operational modes (Operation and Limited) for TWRS facilities are included in the TSR document (HNF-SD-WM-TSR-006). The modes for Tank 241-C-106 and Tank 241-AY-102 during WRSS operations are the same as other single-shell and Aging Waste Facility (AWF) tanks and are defined as follows:

- **Operation**—Waste is being stored. Waste transfers to or from any tank are authorized. Routine operational and maintenance activities may be performed.

- **Limited**—Waste is being stored. Waste transfers to or from any tank are not authorized except in accordance with an approved recovery plan. Routine operational and maintenance activities may be performed.

A mode is the state of an individual tank at a given time. A particular support system may provide services for several individual tanks, with each tank operating in a different mode. Under these circumstances, the applicable mode for the support system is the most restrictive mode applicable to any of the tanks being provided with supporting services.

5.4.2 Minimum Staffing Levels

The minimum operations shift complement in the Operation and Limited Modes for TWRS facilities are included in the TSR document. They are one shift manager/operational engineer, five nuclear operators, two Radiological Control Technicians, and the Emergency Control Center staff. This minimum staff in each mode is considered adequate to perform the minimum safety functions necessary to protect the health and safety of the public, onsite workers, and the environment during normal operations, and abnormal and emergency conditions. The minimum staff does not include individuals necessary to support WRSS operations, therefore additional staff is required. Additional staff is necessary to establish continuous communications between the control rooms for Tanks 241-C-106 and 241-AY-102 during WRSS activities. During sluicing operations in accordance with AC requirements additional staff are required to perform additional surveillances in support of AC 5.18.

5.5 TECHNICAL SAFETY REQUIREMENT DERIVATION

This section details the level of control and derivation bases for the TSRs organized by control for WRSS. It can be used as an interface to link the accident analyses and the TSRs. It defines why WRSS controls were chosen.

Tables 5-1 and 5-2 provide road maps to controls or accident summaries depending on starting points. Table 5-1 is applicable if starting from accidents or Chapter 3.0 of this Addendum. Table 5-2 is applicable if starting from an overall summary of the remaining FSAR Addendum chapters.

All controls are discussed below except for ACs 5.1 through 5.6. Sections AC 5.1, "Purpose," AC 5.2, "Contractor Responsibility," and AC 5.3, "Compliance," define the need for the following AC provisions, and clarify responsibility per good management practice. These three controls could be rewritten as a preface to the AC section, but they were included in this format because they are recognizable to Operations personnel from past Operational Safety Requirements (OSRs). Sections AC 5.4, "Technical Safety Requirement Violation," AC 5.5, "Occurrence Reporting," and AC 5.6, "Organization," satisfy the requirements of DOE 5480.22, Section 9.3.(5). This DOE order section requires ACs for reporting deviations and identifying staffing requirements.

5.5.1 Level of Control Criteria

The section below outlines the criteria for determining the level of control; for example, when an AC is chosen over a Limiting Condition for Operation control. Generalized criteria may be found in U.S. Department of Energy (DOE) orders. The following criteria, while considered to meet the generalized order criteria, reflect an interpretive base determined by coordination with other DOE Site TSR writing personnel, a DOE-sponsored TSR training course, contractor procedures, reactor standard technical specifications (NUREG 1431, *Standard Technical Specifications, Westinghouse Plants*), the proposed TSR rule, and Site expertise. The criteria were used for the BIO TSRs and for the WRSS TSRs.

5.5.1.1 Safety Limits/Limiting Control Settings. There are no additional SLs for WRSS specific accidents. The criteria for selection of the SLs are:

- A primary passive barrier failed (e.g., tank, piping).
- Passive barrier failure was the direct result of exceeding a physical parameter.
- This physical parameter can be directly measured by field personnel.
- Radiological or toxicological consequences without controls exceeded offsite and onsite risk guidelines.

LCSs are setpoints on safety systems that control process variables to prevent exceeding SLs. The specific setpoints are chosen so that, if exceeded, sufficient time is available to automatically or manually correct the condition before exceeding SLs. The LCSs are usually combined with their respective LCOs. By combining the LCSs with the LCOs, the LCS setpoint becomes part of the operability of the system. Furthermore, placing the applicability, actions, and surveillances for a system in a single location enhances safety and reduces the complexity of the TSR document.

5.5.1.2 Limiting Conditions for Operation Versus Administrative Controls. Accidents/hazards exceeding offsite or onsite risk guidelines, that are not candidates for SLs per the criteria listed above, are candidates for either LCOs or ACs. ACs are considered as important to the control philosophy as LCOs; they are not treated as less meaningful controls for safety. An AC is selected over an LCO if the control is better controlled by a program than a direct measurement and ensuing action. The following comparison identifies the process used in determining the proper type of control for reduction of risk. This approach is consistent with the guidance in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, which states: "The decision as to whether an operating limit (such as an LCO) or a TSR AC is more appropriate is left to the judgment of the SAR Preparer."

- Parameter Measurement

  LCO—A process parameter or hardware is available for measurement by field operating or maintenance personnel and is available in real time or near to real time.

  AC—The control involves several parameters required for the accident to occur, or requires an analysis of field parameters by engineering or management personnel, or involves a parameter obtainable only by physical sampling requiring analytical delay time, or no measurement equipment is available.

- Control of Field Condition

  LCO—Hazard/accident results solely from exceeding a physically monitored parameter (e.g., continuous air monitor [CAM] interlock actuation).

  AC—Hazard/accident does not occur as a result of exceeding a physically monitored parameter but requires a combination of conditions to occur. Examples are: noncompliance with procedures, involvement of multiple organizations or personnel, or involving solely the corroboration of field information to protect accident analysis assumptions, or programmatic deficiencies.

- Response Action

  LCO—Exceeding a specific parameter requires immediate actions to reduce risk that are achievable through field personnel and resulting operating or maintenance procedures.

  AC—Exceeding parameter or condition either requires no immediate applicable actions to reduce risk, or actions are complex requiring evaluation and possible further data gathering, or actions solely involve emergency response personnel for mitigation.

- Surveillances

  LCO—Equipment or instrumentation is required to monitor a specific parameter, and it is appropriate to have surveillances to demonstrate operability.

  AC—Conditions leading to accident either cannot be measured by instrumentation; or surveillance intervals may be long because parameter of concern changes slowly; or a condition does not require immediate action, and sufficient recovery time exists to permit response action.

- Prior Control Method

  LCO—Hazard is currently controlled by an LCO or a lower-tiered control involving system(s) measurement and response.

  AC—Hazard is currently managed by an AC or other program.

5.5.2 LCO 3.1.1—Transfer System Covers and Entry Doors

5.5.2.1 Purpose. This control to ensure Transfer System Covers and Entry Doors operability is derived from the "Surface Leak Resulting in a Pool" accident in Section 3.4.2.15, and "Spray Leak from Structure accident in Section 3.4.2.16, for WRSS. The release of radioactive material without controls exceeds offsite and onsite radiological risk guidelines for both accidents. The release of toxicological material without controls exceeds the onsite risk guidelines for the spray leak from structure accident. Ensuring that transfer system covers are placed correctly over their associated structures (and the removable plugs are installed), in conjunction with the other controls selected, reduces the offsite consequences to meet or be within risk guidelines for both accidents and reduces the onsite consequences to within risk guidelines for the spray leak from structure by containing sprayed/splashed materials within the transfer system structure. The analysis in Sections 3.4.2.15 and 3.4.2.16 takes specific credit for the Transfer System Covers and Entry Doors when calculating consequences with controls.

This control is closely associated with "Transfer Pump Administrative Lock Controls" (AC 5.20) and "Transfer System Cover Removal Controls" (AC 5.22). Since surface leaks and spray leaks are improbable when their motive force is removed via administrative locks on pumps, as outlined within AC 5.20, Transfer System Cover operability controls are relaxed (i.e., not applicable) under these conditions. Surface leaks and spray leaks are likewise improbable when multiple isolation valves separate the transfer path and the structure of concern. In this situation, an alternate (and less stringent) control, as outlined within AC 5.22, is allowed in lieu of the Transfer System Cover and Entry Doors control.

5.5.2.2 Derivation Criteria. This control was selected because it takes advantage of existing hardware; Transfer system covers are already an integral part of transfer structure design. In addition, implementation of this control minimizes modifications needed to administrative procedures, as the process for the inspection of Transfer system covers associated with planned transfers is already a part of existing procedures.

5.5.3 LCO 3.1.3—Transfer Leak Detection Systems

5.5.3.1 Purpose. This control is required for the "Subsurface Leak Remaining Subsurface," Section 3.4.2.13, the "Subsurface Leak Resulting in Pool," Section 3.4.2.14 and the "Surface Leak Resulting in a Pool," Section 3.4.2.15 accidents for WRSS. Ensuring that transfer leak detection systems are operable reduces offsite consequences of the surface leak accident to meet the risk guidelines by limiting the amount of waste material released. This is

accomplished by a combination of alarm and operator response to shut down associated transfer pumps, thus removing the motive force behind the leak and limiting further leakage. The onsite consequences still remain above risk guidelines for the surface leak resulting in a pool. This control reduces the consequences to below the onsite radiological risk guidelines for the subsurface leaks.

This control is closely associated with the "Transfer Pump Administrative Lock Controls" (AC 5.20). Since subsurface leaks and surface leaks are improbable when their motive force is removed via administrative locks on pumps, as outlined within AC 5.20, transfer leak detection system operability controls are relaxed (i.e., not applicable) under these conditions.

5.5.3.2 Derivation Criteria. This control was selected because it protects the analysis assumptions and uses existing hardware. Transfer leak detection systems are already installed in all transfer-related structures.

5.5.4 LCO 3.1.4 Ventilation Stack Continuous Air Monitor Interlock Systems

5.5.4.1 Purpose. This control applies to the following accident scenarios: (1) spray leak from structure in Section 3.4.2.16; (2) high-efficiency particulate air (HEPA) filter failure—exposure to high temperature or pressure in Section 3.4.2.2; and (3) unfiltered release in Section 3.4.2.3. Based on the results of the spray leak analysis, the release of radioactive material without controls could exceed offsite and onsite risk guidelines and the onsite risk guidelines for the release of toxicological material. The ventilation stack CAM interlock to the ventilation system exhaust fan is credited in the analysis with stopping the ventilation system thereby terminating an unfiltered release. This control applies to spray leaks inside actively ventilated tanks. This action reduces the potential consequences of a pressurized spray leak event during transfers to maintain radiological consequences below risk guidelines.

Based on the results of the HEPA filter failure analysis and the unfiltered release analysis, the release of radioactive material without controls could exceed onsite risk guidelines. The ventilation stack CAM interlock that detects potential HEPA filter failure and unfiltered release and shuts off the ventilation system exhaust fan within 10 minutes for Tank 241-C-106 is credited in the analysis with stopping the ventilation system and terminating an unfiltered release. This action reduces the potential consequences of an unfiltered release to maintain radiological consequences equal to or below risk guidelines when a HEPA filter fire occurs or a high-pressure event occurs that impacts the HEPA filter.

A related control is AC 5.18, "HEPA Filter Controls." It requires verification that the HEPA filter and prefilter housing radiation levels are less than or equal to 200 mrem/h. This control also requires verification that the radiological dose contribution of the 296-C-006 HEME and HEMF is below 100 mrem/h, requires the 241-AZ-702 system HEGA filters to be changed before the upstream HEPA filter in the associated filter train has been replaced 20 times, or upon indication of degraded HEPA filter performance, and

requires efficiency testing of the HEPA filters upstream of the HEGA filters. This protects a key accident analysis assumption used to calculate the quantity of waste material accumulated on the filters based on the radionuclide content, thereby limiting the inventory on the filters available for release.

5.5.4.2 Derivation Criteria. The ventilation stack CAM interlock systems were selected as the controls because the analysis with controls assumes the ventilation system shuts off within 10 minutes, thereby terminating the unfiltered release. Based on human factor considerations, it is not feasible to have operator monitoring and subsequent response actions within 10 minutes, therefore, it was necessary to rely on an automatic feature to shutdown the ventilation flow through an unfiltered pathway. The CAM interlock was selected because it exists for the majority of applications where the control is required or could be installed where only a CAM alarm currently is available.

Although the accident analysis did not assume a specific setpoint for CAM interlock actuation it did assume that the CAM interlock will actuate on increasing radiation level. The functional requirement is that the CAM activates an interlock after detecting a radiation level that exceeds the preset level based on normal operating practices. Since a specific setpoint was not identified in the analysis, a setpoint of 10,000 cpm was selected, based on normal operating practice and to allow flexibility in adjustment of the setpoint based on radon decay products. Normal setpoint ranges are 4,000-6,000 cpm to allow activation just above background.

5.5.5 LCO 3.2.1—Double-Shell Tank and Aging Waste Facility Tank Ventilation Systems

5.5.5.1 Purpose. This control derives from the flammable gas deflagrations accident in Section 3.4.2.8 for the WRSS and the main text of the FSAR. The release of radioactive material without controls could exceed onsite risk guidelines and offsite risk guidelines for certain scenarios. Maintaining the 241-AY-102 primary tank ventilation system in conjunction with the "Primary Tank Leak Detection Systems" (LCO 3.2.6), "Flammability Controls" (AC 5.9), "Ignition Controls" (AC 5.10), "Flammable Gas Monitoring Controls" (AC 5.11), and "Emergency Preparedness" (AC 5.14) reduces the risk from the steady state release, accumulation and ignition of flammable gases. Due to technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the TWRS FSAR, the risk reduction in unquantified. In addition, for "Tank Bump" accident (Section 3.4.2.11) and "Unfiltered Release" accident (Section 3.4.2.3), primary tank ventilation provides adequate cooling capacity in Tank 241-AY-102 in conjunction with the LCO 3.3.3, "Tank 241-AY-102 Annulus Ventilation System" and AC 5.25, "Ventilation Controls." Maintaining temperature below local saturation temperature prevents the tank bump and unfiltered release accidents.

5.5.5.2 Derivation Criteria. Although the historical requirements related to active ventilation of the primary tanks were not established to control flammable gases, available gas sample results indicate that flammable gas concentration in all sampled tanks are less than 5% of the lower flammability

limit (LFL). These controls require near constant operation of the exhausters for the primary tank ventilation system for DSTs and AWF tanks. Therefore, one of the key elements of the flammable gas control strategy is the use of currently installed active ventilation systems on the primary tanks to dilute and remove flammable gases that are continuously released from stored waste. The DST and AWF tank ventilation systems were selected because the existing systems have demonstrated the necessary operational performance. The ventilation system is credited with providing a flow rate in the headspace that maintains the steady-state flammable gas concentration well below the LFL.

5.5.6 LCO 3.2.2—Single-Shell Tank Ventilation Systems-Active

5.5.6.1 Purpose. This control applies to the flammable gas deflagrations accident in Section 3.4.2.8 for the WRSS. The release of radioactive material without controls could exceed onsite risk guidelines and offsite risk guidelines for certain scenarios. Maintaining the active SST ventilation systems in conjunction with "Flammability Controls" (AC 5.9), "Ignition Controls" (AC 5.10), "Flammable Gas Monitoring Controls" (AC 5.11), and "Emergency Preparedness" (AC 5.14) reduces the risk of a flammable gas deflagration, but due to the technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the FSAR, the risk reduction is unquantified. In addition, for "Tank Bump" accident (Section 3.4.2.11) and "Unfiltered Release" accident (Section 3.4.2.3), Tank 241-C-106 Ventilation System provides cooling capacity in conjunction with AC 5.26, "Tank 241-C-106 Waste Temperature Controls."

5.5.6.2 Derivation Criteria. This control was selected because it took credit for an existing system that had demonstrated the necessary operational performance. Although the historical requirements related to active ventilation of the SSTs with active ventilation systems were not established to control flammable gases, available gas sample results indicate that flammable gas concentrations in all sampled tanks are less than 5% of the LFL. These controls require near-constant operation of the exhausters for the SSTs with active ventilation systems. Therefore, one of the key elements of the flammable gas control strategy is the use of currently installed active ventilation systems on the tanks to dilute and remove flammable gases that are continuously released from stored waste. The ventilation system is credited with maintaining the steady-state flammable gas concentration well below the LFL.

5.5.7 LCO 3.2.6—Primary Tank Leak Detection Systems

5.5.7.1 Purpose. This control is applicable to two accident scenarios: flammable gas deflagrations in Section 3.4.2.8, and surface leak resulting in a pool in Section 3.4.2.15 for the WRSS. For flammability scenarios the release of radioactive material without controls could exceed onsite risk guidelines and offsite risk guidelines for certain scenarios. Maintaining the primary tank leak detection systems in conjunction with the "DST and AWF Tank

Ventilation Systems" (LCO 3.2.1), "Flammability Controls" (AC 5.9), "Ignition Controls" (AC 5.10), "Flammable Gas Monitoring Controls" (AC 5.11), and "Emergency Preparedness" (AC 5.14) reduces risk but due to technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the FSAR, the risk reduction is unquantified.

Based on the results of the analysis for the surface leak resulting in a pool, the release of radioactive material without controls could exceed the offsite and onsite radiological risk guidelines. Maintaining the primary tank leak detection systems in conjunction with the "Transfer Controls" (AC 5.12), "Transfer System Covers and Entry Doors" (LCO 3.1.1), "Transfer Leak Detection Systems" (LCO 3.1.3), "Emergency Preparedness" (AC 5.14), "Excavation Controls" (AC 5.17), "Transfer Pump Administrative Lock Controls" (AC 5.20), and "Transfer System Cover Removal Controls" (AC 5.22) reduces the consequences to meet the risk guidelines for offsite, and the onsite radiological consequences are still above the risk guidelines. Primary tank leakage detection controls are credited in the analysis to provide operators information on potential waste accumulation in the annulus from a transfer system leak. This allows termination of the transfer before the annulus overflows to produce a surface pool.

5.5.7.2 Derivation Criteria. The primary tank leak detection systems were selected as the controls because they took credit for an existing system that had demonstrated the necessary operational performance. The primary tank leak detection system consists of either a CAM that detects the presence of airborne radionuclides in the annulus ventilation exhaust stream or a conductivity probe leak detection system installed in the annulus between the primary and secondary tanks on DSTs and AWF tanks. The primary tank leak detection system will detect primary tank leakage as well as waste infiltration to the annulus.

5.5.8 LCS/LCO 3.3.1—Single-Shell Tank Waste Temperature Controls

5.5.8.1 Purpose. These controls for Tank 241-C-106 are required based on the accident analysis for a tank bump in Section 3.4.2.11, liner breach caused by steam between the liner and concrete shell in Tank 241-C-106 accident scenario in Section 3.4.2.12, and unfiltered release in Section 3.4.2.3. For the tank bump and liner breach accidents, consequences could exceed offsite and onsite radiological risk guidelines and exceed onsite toxicological guidelines. For the unfiltered release accident, consequences could exceed onsite radiological risk guidelines. Temperature controls for Tank 241-C-106 during and after WRSS operations to prevent an unfiltered release or a liner breach due to steam between the steel liner and concrete shell are included in AC 5.26, "Tank 241-C-106 Waste Temperature Controls." A liner breach because of steam under the liner could cause a rapid steam pressurization of the tank headspace. AC 5.26 establishes a new saturation temperature during and after WRSS operations to prevent a liner breach. An unfiltered release could occur because of overheating of the tank. Ventilation controls to inspect portions of the ventilation ductwork on Tank 241-C-106, to prevent an unfiltered release, are included in AC 5.25, Ventilation Controls."

The controls for waste temperature prevent exceeding temperatures at which tank bumps (including steam release events) could occur. Temperature controls reduce the probability of the accident. The waste temperature controls consist of waste temperature limits and monitoring. The monitoring systems provide operators with information on waste temperatures in tanks susceptible to a tank bump, and alert them to take actions necessary to prevent exceeding temperatures at which tank bumps can occur. Programmatic controls for the temperature monitoring systems in AC 5.19 are discussed in Section 5.5.21.

This control is closely associated with "SST Ventilation Systems-Active" (LCO 3.2.2). The active ventilation system for Tank 241-C-106 is one method to control waste temperature by removing heat from the tank headspace.

This control is also associated with "Transfer Controls" (AC 5.12). Transfer controls are imposed during WRSS operations to ensure that planned transfer parameters such as level and heat generation rate are consistent with existing tank conditions.

5.5.8.2 Derivation Criteria. Waste temperature controls were selected because temperature is the parameter of concern, is under the control of operations, and is monitored with existing systems. In addition, implementation of temperature controls minimizes modifications needed to administrative procedures, as the process for monitoring temperatures is already a part of existing procedures. Temperature can be controlled by a variety of methods (e.g., ventilation, engineered heat removal, limiting activities in the tank).

5.5.9 LCS/LCO 3.3.2—Double-Shell Tank and Aging Waste Facility Tank Waste Temperature Controls

5.5.9.1 Purpose. These controls for Tank 241-AY-102 are required based on the accident analyses for a tank bump in Section 3.4.2.11 (in this addendum) and unfiltered release in Section 3.4.2.3 (in this addendum). For the tank bump accident, consequences could exceed offsite and onsite radiological risk guidelines and onsite toxicological risk guidelines. For the unfiltered release accident, consequences could exceed onsite risk guidelines. An unfiltered release could occur because of overheating of the tank. Ventilation controls for Tank 241-AY-102 to prevent a tank bump (and unfiltered release) are included in AC 5.25, "Ventilation Controls."

The controls for waste temperature prevent exceeding temperatures at which tank bumps (including steam release events) could occur. Temperature controls reduce the probability of the accident. The waste temperature controls consist of waste temperature limits and monitoring. The monitoring systems provide operators information on waste temperatures in tanks susceptible to a tank bump, and alert them to take actions necessary to prevent exceeding temperatures at which tank bumps can occur. Programmatic controls for the temperature monitoring systems in AC 5.19 are discussed in Section 5.5.21.

This control is closely associated with "DST and AWF Tank Ventilation Systems" (LCO 3.2.1), and "Tank 241-AY-102 Annulus Ventilation System" (LCO 3.3.3). The active ventilation systems for Tank 241-AY-102 are the primary method to control waste temperature by removing heat from the tank headspace, sides, and bottom.

This control is also associated with "Transfer Controls" (AC 5.12). Transfer controls are imposed during WRSS operations to ensure that planned transfer parameters such as level and heat generation rate are consistent with existing tank conditions.

5.5.9.2 Derivation Criteria. Waste temperature controls were selected because temperature is the parameter of concern, is under the control of operations, and is monitored with existing systems. In addition, implementation of temperature controls minimizes modifications needed to administrative procedures, as the process for monitoring temperatures is already a part of existing procedures. Temperature can be controlled by a variety of methods (e.g., ventilation, engineered heat removal, limiting activities in the tank).

5.5.10 LCO 3.3.3-Tank 241-AY-102 Annulus Ventilation System

5.5.10.1 Purpose. This control for tank 241-AY-102 is required based on the accident analyses for a tank bump in Section 3.4.2.11 and unfiltered release in Section 3.4.2.3. For the tank bump accident, consequences could exceed offsite and onsite radiological risk guidelines and onsite toxicological risk guidelines. For the unfiltered release accident, consequences could exceed onsite radiological risk guidelines. An unfiltered release could occur because of overheating of the tank. Ventilation controls for Tank 241-AY-102 to prevent a tank bump (and unfiltered release) are included in AC 5.25, "Ventilation Controls."

The controls for waste temperature (LCO 3.3.2) prevent exceeding temperatures at which tank bumps (including steam release events) could occur. Temperature controls reduce the probability of the accident to within acceptable offsite and onsite risk guidelines. The waste temperature controls consist of waste temperature limits and monitoring. The annulus ventilation system provides a means to control waste temperature. The monitoring systems provide operators information on waste temperatures in tanks susceptible to a tank bump, and alert them to take actions necessary to prevent exceeding tank bump, and alert them to take actions necessary to prevent exceeding temperatures at which tank bumps can occur. Programmatic controls for the temperature monitoring systems in AC 5.19 are discussed in Section 5.5.21.

This control is closely associated with "DST and AWF Tank Ventilation Systems" (LCO 3.2.1). The active ventilation systems for Tank 241-AY-102 are the primary method to control waste temperature by removing heat from the tank headspace, sides, and bottom.

This control is also associated with "Transfer Controls" (AC 5.12). Transfer controls are imposed during WRSS operations to ensure that planned transfer parameters such as level and heat generation rate are consistent with existing tank conditions.

5.5.10.2 Derivation Criteria. This control is selected because the annulus ventilation system is used to control the temperature of the waste in Tank 241-AY-102. Temperature is the parameter of concern, is under the control of operations, and is monitored with existing systems. Temperature can be controlled by a variety of methods (e.g., ventilation, engineered heat removal, limiting activities in the tank).

5.5.11 AC 5.7—Nuclear Criticality Safety

5.5.11.1 Purpose. This control protects the accident analysis assumptions of the nuclear criticality accident in Section 3.4.2.1 for the WRSS. The bounding nuclear criticality accident is considered beyond extremely unlikely, therefore a quantitative accident analysis was not performed. Initial assumptions that were key to this conclusion were identified. The controls protect these initial condition assumptions.

5.5.11.2 Derivation Criteria. Several initial conditions were noted in the accident analysis. The controls included in the TSR represent those initial conditions necessary to protect key analysis assumptions, specifically, plutonium concentration subcriticality limit. An AC was appropriate because the controls apply to documenting criticality limits and controls in Criticality Safety Evaluation Reports and implementation in Criticality Prevention Specifications and procedures which are not under the direct control of the tank farm operator.

A nuclear criticality program is also required per DOE 5480.22, Section 9.e.(5) as one of the standard ACs. This control meets the intent of that requirement.

5.5.12 AC 5.9—Flammability Controls

5.5.12.1 Purpose. This control is required for the flammable gas deflagration accident in Section 3.4.2.8 for the WRSS. However, no change to this FSAR control was identified as a result of the WRSS accident analysis. Based on the results of the analysis for the flammable gas deflagrations in DSTs, the release of radioactive material without controls could exceed onsite risk guidelines and offsite risk guidelines for certain scenarios. Maintaining the flammability controls in conjunction with the "DST and AWF Tank Ventilation Systems" (LCO 3.2.1), "Primary Tank Leak Detection Systems" (LCO 3.2.6), "Ignition Controls" (AC 5.10), "Flammable Gas Monitoring Controls" (AC 5.11), and "Emergency Preparedness" (AC 5.14) reduces risk but due to technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the FSAR, the risk reduction is unquantified.

Based on the results of the analysis for the flammable gas deflagrations in SSTs, the release of radioactive material without controls could exceed onsite risk guidelines and offsite risk guidelines for certain scenarios. Maintaining the flammability controls in conjunction with the active SST ventilation systems (LCO 3.2.2), "Ignition Controls" (AC 5.10), "Flammable Gas Monitoring Controls" (AC 5.11), and "Emergency Preparedness" (AC 5.14) reduces risk but due to technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the FSAR, the risk reduction is unquantified.

5.5.12.2 Derivation Criteria. The administrative program for flammability controls is credited in the reduction of frequency of a flammable gas deflagration. This control identifies flammable gas Facility Group assignments for Tank 241-AY-102 and Tank 241-C-106.

5.5.13 AC 5.10—Ignition Controls

5.5.13.1 Purpose. This control applies to several WRSS accidents: fire in contaminated area in Section 3.4.2.4, flammable gas deflagrations in Section 3.4.2.8, organic solvent fire in Section 3.4.2.9, and in-tank fuel fire/deflagration in Section 3.4.2.10.

Based on the results of the analysis for the fire in contaminated area, the release of radioactive and toxic material without controls could exceed onsite risk guidelines. Maintaining the ignition controls in conjunction with "Emergency Preparedness" (AC 5.14) reduces the accident frequency below the risk guidelines.

Based on the results of the analysis for the flammable gas deflagrations, the release of radioactive material without controls could exceed onsite and offsite risk guidelines for most cases. Maintaining the ignition controls in conjunction with the "DST and AWF Tank Ventilation Systems" (LCO 3.2.1), the active SST ventilation systems (LCO 3.2.2), "Primary Tank Leak Detection Systems" (LCO 3.2.6), "Flammability Controls" (AC 5.9), "Flammable Gas Monitoring Controls" (AC 5.11), and "Emergency Preparedness" (AC 5.14) reduces risk but due to technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the FSAR, the risk reduction is unquantified.

Based on the results of the organic solvent fire analysis, the release of radioactive and toxic materials without controls could exceed onsite risk guidelines. Maintaining the ignition controls in conjunction with "Transfer Controls" (AC 5.12), "Emergency Preparedness" (AC 5.14), and "HEPA Filter Controls" (AC 5.18) does not reduce the accident frequency or consequences below the risk guidelines for all scenarios.

Based on the results of the analysis for the in-tank fuel fire/ deflagration, the release of radioactive and toxic materials without controls could exceed onsite risk guidelines. Maintaining the ignition controls in conjunction with Transfer Controls" (AC 5.12), "Emergency Preparedness" (AC 5.14), and "HEPA Filter Controls" (AC 5.18) does not reduce the frequency or consequences of the event to within risk guidelines.

5.5.13.2 Derivation Criteria. The administrative program to control ignition sources is credited primarily in the reduction of frequency of the accident scenarios for which the control was selected. The controls apply to fire in contaminated area, reducing the frequency to within risk guidelines; to flammable gas deflagrations, reducing the frequency; to organic solvent fire, reducing the frequency and protecting the facility worker with significant Defense-in-Depth key elements; and to in-tank fuel fire/deflagration, reducing the frequency and protecting the facility worker with significant Defense-in-Depth key elements.

5.5.14 AC 5.11—Flammable Gas Monitoring Controls

5.5.14.1 Purpose. This control applies to the flammable gas deflagration accident analysis presented in Section 3.4.2.8. The results of the analysis for the flammable gas deflagrations in DSTs indicate that the release of radioactive material without controls could exceed onsite risk guidelines and offsite risk guidelines for certain scenarios. Maintaining the flammable gas monitoring controls in conjunction with the "DST and AWF Tank Ventilation Systems" (LCO 3.2.1), "Primary Tank Leak Detection Systems" (LCO 3.2.6), "Ignition Controls" (AC 5.10), "Flammability Controls" (AC 5.9), and "Emergency Preparedness" (AC 5.14) reduces risk but due to technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the FSAR, the risk reduction is unquantified.

Based on the results of the analysis for the flammable gas deflagrations in SSTs, the release of radioactive material without controls could exceed onsite risk guidelines and offsite risk guidelines for certain scenarios. Maintaining the flammable gas monitoring controls in conjunction with the active SST ventilation systems (LCO 3.2.2), "Ignition Controls" (AC 5.10), "Flammability Controls" (AC 5.9), and "Emergency Preparedness" (AC 5.14) reduces risk but due to technical uncertainties related to this hazard, and the nature of the analysis contained in the main text of the FSAR, the risk reduction is unquantified.

5.5.14.2 Derivation Criteria. Flammable gas monitoring is used as part of the flammable gas hazard management strategy. These controls prevent the introduction of an uncontrolled or errant spark source into a location when and where flammable gas concentrations are above a level of concern for a fire, deflagration, or detonation. Therefore, flammable gas monitoring is required during manned activities, during certain unmanned activities, and upon loss of ventilation. These controls are credited in reducing the frequency of the flammable gas deflagration scenario and represents activities currently in progress in the tank farms.

The applicable key elements of AC 5.11 for WRSS are (a), (b) and (c). Key element (d) protects a key assumption associated with double-contained receiver tanks and does not apply to WRSS.

Key element (e) represents ignition control methodologies specific for WRSS operations. These actions are added because of the continued potential significant consequences of the flammable gas deflagration accident. The actions specified do not quantitatively control the consequences to below risk guidelines, but enhance facility worker protection.

5.5.15 AC 5.12—Transfer Controls

5.5.15.1 Purpose. This control applies to several WRSS accidents. The controls apply to organic solvent fire in Section 3.4.2.9, in-tank fuel fire in Section 3.4.2.10, tank bump in Section 3.4.2.11, liner breach due to steam between steel liner and concrete shell in Tank 241-C-106 in Section 3.4.2.12, subsurface leak remaining subsurface in Section 3.3.2.13, subsurface leak resulting in pool in Section 3.4.2.14, surface leak resulting in a pool in Section 3.4.2.15, and spray leak from structure in Section 3.4.2.16.

Based on the results of the in tank fuel fire and organic solvent fire analyses, the release of radioactive and toxic materials without controls could exceed onsite risk guidelines. Maintaining the transfer controls in conjunction with "Ignition Controls" (AC 5.10), "Emergency Preparedness" (AC 5.14), and "HEPA Filter Controls" (AC 5.18) does not reduce the accident frequency or consequences below the risk guidelines for all scenarios. The transfer controls include a compatibility evaluation to minimize the potential for introducing organic solvents into tanks.

Based on the results of the tank bump analysis, the release of radioactive material without controls could exceed onsite risk guidelines and offsite radiological risk guidelines. Maintaining the transfer controls (which require compatibility analysis and periodic evaluation of the amount of the heat-generating material transferred) in conjunction with "DST and AWF Ventilation Systems" (LCO 3.2.1), "SST Waste Temperature Controls" (LCO 3.3.1), "DST and AWF Tank Waste Temperature Controls" (LCO 3.3.2), "Tank 241-AY-102 Annulus Ventilation System" (LCO 3.3.3), "Ventilation Controls" (AC 5.25), "Process Instrumentation and Measuring and Test Equipment" (AC 5.19), and "Tank 241-C-106 Waste Temperature Controls" (AC 5.26) prevents the accident. The transfer controls include a compatibility evaluation to ensure that transfers do not produce conditions in a tank (e.g., high-sludge level and high heat load) so that, if tank cooling were inoperable, there would be a possibility of creating a tank bump before cooling was restored. The transfer controls also include a material balance after each sluicing batch of 12 hours maximum duration during sluicing to ensure that planned transfer parameters, such as level and heat generation rate, are consistent with existing tank conditions.

Based on the results of the liner breach due to steam between steel liner and concrete shell in Tank 241-C-106 accident, the consequences without controls could exceed onsite and offsite radiological risk guidelines and onsite toxicological risk guidelines. Maintaining transfer controls in conjunction with the "SST Waste Temperature Controls" (LCO 3.3.1), "Process Instrumentation and Measuring and Test Equipment" (AC 5.19), and

"Tank 241-C-106 Waste Temperature Controls" (AC 5.26) reduces the consequences below the risk guidelines. The transfer controls include a requirement to ensure that the final tank state is within analyzed conditions.

Based on the results of the subsurface leak remaining subsurface analysis, the release of radioactive material without controls exceeds onsite radiological risk guidelines. Maintaining the transfer controls in conjunction with "Transfer Leak Detection Systems" (LCO 3.1.3), "Encasement Seal Loop Controls" (AC 5.13) and "Transfer Pump Administrative Lock Controls" (AC 5.20), "Excavation Controls" (AC 5.17), and the design feature of the double-encased pipe reduce the consequences below the risk guidelines. The transfer controls include material balances, configuration management, independent route verification, and establishing communications between the control rooms for Tanks 241-C-106 and 241-AY-102. These controls minimize the potential for a misrouting and facilitate the detection of leakage.

Based on the results of the subsurface leak resulting in a pool analysis, the release of radioactive material without controls could exceed the offsite and onsite radiological risk guidelines. Maintaining the transfer controls in conjunction with "Transfer Leak Detection System," (LCO 3.1.3) and "Emergency Preparedness" (AC 5.14) reduces the consequences to meet the risk guidelines for offsite, and the onsite radiological consequences are still above the risk guidelines. The transfer controls include material balances, configuration management, independent route verification, and establishing communications between the control rooms for Tanks 241-C-106 and 241-AY-102. These controls minimize the potential for a misrouting and facilitate the detection of leakage.

Based on the results of the analysis for the surface leak resulting in a pool, the release of radioactive material without controls could exceed the offsite and onsite radiological risk guidelines. Maintaining the transfer controls in conjunction with the "Transfer System Covers and Entry Doors" (LCO 3.1.1), "Transfer Leak Detection Systems" (LCO 3.1.3), "Primary Tank Leak Detection Systems" (LCO 3.2.6), "Emergency Preparedness" (AC 5.14), "Excavation Controls" (AC 5.17), "Transfer Pump Administrative Lock Controls" (AC 5.20), and "Transfer System Cover Removal Controls" (AC 5.22) reduces the consequences to meet the risk guidelines for offsite, and the onsite radiological consequences are still above the risk guidelines. The transfer controls include material balances, configuration management, vehicle restrictions, cap/blanks on open nozzles, and establishing communications between the control rooms for Tanks 241-C-106 and 241-AY-102. These controls minimize the potential for a misrouting, overflows from a misrouting, and facilitate the detection of leakage.

Based on the results of the spray leak from structure analysis, the release of radioactive material without controls exceeds the offsite and onsite radiological risk guidelines and onsite toxicological risk guidelines. Maintaining the transfer controls in conjunction with the "Transfer System Covers and Entry Doors" (LCO 3.1.1), "Ventilation Stack CAM Interlock Systems" (LCO 3.1.4), "Encasement Seal Loop Controls" (AC 5.13), "Transfer Pump Administrative Lock Controls" (AC 5.20), and "Transfer System Cover Removal Controls" (AC 5.22) reduces the consequences below the risk guidelines. The transfer controls include configuration management, vehicle restrictions, and

independent route verification. These controls minimize the potential for a misrouting, facilitate the detection of leakage and protect the transfer lines from vehicle damage.

5.5.15.2 Derivation Criteria. The transfer controls were selected to reduce consequences below risk guidelines where possible, reflect current operational practices, protect the analysis assumptions, and use existing systems to the maximum extent possible.

5.5.16 AC 5.13—Encasement Seal Loop Controls

5.5.16.1 Purpose. This reduces the consequences of a leak in the primary piping by ensuring that material is directed into the pit and activates transfer leak detection. This protects key assumptions in the following two accidents: subsurface leak remaining subsurface (Section 3.4.2.13) and spray leak from structure (Section 3.4.2.16). This control ensures that if a leak occurred in primary piping it would be directed toward pit leak detection, and would not pressurize the encasement, causing a spray through abovegrade encasement test riser extensions or WRSS transfer system extensions.

5.5.16.2 Derivation Criteria. Leak detection, cover blocks, and transfer controls are the primary controls for the noted accidents. This control is specific since it protects a key assumption of plant configuration in the analysis; namely, that leaked material will be detected or that it will not cause pressurized conditions.

5.5.17 AC 5.14—Emergency Preparedness

5.5.17.1 Purpose. This control is required to respond to leaks on the surface to limit pool sizes per the subsurface leak resulting in a pool accident as specified in Section 3.4.2.14. This is the only accident where emergency response is required to reduce consequences. This control works together with LCO 3.1.3, "Transfer Leak Detection Systems" and AC 5.12, "Transfer Controls," to ensure minimal pool size and proper emergency response.

The control also represents a significant Defense-in-Depth item that is justifiably elevated to control status for mitigating the following pool and fire accidents: "Fire in Contaminated Area" (Section 3.4.2.4), "Flammable Gas Deflagrations" (Section 3.4.2.8), "Organic Solvent Fire" (Section 3.4.2.9), "In-Tank Fuel Fire/Deflagration" (Section 3.4.2.10), and "Surface Leak Resulting in a Pool" (Section 3.4.2.15). Because this control was originally a Defense-in-Depth item for these accidents, actual mitigation results are not quantified in the analyses.

5.5.17.2 Derivation Criteria. The subsurface leak resulting in a pool accident takes credit for evacuation of personnel from the vicinity of the pool. This activity is a programmatic response rather than an operator-directed event. It involves the coordination of several operational organizations and maintenance crafts, thus making emergency preparedness a logical programmatic control.

This control is also applied to those accidents where site conditions and controls degrade. Fire is an example of a situation where emergency responses activate facility worker protection controls (e.g., safety equipment) and protect Site personnel through fire-fighting and evacuation procedures. This control was selected for all of the fire-related accidents because, in a fire event, it is necessary to protect personnel before attempting to determine cause and subsequent actions. Likewise, for waste leak pools on the surface, this control helps isolate personnel to minimize exposures to radioactive and hazardous material. Lastly, this control requires the development of responses to earthquakes, thus ensuring proper protection of personnel and property and the public when earthquakes produce indeterminate damage or disrupt normal communications and safety controls.

5.5.18 AC 5.16—Dome Loading Controls

5.5.18.1 Purpose. This control minimizes the risk of dropping objects through pit floors and tank domes. This relates to the tank failure due to excessive loads (Section 3.4.2.6). Based on the results of the tank failure due to excessive loads analysis, the release would exceed the onsite radiological and toxicological guidelines without controls. The dome loading controls prevent the accident scenario from occurring.

5.5.18.2 Derivation Criteria. The controlling of lifted loads was detailed as an AC because the varied methodologies for control are limited to the use of streamers (tag lines), temporary barriers to restrict lift height, and the need for restrictions over certain vessels. Because the control requires several parameters, and because of the conservatisms in the analysis, exceeding 6 m (20-ft) does not directly cause the accident (e.g., no credit taken for piping or pumps within the pit). This is consistent with several of the criteria noted in Section 5.3.2.1. This control was chosen because of its minimal impact on operational activities.

The dome loading controls in AC 5.16 are a realistic summary. For example, there are no specific controls on snow or ash loading because these were noted in the analysis as being insignificant. Of great value for the analysis, however, is the requirement for baselining and managing changing loads. This detail protects the assumptions of the analysis.

5.5.19 AC 5.17—Excavation Controls

5.5.19.1 Purpose. This control protects the facility worker, as well as onsite and offsite personnel, from spray or pool consequences while excavating piping systems during a transfer. The WRSS accidents related to this control are subsurface leak remaining subsurface (Section 3.4.2.13), surface leak resulting in a pool (Section 3.4.2.15) and spray leak from an underground waste transfer line (Section 3.4.2.17). This accident is associated with the spray and pool scenarios, and the control strategy is preventive to minimize the probability of the excavation accident and mitigative to reduce consequences below risk guidelines.

5.5.19.2 Derivation Criteria. The control represents a broad selection of current operational activities to cover the varied contingencies during excavation activities. It does not rely solely upon an excavation permit process, since transfers could be initiated after proper completion of permitting. These activities involve a variety of field personnel and include several activities prior to actual excavation, thus qualifying this control as administrative.

5.5.20 AC 5.18—High-Efficiency Particulate Air Filter Controls

5.5.20.1 Purpose. These controls apply to several accidents for the WRSS. The controls apply to HEPA filter failure-exposure to high temperature or pressure (Section 3.4.2.2), unfiltered release (Section 3.4.2.3), flammable deflagrations (Section 3.4.2.8), organic solvent fire (Section 3.4.2.9) and in-tank fuel fire/deflagration (Section 3.4.2.10) to limit the radioactive inventory available for release from the HEPA filters that is assumed in the accident analysis.

Based on the results of the HEPA filter failure analysis and unfiltered release analysis, the release of radioactive material without controls could exceed onsite risk guidelines for DSTs and SSTs with active ventilation. The consequences are reduced by: (1) maintaining the HEPA filter and prefilter housing contact dose radiation level at less than or equal to 200 mrem/h; verifying that the radiological dose contribution of the 296-C-006 HEME and HEMF is below 100 mrem/h; requiring the 241-AZ-702 system HEGA filters to be changed before the upstream HEPA filter in the associated filter train has been replaced 20 times, or upon indication of degraded HEPA filter performance; and performing efficiency testing of the HEPA filters upstream of the HEGA filters, and (2) an operable CAM interlock, per LCO 3.1.4, that stops the ventilation system.

Based on the results of the organic solvent fire analysis and in-tank fuel fire/deflagration analysis, the release of radioactive material without controls could exceed onsite risk guidelines. Monitoring the ventilation system filter dose rates in conjunction with "Ignition Controls" (AC 5.10), "Transfer Controls" (AC 5.12), and "Emergency Preparedness" (AC 5.14) does not reduce the accident frequency or consequences below the risk guidelines for all scenarios.

5.5.20.2 Derivation Criteria. The HEPA filter control on radioactive loading was selected because it was a key analysis assumption and reflected current practices for filter monitoring and replacement. The control also applied to multiple accidents and reduced the consequence to within acceptable risk guidelines where possible.

5.5.21 AC 5.19—Process Instrumentation and Measuring and Test Equipment

5.5.21.1 Purpose. This provides a support control for the process instrumentation and measuring and test equipment used to verify that process

parameters comply with the TSRs when specific instrumentation and associated surveillances are not included in the TSR for the WRSS. This provides controls for the instrumentation used to monitor temperatures to comply with the tank bump analysis (Section 3.4.2.11), unfiltered release (Section 3.4.2.3) and the liner breach due to steam between steel liner and concrete shell in Tank 241-C-106 (Section 3.4.2.12), as well as instrumentation used to verify process parameters for the ACs in the TSR. This control on the process instrumentation and measuring and test equipment ensures that process parameters are properly monitored.

5.5.21.2 Derivation Criteria. This control was included because for some process parameters included in the TSR, it is not essential to specify the particular instrumentation or measuring equipment to demonstrate compliance with the process parameter, provided the instrumentation or equipment used to monitor the parameter is maintained. If the analysis credits a specific process parameter (e.g., temperature) but does not require specific instrumentation (e.g., credit is not taken for interlock actuation upon reaching the setpoint), then any instrumentation or measuring equipment can be used, provided it has the capability to monitor the required parameter. This support control was selected because it provides operational flexibility to use various instrumentation and equipment to measure TSR parameters, provided it complies with requirements of AC 5.19 while ensuring the safety functions assumed in the accident analysis are met.

5.5.22 AC 5.20—Transfer Pump Administrative Lock Controls

5.5.22.1 Purpose. The control to establish a program for administrative lock controls on waste transfer pumps is prompted by the WRSS accident analysis for a subsurface leak remaining subsurface (Section 3.4.2.13), surface leak resulting in a pool (Section 3.4.2.15), and spray leak from structure (Section 3.4.2.16).

When active transfer pumps are under administrative lock, the potential for pressurizing the transfer system is significantly decreased. This greatly reduces the risk of all three accidents identified above, as the motive force behind the accidents (i.e., a pressurized system) is eliminated.

This control is closely associated with a number of other controls: "Transfer System Covers" (LCO 3.1.1), and "Transfer Leak Detection Systems" (LCO 3.1.3). These controls are established based on the potential for leaks caused by the pressurization of the waste transfer system. Since leaks are improbable when their motive force is removed, these controls are relaxed (i.e., not applicable) when all physically connected transfer pumps are administratively locked per AC 5.20.

5.5.22.2 Derivation Criteria. An AC was selected because it is applicable to multiple accident scenarios, and is implemented and monitored similar to other lock programs onsite. This control reduces implementation costs, and allows operational flexibility, because implementation of this control allows relaxation of other transfer system leak-related controls while transfer pumps are administratively locked.

5.5.23 AC 5.22—Transfer System Cover Removal Controls

5.5.23.1 Purpose. The Transfer System Cover removal controls program is applicable to a surface leak resulting in a pool (Section 3.4.2.15), and spray leak from structure (Section 3.4.2.16). Without controls, the surface leak resulting in a pool and the spray leak have unacceptable onsite and offsite consequences.

When two or more closed valves in series separate the waste transfer route and a transfer system structure, the potential for waste leakage through the valves with sufficient pressurization of the piping to cause significant leakage within the structure is minimal. This greatly reduces the probability of the accidents identified above from occurring within the structure. In this situation, an alternative (and less stringent) control, using the Transfer System Cover removal control program, is allowed in lieu of the Transfer System Cover control.

5.5.23.2 Derivation Criteria. This control was selected because it allows operational flexibility through the relaxation of Transfer System Cover operability controls when a minimum of two closed valves in series separates the transfer route and the structure of concern. Because it involves monitoring of varied configurations rather than strict operability (though this is the prime definition for transfer cover operability), an AC format was selected.

5.5.24 AC 5.23—Caustic Transfer Controls

5.5.24.1 Purpose. This control minimizes the risk of a caustic spray leak. The caustic spray leak program is applicable to the accident analysis for a caustic spray leak (Section 3.4.2.5) for the WRSS. The caustic spray leak, when not controlled by TSR controls, is assumed to have onsite and offsite toxicological consequences.

Requiring sodium hydroxide cargo tanks to provide proof of DOT specification and restricting the operating pressure will decrease the potential for the cargo tank to rupture due to overpressurization. This reduces the probability of the accident occurring. Requiring traffic barriers also reduces the probability of the accident occurring.

5.5.24.2 Derivation Criteria. This control was selected because it represents a minimal cost to implement and it does not involve the installation of new equipment.

5.5.25 AC 5.25—Ventilation Controls

5.5.25.1 Purpose. The ventilation controls program is derived from the accident analyses for an unfiltered release (Section 3.4.2.3), and tank bump (Section 3.4.2.11) for the WRSS. Without controls, the unfiltered release exceeds the onsite radiological evaluation guidelines, and the tank bump

exceeds the onsite and offsite radiological evaluation guidelines and onsite toxicological evaluation guidelines.

With a visual inspection of aboveground recirculation ventilation ductwork for Tank 241-C-106 every 24 hours during sluicing, the potential for an unfiltered release through damaged ductwork is minimal. This greatly reduces the probability of the unfiltered release accident from occurring. In this situation, the control prevents continued operation of a breached duct found during sluicing. This control applies only after the new Tank 241-C-106 ventilation system (296-C-006) is installed.

With the periodic determination of the cooling capacity requirements for Tank 241-AY-102 and provision of the necessary cooling capability, the potential for a tank bump due to exceeding the saturation temperature of the waste is prevented. This greatly reduces the probability of the tank bump accident from occurring. In this situation, the control protects the temperature limits in LCS/LCO 3.3.2, "DST and AWF Tank WASTE Temperature Controls," which prevents the saturation temperature of the waste from being reached because the necessary cooling to maintain temperatures below the saturation temperature is being provided. This control is applicable only to Tank 241-AY-102 after 0.61 m (2 ft) of waste have been added to the tank by the WRSS.

5.5.25.2 Derivation Criteria. The ventilation inspection control was selected because it took credit for an existing program that demonstrates the necessary operational performance. The visual inspection of the ventilation ductwork will identify damage or leaks (e.g., condensate dripping) so that WRSS operations can be stopped by preventing continued use of a breached duct found during sluicing. This control applies only to Tank 241-C-106 after the 296-C-006 ventilation system is installed and sluicing is in progress.

The cooling capacity control was selected because it allows for determination of the cooling requirements for Tank 241-AY-102 based on the heat generation rate conditions determined in the tank and then provides the necessary cooling requirements. The annulus ventilation system will typically provide the necessary cooling but, based on the heat generation rate determined, it is anticipated that operation of the annulus ventilation system will only be required when more than 2 ft of waste has been transferred to Tank 241-AY-102.

5.5.26 AC 5.26—Tank 241-C-106 Waste Temperature Controls

5.5.26.1 Purpose. The controls for SST waste temperature during WRSS operations are required based on the WRSS accident analysis for liner breach due to steam between the steel liner and the concrete shell in Tank 241-C-106 (Section 3.4.2.12) and the unfiltered release due to overheating (Section 3.4.2.3). This control also applies to Tank 241-C-106 for WRSS tank bump (Section 3.4.2.11) during and after sluicing. The bounding accidents for tank bump and liner breach exceeded both onsite and offsite radiological risk guidelines, and consequences were above onsite radiological risk guidelines for unfiltered release. Also, the tank bump and liner breach bounding accidents exceeded onsite toxicological risk guidelines.

5.5.26.2 Derivation Criteria. AC 5.26 replaces LCS/LCO 3.3.1 during and after sluicing operations. This control is designed to protect a more restrictive temperature limit for saturation conditions, to prevent a liner breach scenario. This limit varies with the hydrostatic head due to waste, therefore an AC program was determined to be most appropriate.

Waste temperature controls were selected because temperature, the parameter of concern, is under the control of operations and is monitored with existing systems. In addition, implementation of temperature controls minimizes modifications needed to administrative procedures, as the process for monitoring temperatures is already a part of existing procedures. Temperature can be controlled by a variety of methods (e.g., ventilation, engineered heat removal). The monitored temperatures can then be modelled to determine the maximum tank bottom temperatures.

Level monitoring is also under the control of operations and is observed with existing systems. Using the level detection system, the pressure at the tank bottom can be found, in order to determine the local saturation temperature of water.

5.6 DESIGN FEATURES

Design Features are those features not covered elsewhere in the TSRs and which, if altered or modified, would have a significant effect on safety. Design Features are normally permanently built-in features that do not require, or infrequently require, maintenance or surveillance and are normally not subject to change by Operations personnel. The categories of design features to be addressed in accordance with DOE 5480.22 include the following:

- Vital passive components, such as piping, vessels, supports, confinement structures, and containers
- Configuration and physical arrangement of the facility where safety is a concern including site characteristics, such as the locations of public access roads, collocated facilities, facility area boundaries, site boundaries, and distances to the nearest residences
- Building materials, if the safe operation of the facility depends on any component being constructed of a particular material.

Changes to Design Features are considered significant modifications. The unreviewed safety question process ensures that changes to Design Features are appropriately analyzed and controlled so that they do not adversely affect safe operation of the facility. The configuration management system that controls changes to Design Features is discussed in the main text of Section 17.4.2, "Configuration and Document Control," of this FSAR.

Design Features for TWRS facilities are included in the TSR document. Unique Design Features for the WRSS that, if altered or modified, would have a significant effect on safe operation are listed below. Descriptions of these Design Features are provided in Chapter 2.0 of this Addendum. Based on the criteria for Design Features in DOE 5480.22, passive features that are only

for environmental protection are not listed. Environmental features are, however, discussed in Chapter 3.0 of this Addendum. Radioactive and hazardous waste management control features are discussed in the main text of Section 9.3, "Radioactive and Hazardous Waste Management Program and Organization," of the FSAR.

5.6.1 Waste Retrieval Sluicing System

Design Features for the WRSS include the following:

- Positive mechanical stops are provided on the remotely operated, hydraulically controlled sluicer in Tank 241-C-106 to limit nozzle travel to 115° vertically (0° reference is the nozzle pointed straight down). This prevents the sluice stream from impinging on an area above the tank liner and leaking into the liner from the top of the liner.

- Syphon protection (holes) is provided on the slurry distributor and the submersible sluice pump discharge lines within Tank 241-AY-102 to prevent a syphon when the slurry pumps or sluice pumps are shut down.

- The sluicer hose in Tank 241-C-106 is engineered to maintain structural integrity to prevent the hose from breaking off and causing a liner breach.

- The WASTE transfer pipe-in-pipe encasement confines leaks from the primary piping and channels waste leaked from the primary pipe to a transfer-associated structure where the leak can be detected. The encasement also provides outside protection against corrosion of the inside pipe.

- The weight of the removable plugs in cover blocks for the sluice slurry line flush connection pits on Tank 241-A4-102 exceeds the maximum lifting force caused by waste discharged from the open flush nozzle.

5.7 INTERFACES WITH TECHNICAL SAFETY REQUIREMENTS FROM OTHER FACILITIES

The TWRS Facility interfaces with other Hanford facilities are identified and discussed in Chapter 2, "Facility Description," of this FSAR. TWRS programs are in place and are adequate to ensure that interactions with other facilities and their safety requirements do not affect the TWRS safety basis, and do not exceed the safety analyses requirements. There are no interface requirements that affect the WRSS safety basis.

5.8 REFERENCES

DOE 5480.22, 1996, *Technical Safety Requirements*, Change 2, U.S. Department of Energy, Washington, D.C.

DOE 5480.23, 1994, *Nuclear Safety Analysis Reports*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE-STD-3009-94, 1994, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

HNF-SD-WM-HSP-002, 1998, *Tank Farms Health and Safety Plan*, Rev. 3, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-SD-WM-TSR-006, 1997, *Tank Waste Remediation System Technical Safety Requirements*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

NUREG 1431, 1992, *Standard Technical Specifications, Westinghouse Plants*, Rev. 0, U.S. Nuclear Regulatory Commission, Washington, D.C.

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (6 sheets)

Analyzed accident and FSAR Addendum section	Technical Safety Requirement	Control basis
Nuclear Criticality (3.4.2.1)	AC 5.7 Nuclear Criticality Safety - Establish CPSs based on CSERs - Recovery actions if limits exceeded - Criticality training program	AC 5.7 provides for a criticality safety program as required by DOE 5480.22, Section 9.e.(5). Implementation of these controls protects the assumptions in the accident analysis to prevent a criticality from occurring Criticality limits and controls are documented in CSERs and implemented in CPSs through procedures. Criticality safety training is provided and procedures identify the recovery actions in the event the CPS requirements are not met
HEPA Filter Failure—Exposure to High Temperature or Pressure (3.4.2.2)	LCO 3.1.4 Ventilation Stack CAM Interlock Systems AC 5.18 HEPA Filter Controls - Periodic radiation surveillance - Replacement based on accumulation - Aerosol test upon installation (AWF 241-AZ-702) - Periodic aerosol test (AWF 241-AZ-702)	LCO 3.1.4 controls consequences of accident to meet onsite radiological risk guidelines. CAM interlock detects increasing radiological effluent releases and stops the ventilation exhaust fan within 10 minutes AC 5.18 protects radioactive loading assumptions on ventilation system filters in accident analysis
Unfiltered Release (3.4.2.3)	AC 5.25 Ventilation Controls - Visual inspection of aboveground recirculation ventilation ductwork for Tank 241-C-106 every 24 hours during sluicing (only applies after the 296-C-006 ventilation system is installed) TSR controls in FSAR Addendum 1, Section 3.4.2.2 (HEPA Filter Failure) and 3.4.2.11 (Tank Bump) also apply	AC 5.25 prevents continued operation of a damaged recirculation ventilation duct on Tank 241-C-106 (only applies after the 296-C-006 ventilation system is installed)
Fire in Contaminated Area (3.4.2.4)	AC 5.10 Ignition Controls - Vehicle fuel system protection - Physical barriers outside tank farms - Speed limit controls AC 5.14 Emergency Preparedness - Response procedures	AC 5.10 provides controls to lessen the probability of the accident. Vehicle controls prevent the rupture of a vehicle fuel system which may result in a fire in a contaminated area (e.g., open pit) AC 5.14 represents a significant Defense-in-Depth control that has been elevated to a TSR. It provides direction for fire response and recovery activities

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (6 sheets)

Analyzed accident and FSAR Addendum section	Technical Safety Requirement	Control basis
Caustic Spray Leak (3.4.2.5)	AC 5.23 Caustic Transfer Controls - Plastic sleeving around delivery piping - Caustic delivery system transfer pressure ≤ 125 psig or below sodium hydroxide cargo tanks specified maximum allowable operating pressure whichever is lower - Piping thickness - Sodium hydroxide cargo tanks meet applicable DOT specifications - Traffic barriers shall surround the cargo tank (e.g., traffic cones or stanchions and chains)	AC 5.23 provides controls to reduce the consequences and probability of the accident TSR controls are established for plastic sleeving around delivery piping (≥ 4 mil thickness) to prevent or mitigate the consequences of a spray leak. The limitations on the caustic delivery system pressure and piping thickness for caustic delivery reduces the consequences of a leak by reducing the leak rate. NaOH cargo tanks must meet applicable DOT inspections to minimize the potential for a tanker leak. Traffic barriers reduce the probability of a caustic leak
Tank Failure Due to Excessive Loads (3.4.2.6)	AC 5.16 Dome Loading Controls - Limits on load height - Hanford Site Hoisting and Rigging Manual for critical lifts - Uniform and concentrated load limits	AC 5.16 provides controls to prevent the accident and protect the onsite worker These controls limit the potential for a load damaging a waste retaining structure, resulting in an uncontrolled release
Tank Failure Due to Excessive Vacuum (3.4.2.7)	None	No credible tank failure and collapse due to an excessive vacuum scenario has been identified
Flammable Gas Deflagrations (3.4.2.8)	LCO 3.2.1 DST and AWF Tank Ventilation Systems LCO 3.2.2 SST Ventilation Systems - Active LCO 3.2.6 Primary Tank Leak Detection Systems AC 5.9 Flammability Controls AC 5.10 Ignition Controls AC 5.11 Flammable Gas Monitoring Controls AC 5.14 Emergency Preparedness - Response procedures AC 5.18 HEPA Filter Controls - Periodic radiation surveillance - Replacement based on accumulation	LCO 3.2.1, LCO 3.2.2, LCO 3.2.6, AC 5.9, AC 5.10, and AC 5.11 provide controls to lessen the probability of accident AC 5.14 represents a significant Defense-in-Depth control that has been elevated to a TSR. It provides direction for fire response and recovery activities AC 51.8 protects radioactive loading assumptions on ventilation system filters in accident analysis

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (6 sheets)

Analyzed accident and FSAR Addendum section	Technical Safety Requirement	Control basis
Organic Solvent Fire (3.4.2.9)	AC 5.10 Ignition Controls - Lightning (stop intrusive work, secure elevated equipment) - Barrier for hot metal during flame cutting - Vehicle fuel system protection - Physical barriers outside tank farms - Speed limit controls AC 5.12 Transfer Controls - Evaluate impact on organic solvent transfer AC 5.14 Emergency Preparedness - Response procedures AC 5.18 HEPA Filter Controls - Periodic radiation surveillance - Replacement based on accumulation - Aerosol test upon installation (AWF 241-AZ-702) - Periodic aerosol test (AWF 241-AZ-702)	AC 5.10 and AC 5.12 provide controls to lessen probability of accident, and AC 5.10 protects the facility worker with significant Defense-in-Depth key elements Ignition controls minimize the initiators (lightning, hot metal, and vehicle fuel fire) with sufficient energy to ignite an organic solvent fire AC 5.14 represents a significant Defense-in-Depth control that has been elevated to a TSR. It provides direction for fire response and recovery activities AC 5.18 protects radioactive loading assumptions on ventilation system filters in accident analysis
In-Tank Fuel Fire/Deflagration (3.4.2.10)	Note: This accident credits the same controls as the Organic Solvent Fire (3.4.2.9) above.	--

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (6 sheets)

Analyzed accident and FSAR Addendum section	Technical Safety Requirement	Control basis
Tank Bump (3.4.2.11)	LCO 3.2.1 DST and AWF Ventilation Systems LCS/LCO 3.3.1 SST Waste Temperature Controls - Temperature ≤ 205 °F (prior to start of sluicing) LCS/LCO 3.3.2 DST and AWF Tank Waste Temperature Controls - Temperature ≤ 195 °F (or 215 °F based on waste level) LCO 3.3.3 Tank 241-AY-102 Annulus Ventilation System - Operability AC 5.12 Transfer Controls - Ensure final tank state within analyzed conditions - Incremental waste transfer, with material balance after each sluicing batch of 12 hours maximum duration during transfer operations AC 5.19 Process Instrumentation and Measuring and Test Equipment - Calibrate and properly maintain AC 5.25 Ventilation Controls - Provide adequate cooling capacity for Tank 241-AY-102 after 2 ft of waste added (Primary and Annulus Ventilation Systems) AC 5.26 Tank 241-C-106 Waste Temperature Controls - Predict saturation temperatures at the bottom of Tank 241-C-106. Use predicted height of the waste throughout the incremental transfer and periodically monitor the waste temperature. - During the first two 1 ft transfer increments, the liquid level established before start of each sluicing increment will be maintained throughout the increment.	LCO 3.3.1, LCO 3.3.2, AC 5.12, AC 5.19, AC 5.25, and AC 5.26 provide controls to prevent accident LCOs 3.2.1 and 3.3.3 and AC 5.25 provide controls for operability of the ventilation systems in Tank 241-AY-102 for cooling after at least 2 ft of sludge from Tank 241-C-106 is transferred.
Liner Breach Caused by Steam Between the Steel Liner and Concrete Shell in Tank 241-C-106 (3.4.2.12)	LCS/LCO 3.3.1 SST Waste Temperature Controls - Temperature ≤ 205 °F (prior to start of sluicing) AC 5.12 Transfer Controls - Ensure final tank state within analyzed conditions AC 5.19 Process Instrumentation and Measuring and Test Equipment - Calibrate and properly maintain AC 5.26 Tank 241-C-106 Waste Temperature Controls - Establish temperature controls that are < T_{sat} for existing tank conditions [applies during and after sluicing]	LCO 3.3.1, AC 5.12, AC 5.19, and AC 5.26 provide controls to prevent accident

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (6 sheets)

Analyzed accident and FSAR Addendum section	Technical Safety Requirement	Control basis
Subsurface Leak Remaining Subsurface (3.4.2.13)	LCO 3.1.3 Transfer Leak Detection Systems AC 5.12 Transfer Controls - Material Balance after each sluicing batch of 12 hours maximum duration during sluicing - Establish communication between control rooms for Tanks 241-C-106 and 241-AY-102 during sluicing operations - Configuration management - Independent transfer route verification AC 5.13 Encasement Seal Loop Controls - Encasement drain line valve not closed AC 5.17 Excavation Controls (see 3.4.2.17) AC 5.20 Transfer Pump Administrative Lock Controls	LCO 3.1.3, and AC 5.12 represent controls to detect a leak and stop the transfer to protect the onsite and facility worker AC 5.12 requires calculation of solids loading after each sluicing batch to confirm analysis assumptions AC 5.13 protects a key assumption of the accident analysis AC 5.17 and AC 5.20 provide controls to lessen the probability of the accident
Subsurface Leak Resulting in Pool (3.4.2.14)	LCO 3.1.3 Transfer Leak Detection Systems AC 5.12 Transfer Controls - Material Balance after each sluicing batch of 12 hours maximum duration during sluicing - Establish communications between 241-C-106 and 241-AY-102 control rooms during sluicing operations - Configuration management - Independent route verification during transfer setup AC 5.14 Emergency Preparedness - Response procedures	LCO 3.1.3, AC 5.12 and AC 5.14 control consequences of accident from exceeding offsite risk guidelines
Surface Leak Resulting in a Pool (3.4.2.15)	LCO 3.1.1 Transfer System Covers and Entry Doors LCO 3.1.3 Transfer Leak Detection Systems LCO 3.2.6 Primary Tank Leak Detection Systems AC 5.12 Transfer Controls - Material Balance after each sluicing batch of 12 hours maximum duration during transfer operations - Establish communication between control rooms for Tanks 241-C-106 and 241-AY-102 during sluicing operations -Configuration management - Vehicle restrictions around transfer lines - Caps/blanks on open nozzles AC 5.14 Emergency Preparedness - Response procedures AC 5.17 Excavation Controls (see 3.4.2.17) AC 5.20 Transfer Pump Administrative Lock Controls AC 5.22 Transfer System Cover Removal Controls	LCO 3.1.1 Limits releases of aerosols generated by splatter inside the pit and limits shine and skyshine dose to onsite receptors LCO 3.1.3, LCO 3.2.6, AC 5.14, and AC 5.22 represent items which help control consequences of accident AC 5.12, AC 5.17, and AC 5.20, provide controls to lessen probability of accident AC 5.12 requires calculation of solids loading after each sluicing batch to confirm analysis assumptions

Table 5-1. Hazard and Accident Analyses and Technical Safety Requirement Cross-Reference. (6 sheets)

Analyzed accident and FSAR Addendum section	Technical Safety Requirement	Control basis
Spray Leak from Structure (3.4.2.16)	LCO 3.1.1 Transfer System Covers and Entry Doors LCO 3.1.4 Ventilation Stack CAM Interlock Systems AC 5.12 Transfer Controls - Configuration management - Independent transfer route verification - Vehicle restrictions around transfer lines AC 5.13 Encasement Seal Loop Controls - Encasement drain line valve not closed AC 5.20 Transfer Pump Administrative Lock Controls AC 5.22 Transfer System Cover Removal Controls	AC 5.20 provides controls to lessen probability of accident to within acceptable offsite risk guidelines LCO 3.1.1 and LCO 3.1.4 control consequences of accident from exceeding onsite and offsite radiological risk guidelines and onsite toxicological risk guidelines. LCO 3.1.1 ensures the covers are installed AC 5.13 protects a key assumption of the accident analysis AC 5.12 and AC 5.22 represent significant Defense-in-Depth items which help lessen accident probability and control consequences of accident
Spray Leak from an Underground Waste Transfer Line (3.4.2.17)	AC 5.17 Excavation Controls - An excavation permit shall be required when excavating in areas where waste transfer lines exist. - Encased pipe outside of the tank farm boundaries shall be identified with permanent aboveground labels. - Waste transfers are prohibited through lines uncovered by excavation activities unless compensatory controls are established. - Waste transfers shall not be conducted in transfer lines located within approximately 15 ft of ongoing excavation activities. - Prior to initiation of an excavation activity, identify emergency response actions and establish communications between the excavation site and operations personnel to ensure immediate shutdown of waste transfers when leakage is indicated.	AC 5.17 provides controls to lessen the probability of the accident and to mitigate consequences to within acceptable onsite and offsite risk guidelines
Natural Phenomena (3.4.2.18)	AC: Not required Note: Refer to FSAR main text.	--

AC = Administrative Control
AWF = Aging Waste Facility
CAM = continuous air monitor
CPS = Criticality Prevention Specifications
CSER = Criticality Safety Evaluation Report
DST = double-shell tank
FSAR = Final Safety Analysis Report
HEPA = high-efficiency particulate air (filter)
LSO = Limiting Condition for Operation
SHM = Standard Hydrogen Monitoring System
SST = single-shell tank
TSR = Technical Safety Requirement
ULD = unit liter dose

Table 5-2. FSAR Addendum Chapter and Administrative Control Technical Safety Requirement Cross-Reference.

FSAR Addendum Chapter	TSR Administrative Controls
Chapter 1 - Site Characteristics	None
Chapter 2 - Facility Description	None
Chapter 3 - Hazard and Accident Analyses	Table 5-1
Chapter 4 - Safety Structures, Systems, and Components	Table 5-1
Chapter 5 - Derivation of Technical Safety Requirements	Table 5-1
Chapter 6 - Prevention of Inadvertent Criticality	AC 5.7 - Nuclear Criticality Safety
Chapter 7 - Radiation Protection	AC 5.24 Safety Management Program
Chapter 8 - Hazardous Material Protection	None
Chapter 9 - Radioactive and Hazardous Waste Management	AC 5.24 Safety Management Program
Chapter 10 - Initial Testing, In-Service Surveillance, and Maintenance	None
Chapter 11 - Operational Safety	None
Chapter 12 - Procedures and Training	None
Chapter 13 - Human Factors	None
Chapter 14 - Quality Assurance	None
Chapter 15 - Emergency Preparedness Program	AC 5.14 - Emergency Preparedness
Chapter 16 - Provisions for Decontamination and Decommissioning	None
Chapter 17 - Management, Organization, and Institutional Safety Provisions	AC 5.2 - Contractor Responsibility AC 5.3 - Compliance AC 5.4 - Technical Safety Requirement Violations AC 5.5 - Occurrence Reporting AC 5.6 - Organization AC 5.8 - Source Inventory Controls

AC = Administrative Control.
TSR = Technical Safety Requirement.

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6.0 PREVENTION OF INADVERTENT CRITICALITY

This chapter contains information relevant to prevention of inadvertent criticality at Tank Waste Remediation System facilities as a result of the activities associated with the Waste Retrieval Sluicing System (WRSS).

6.1 REQUIREMENTS

See the main text in Section 6.2, "Requirements," of the FSAR for requirements.

6.2 FACILITY IMPLEMENTATION

See the main text in Chapter 6.0, "Prevention of Inadvertant Criticality," of the FSAR for facility implementation.

6.3 CRITICALITY CONCERNS

HNF-SD-W320-CSA-001, *Criticality Safety Assessment of Tank 241-C-106 Remediation*, concludes that an inadvertent criticality as a result of the activities associated with WRSS is not considered possible for the plutonium concentration determined to be in tank waste and the WRSS process to be applied to the tank waste.

6.4 CRITICALITY CONTROLS

See the main text in Chapter 6.0 of the FSAR for criticality concerns.

6.5 CRITICALITY PROTECTION PROGRAM

See the main text in Chapter 6.0 of the FSAR for details of the criticality protection program.

6.6 CRITICALITY INSTRUMENTATION

See the main text in Chapter 6.0 of the FSAR for criticality discussion.

6.7 REFERENCES

HNF-SD-W320-CSA-001, 1997, *Criticality Safety Assessment Of Tank 241-C-106 Remediation*, Rev. 1, Duke Engineering and Services Hanford, Inc., Richland, Washington.

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CHAPTER 7.0
RADIATION PROTECTION

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7.0 RADIATION PROTECTION

7.1 INTRODUCTION

This chapter identifies the requirements for radiation protection for Tank Waste Remediation System Waste Retrieval Sluicing System facilities and operations and the implementing program documents. Implementation of these programmatic requirements by the Waste Retrieval Sluicing System assures that the appropriate radiation protection standards are incorporated in project design and construction.

7.2 REQUIREMENTS

Chapter 7.0, "Radiation Protection," of the main text of the FSAR provides the radiation protection requirements and facility implementation for the Waste Retrieval Sluicing System.

7.3 PROJECT IMPLEMENTATION

The radiation dose and dose rate design limits for Waste Retrieval Sluicing System activities are delineated in HNF-SD-W320-FDC-001, *Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320*. Design details required to comply with the criteria are verified in calculations completed by the architect-engineer/constructor. Programmatic elements of radiation protection are governed by existing Site and facility programs. Descriptions of radiation monitoring and instrumentation are given in the system description in Chapter 2.0, "Facility Description." No requirements above those identified in the programmatic documents were required for the Waste Retrieval Sluicing System.

7.4 REFERENCES

HNF-SD-W320-FDC-001, 1998, *Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320*, Rev. 4, Numatec Hanford Company, Richland, Washington.

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8.0 HAZARDOUS MATERIAL PROTECTION

8.1 INTRODUCTION

Hazardous material protection requirements for this facility are fully defined in Chapter 8.0, "Hazardous Material Protection," in the main text of the FSAR. No specific requirements related to occupational hazardous material protection above those specified in the main text are required for Waste Retrieval Sluicing System activities.

8.2 PROJECT IMPLEMENTATION

No specific requirements related to occupational hazardous material protection were identified for Waste Retrieval Sluicing System activities; therefore, no specific requirements related to occupational hazardous material protection above those identified in the programmatic documents are required.

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CHAPTER 9.0
RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

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CHAPTER 9.0
RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

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9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

9.1 INTRODUCTION

Radioactive and hazardous waste management requirements for the Waste Retrieval Sluicing System are fully-defined in Chapter 9.0 "Radioactive and Hazardous Waste Management," in the main text of the FSAR.

9.2 PROJECT IMPLEMENTATION

No specific requirements related to radioactive and hazardous waste management above those identified in the programmatic documents were required for Waste Retrieval Sluicing System activities.

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CHAPTER 10.0
INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

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CHAPTER 10.0
INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

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10.0 INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

10.1 INTRODUCTION

This section identifies the requirements for initial testing, in-service surveillance, and maintenance of Tank Waste Remediation System (TWRS) Waste Retrieval Sluicing System (WRSS) safety structures, systems, and components (SSCs).

10.2 REQUIREMENTS

Initial testing, in-service surveillance, and maintenance policies and programs addressed in this section are regulated by the following U.S. Department of Energy orders:

- DOE 4330.4B, *Maintenance Management Program* (1994)[1]
- DOE 4700.1, *Project Management System*, Change 1 (1992)[1]
- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1 (1992)
- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)
- DOE-76-45/1, *Occupancy/Use Readiness Manual* (1992)

TWRS implementation of the initial testing, in-service surveillance, and maintenance program requirements is documented in the following:

- WHC-CM-1-8[2], *Work Management* (1996)
- WHC-CM-4-2[2], *Quality Assurance Manual* (1996)
- HNF-IP-0842, *TWRS Administration* (1996)
- WHC-SP-0850, *Maintenance Implementation Plan* (1994)

---

[1]DOE 4330.4B and DOE 4700.1 will be phased out/canceled upon meeting implementation conditions of DOE O 430.1.

[2]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., FDH Procedures (e.g., HNF-PRO-XXX).

10.3 TESTING PROGRAM

The W320 Project is responsible for testing prior to Official Acceptance of Constructions (OAC) section II (HNF-CM-6-2, *Project Management*). Subsequent to OAC section II East Tank Farms Operations is responsible for testing. Testing will be performed following a graded approach with more extensive testing conducted on Safety-Class components, components included as Defense-in-Depth items and components not readily accessible following installation. Note: Testing was conducted based on the safety classification of the components in place at the time of the testing.

HNF-SD-W320-TP-001, *Project W-320, Tank 241-C Waste Retrieval Sluicing System Testing Plan*, was prepared to support test planning and define test controls for acceptance testing and operational testing of the Project W-320 equipment.

10.3.1 Acceptance Testing

To facilitate operational testing and phased turnover, the WRSS was broken into subsystems. Many of the WRSS subsystems are relatively simple systems consisting of standard structures, off the shelf components or non-electromechanical systems. These subsystems will be placed in service following acceptance testing and will not be subjected to operational testing.

The majority of acceptance testing was performed either by the equipment vendors or the construction contractor. Once acceptance testing is verified as complete, subsystems of the WRSS may be turned over to East Tank Farm Operations and placed into service.

Acceptance testing will be performed by Project W-320 on all WRSS equipment and component to demonstrate fabrication, assembly, installation, and construction requirements specified in design documents were met. Acceptance testing includes fabrication and cleanliness inspections; wire continuity checks and adjustment of electrical protective devices; adjustment of torque-limiting devices; instrument calibration; testing instrumentation loops; and adjustment of controllers, limit switches, and other similar devices. Acceptance testing may also include equipment mock up and run-in tests, conducted both prior to and following installation.

Project W-320 acceptance testing includes three basic types of tests: vendor factory acceptance tests; general construction acceptance tests; and final acceptance tests. All acceptance testing will be the responsibility of the construction contractor and will be successfully completed prior to turnover of a WRSS subsystem or component to Projects.

Some WRSS subsystems will be placed in service following acceptance testing and will not be subjected to operational testing. These subsystems are:

- 241-C-106 Electrical Power Supply System
- 241-AY-102 Electrical Power Supply System

- Air and Water Service System
- Fire Protection System
- 241-Air Intake Chiller System.

10.3.2 Pre-Operational Testing

Preoperational testing will be conducted by performing Operational Test Procedures (OTPs) on the sluicing, ventilation, and instrumentation systems after turnover to Tank Farms operations. These integrated OTPs test the overall operability of the systems and procedures, except that no waste is actually transferred. Any test exceptions are documented and resolved. It is important to note that this Safety Assessment envelopes the consequences of accidents during the planned preoperational test activities. During operational testing, components of the WRSS will be operated at defined parameters to ensure they are ready for full operational testing. At the completion of preoperational testing, conditions and test results will be evaluated by the test director and a determination will be made to proceed with operational testing.

10.4 PROCEDURES

Prior to Project turnover, test procedures will be developed, reviewed and approved in accordance with the W-320 Test Plan. After turnover, test procedures will be developed, reviewed, and approved in accordance with HNF-IP-0842.

10.5 IN-SERVICE SURVEILLANCE PROGRAM

In-service surveillance and inspections at TWRS WRSS will be performed according to DOE 4330.4B using a graded approach. Program requirements include periodic inspections to ensure that proper conditions, cleanliness, and housekeeping are maintained to support safe and reliable facility operations.

The surveillance program is conducted in conjunction with the maintenance and testing program. Together, these programs ensure continued operation of Safety-Class and Safety-Significant SSCs at TWRS WRSS.

10.5.1 Provisions for Testing and Calibrations

The TWRS program for surveillance, inspection, and testing activities ensures that equipment needed for safe, reliable facility operation performs as required and that the program responds to the requirements of DOE 4330.4B. At TWRS the design authority is responsible for planning and documenting surveillance tests and other tests as discussed in Chapter 17.0.

10.5.2 Control and Calibration of Measuring and Test Equipment

The control and calibration of measuring and test equipment shall follow the guidelines of DOE 4330.4B and HNF-IP-0842, Volume V, "Maintenance/Production Control."

10.5.3 Training of Personnel Performing Surveillance

Training of maintenance personnel shall follow the guidelines and procedures of HNF-IP-0842, Volume III, Section 10.6, "Maintenance Training," which include references to DOE 4330.4B and also apply to training used for in-service surveillance personnel.

10.6 MAINTENANCE PROGRAM

The TWRS operations manager has overall responsibility for operation and maintenance of the WRSS. The scope of the TWRS WRSS is discussed in Chapter 2.0. The TWRS WRSS maintenance program is conducted according to DOE 4330.4B, which provides general policy and objectives for establishing cost-effective maintenance and repairs.

10.7 REFERENCES

DOE 4330.4B, 1994, *Maintenance Management Program*, U.S. Department of Energy, Washington, D.C.

DOE 4700.1, 1992, *Project Management System*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE 5480.19, 1992, *Conduct of Operations Requirements for DOE Facilities*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE 5480.23, 1994, *Nuclear Safety Analysis Reports*, Change 1, U.S. Department of Energy, Washington, D.C.

DOE-76-45/1, 1992, *Occupancy/Use Readiness Manual*, U.S. Department of Energy, Washington, D.C.

DOE O 430.1, 1995, *Life Cycle Asset Management*, Change 1, U.S. Department of Energy, Washington, D.C.

HNF-CM-6-2, 1996, *Project Management*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-IP-0842, 1997, *TWRS Administration*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-W320-TP-001, 1998, *Project W-320, Tank 241-C Waste Retrieval Sluicing System Testing Plan*, Rev. 1, Numatec Hanford Company, Richland, Washington.

WHC-CM-1-8, 1996, *Work Management*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-2, 1996, *Quality Assurance Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-SP-0850, 1992, *Maintenance Implementation Plan*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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CHAPTER 11.0
OPERATIONAL SAFETY

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11.0 OPERATIONAL SAFETY

11.1 INTRODUCTION

This chapter identifies requirements and implementing program documents for the Waste Retrieval Sluicing System (WRSS) operational safety and fire protection.

11.2 REQUIREMENTS

Operational safety requirements are defined for this facility in Chapter 11.0, "Operational Safety," in the main text of the FSAR and in HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*. Specific requirements for Waste Retrieval Sluicing System activities related to fire protection above those specified in the main text are noted in the following subsections.

11.3 PROJECT IMPLEMENTATION

A fire hazards analysis was performed by Columbia Energy and Environment Services Inc., for Waste Retrieval Sluicing System activities (WHC-SD-W320-FHA-001, *Fire Hazard Analysis for Project W-320 Tank 241-C-106 Waste Retrieval*). The conclusion from this analysis is described in the following paragraphs.

The fire hazards analysis comprehensively assessed the risk from fire at Waste Retrieval Sluicing System facilities to determine (1) the potential for the occurrence of fire is minimized; (2) fire will not cause an onsite or offsite release of radiological and other hazardous materials that will threaten the public health and safety or the environment; (3) requirements that will provide an acceptable degree of life safety to U.S. Department of Energy and contractor personnel are in place and there are no undue hazards to the public from fire and its effects on U.S. Department of Energy facilities; and (4) safety systems will not be damaged by fire. The following discussion summarizes the conclusions from the fire hazards analysis.

There are no fixed fire protection systems protecting the equipment and structures in Tank Farm 241-C. A fire involving a trailer in this area is not likely to be controlled or extinguished without the use of hose streams flowing significant quantities of water. Fire hydrants within the vicinity of Tank 241-C-106 equipment and in accordance with the applicable requirements of DOE 6430.1A, *General Design Criteria*, were installed.

The Safety-Class equipment is designed with redundancy. It has been concluded that an accidental fire will not result in a loss of the capability of the Safety-Class system to accomplish its required safety function.

Accumulation of tumbleweeds and other transient combustibles is likely to occur periodically in and around Waste Retrieval Sluicing System equipment and structures. In keeping with Fluor Daniel Hanford policy to limit combustibles to a level As Low as Reasonably Achievable, there is a procedure to ensure periodic removal of tumbleweeds and other unwanted transient combustibles from TWRS facilities.

DOE 6430.1A, Section 1530.99.0, stipulates that automatic water sprinkler coverage be provided throughout nonreactor nuclear facilities. Automatic sprinkler protection is not expected to prevent or reduce any subsequent loss that may result from a fire in the Process Building. Based on the evaluation of combustibles and processes planned for Waste Retrieval Sluicing System activities, a deviation from the DOE 6430.1A requirement for full automatic water sprinkler protection has been made.

11.4 REFERENCES

DOE 6430.1A, 1989, *General Design Criteria*, U.S. Department of Energy, Washington, D.C.

HNF-SD-WM-TSR-006, 1998, *Tank Waste Remediation System Technical Safety Requirements*, Rev. 1, Fluor Daniel Hanford, Inc., Richland, Washington.

WHC-SD-W320-FHA-001, 1995, *Fire Hazard Analysis for Project W-320 Tank 241-C-106 Waste Retrieval*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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12.0 PROCEDURES AND TRAINING

12.1 INTRODUCTION

Procedures and training requirements are defined in Chapter 12.0 "Procedures and Training," in the main text of the FSAR. Specific requirements for Waste Retrieval Sluicing System operations related to procedures and training above those specified in the main text are noted as follows.

12.2 PROJECT IMPLEMENTATION

Responsibility for training on the new systems prior to commencement of operations is defined in HNF-IP-0842, *TWRS Administration*. Training and procedure development is to be conducted per existing Site and facility requirements. Procedures and training requirements for areas specifically related to Waste Retrieval Sluicing System activities will be developed in accordance with DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, and with the results of the accident analysis (Chapter 3.0).

12.3 REFERENCES

DOE 5480.19, 1992, *Conduct of Operations Requirements for DOE Facilities*, Change 1, U.S. Department of Energy, Washington, D.C.

HNF-IP-0842, 1997, *TWRS Administration*, Fluor Daniel Hanford, Inc., Richland, Washington.

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13.0 HUMAN FACTORS

13.1 REQUIREMENTS

Human factors requirements are defined in Section 13.2, "Requirements," in the main text of Chapter 13.0 of the FSAR.

13.2 PROJECT IMPLEMENTATION

The application of human factors is graded on project risk, complexity, and level of involvement of the operator at the facility. With the Tank Waste Remediation System, human factors are considered in the development of procedures and controls; staffing; interface with safety structures, systems, and components; surveillance; maintenance; and safety analyses.

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CHAPTER 14.0
QUALITY ASSURANCE

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14.0 QUALITY ASSURANCE

14.1 INTRODUCTION

The quality assurance requirements and provisions during the procurement, design, and construction phases of project W-320 are defined in the Tank Waste Remediation System (TWRS) general project plan WHC-SD-WM-QAPP-018, *Tank Waste Projects Quality Assurance Program Plan*, and the project specific quality assurance program plan (QAPP) WHC-SD-W320-QAPP-001, *Project Specific Quality Assurance Plan*.

The quality assurance requirements and provisions for the TWRS operations, including the sluicing of Tank 241-C-106, are outlined in WHC-SP-1131, *Westinghouse Hanford Company Quality Assurance Program and Implementation Plan*, the Project Hanford Management Contract (PHMC)-adopted and the Department of Energy (DOE)-approved document required under the Part 10 Code of Federal Regulations, Section 830.120, "Quality Assurance." Specific operating procedures applicable to the project W-320 sluicing operation are contained in the TWRS Procedures Manual, most current revision.

The details of the quality assurance program for the project and the operation are contained in the above mentioned documents. The following sections of this chapter provide a summary of the quality assurance processes employed during the project and to be employed during the course of the sluicing operation.

14.2 REQUIREMENTS

The controlling requirements for the design and construction phases of the project are those applicable requirements found in DOE Order 6430.1A, *General Design Criteria*. Quality assurance requirements related to the design, procurement, and construction phases of the project are identified in the project specific QAPP. Quality assurance requirements for the operation of 241-C-106 sluicing activities are bounded by the QA requirements contained and referenced in the TWRS Project Procedures Manual.

14.3 TANK WASTE REMEDIATION SYSTEM QUALITY ASSURANCE PROGRAM AND ORGANIZATION

The quality assurance program implementation is outlined in the WHC-SP-1131 document identified earlier. Specific TWRS QA organizational structure and processes are contained in the adopted WHC-CM-6-34[1], *TWRS Quality Management Plan*, and WHC-CM-6-50, *TWRS Quality Assurance*.

[1]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., FDH Procedures (e.g., HNF-PRO-XXX).

14.4 QUALITY IMPROVEMENT

Safety-Class/approval designators are identified on all procurement documents. The designators provide a key to the level of receipt inspection required to be conducted upon receipt of items. Special inspection plans are written for items requiring special or unique receipt inspections. Processes used during the W-320 project for receipt inspections and the filing and resolution of nonconformance reports are identified in the project specific QAPP.

TWRS operational quality improvement processes are outlined and referenced in the TWRS Project Procedures Manual (CM manuals 6-34 and 6-50). These procedures bound the 241-C-106 sluicing activities by requiring that all activities conducted within the TWRS project adhere to requirements contained within the Manual.

14.5 DOCUMENTS AND RECORDS

Documents and records maintained within the quality system include but are not limited to: certified vendor information, instrument/equipment calibration records, adverse assessment results until they are corrected. Project design media (e.g. certified vendor information) are retained in project files until project completion and then turned over to operations. Operational media (e.g. calibration records) are retained in auditable files until archived. Improvement media (e.g. assessment findings and selected observations) are retained on electronic data bases until corrected or resolved. Specific details of document and record processes are contained in the TWRS Project Procedures Manual.

14.6 QUALITY ASSURANCE PERFORMANCE

14.6.1 Work Processes

The PHMC adopted QA Program and Implementation Plan requires that all work be conducted in accordance with approved policies, procedures, or instructions. TWRS operations work procedures are contained in the Project Procedures Manual. When an activity is needed that is not covered by existing procedures, documents (justification for continued operation [JCO], recovery plan, work plan, procedure, etc.) are prepared and approved prior to conducting the activity. The requirements for producing these activity documents are currently contained in the TWRS Procedures Manual.

14.6.2 Design

One of the initial documents produced following conceptual design is the project specific quality assurance project plan (QAPP). The QAPP defines the quality assurance measures required during the course of project including

subsequent design, procurement, and construction. The QAPP specific to project W-320 is the HNF-SD-W320-QAPP-001 document mentioned earlier in this chapter.

14.6.3 Procurement

Quality assurance requirements for procurements are contained in the project specific quality assurance plan. Vendors/Sellers are evaluated to determine their capability to produce the desired item at the specified level of quality. Also, each procurement item is required to have a "Safety-Class/approval" designator derived from the safety analysis. This designator acts as a key to aid in defining the necessary and sufficient set of quality requirements that is included in the procurement package. Quality clauses and/or specific quality requirements are included in the procurement package to assure that the desired function, form, and fit derived by the analyses is communicated to the Seller. Specific requirements for procurement during the W-320 project are outlined in the project specific QAPP.

14.6.4 Inspection and Testing for Acceptance

Quality control inspections are defined during the procurement phase based on the importance of the item as determined by analyses conducted during the design phase. Inspections can take the form of visual examinations, non-destructive testing, and in limited cases, destructive testing of a small sample of items. Specific inspection requirements are based on the particular item and its application/needed function. The requirements for inspection and testing are outlined in the project specific QAPP.

14.6.5 Independent and Management Assessment

The conduct of assessments during the operational phase within the TWRS project is defined and controlled by requirements outlined and referenced in the TWRS Project Procedures Manual. During the conduct of the project, assessments were conducted in the form of surveillances conducted internal and external to the W-320 project. In both cases, plans for the assessments are required to be developed at the beginning of each year. If a problem is noted or develops during the course of the year, special assessments can be conducted to gain insights and/or information needed by management to effect corrective actions.

14.6.6 Training and Qualifications

Project personnel (craft, engineers, supervisors) undergo performance-based training according to specific qualification and training programs for their respective areas of responsibility. National standards provide the training and qualification requirements for the various crafts. Site and/or facility specific needs (e.g., radiological, toxicological, emergency preparedness, etc. specific to TWRS) are provided on the Hanford reservation through annual training in both general and facility specific areas.

Qualification and training requirements for nuclear operators are outlined in the DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*. TWRS operating personnel are trained and qualified in accordance with the applicable requirements contained within this DOE Order.

14.7 REFERENCES

10 CFR 830.120, "Quality Assurance," Code of Federal Regulations.

DOE Order 5480.20A, 1994, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

DOE Order 6430.1A, 1989, *General Design Criteria*, U.S. Department of Energy, Washington, D.C.

WHC-CM-6-34, *TWRS Quality Management Plan*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-50, *TWRS Quality Assurance*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-W320-QAPP-001, 1996, *Project Specific Quality Assurance Plan*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-QAPP-018, 1995, *Tank Waste Projects Quality Assurance Program Plan*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SP-1131, 1996, *Westinghouse Hanford Company Quality Assurance Program and Implementation Plan*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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EMERGENCY PREPAREDNESS PROGRAM

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CHAPTER 15.0
EMERGENCY PREPAREDNESS PROGRAM

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15.0 EMERGENCY PREPAREDNESS PROGRAM

Emergency preparedness program requirements are fully defined in Chapter 15.0, "Emergency Preparedness Program," in the main text of the FSAR. No additional project-specific requirements related to emergency preparedness are required beyond those identified as appropriate for Waste Retrieval Sluicing System activities in Sections 3.0, 4.0, and 5.0.

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CHAPTER 16.0
PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

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16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

16.1 INTRODUCTION

This section describes provisions that facilitate the decontamination and decommissioning of facilities associated with Waste Retrieval Sluicing System activities.

16.2 REQUIREMENTS

The Tank Waste Remediation System does not have a formal decontamination and decommissioning plan. The main text of Chapter 16.0, "Provisions for Decontamination and Decommissioning," of the FSAR contains provisions for decontamination and decommissioning. Detailed plans will be prepared as required to support the decontamination and decommissioning of the Waste Retrieval Sluicing System.

DOE 5820.2A, *Radioactive Waste Management*, contains the primary requirements for decontamination and decommissioning activities. The current regulatory basis for decontamination and decommissioning activities is minimal. Some definitions of technical requirements for decontamination and decommissioning are listed in DOE 5400.5, *Radiation Protection of the Public and the Environment*.

16.3 DESCRIPTION OF CONCEPTUAL PLANS

The design of the Waste Retrieval Sluicing System shall facilitate decontamination per HNF-SD-W320-FDC-001, *Functional Design Criteria for Tank 241-C-106 Waste Retrieval*, *Project W-320*, so the facility can be decommissioned at a future date. Guidance for retrieval equipment design to facilitate eventual decommissioning shall be obtained from ANSI N300-1975, *Design Criteria for Decommissioning of Nuclear Fuel Reprocessing Plants*, and DOE 6430.1A, *General Design Criteria*, Sections 1300-11.2 and 1321-7.

The following principles shall be employed to the extent practicable.

- Modular, separable confinements shall be used for radioactive and other hazardous materials to preclude contamination of fixed portions of the structure.
- Filtration components of the ventilation systems shall be located at or near individual enclosures and as close as practical to the sources of contamination to minimize long runs of internally contaminated ducts.
- Areas subject to contamination shall be designed to facilitate decontamination. Liners and coatings shall be selected to withstand decontaminating agents and radiation degradation throughout the life of the facility. Surfaces should be free of crevices, ledges, and/or protrusions that could collect radioactive material.

- Penetrations shall be designed to minimize technical and construction problems in the structural closing and sealing of these penetrations at the time of decommissioning.
- Penetrations shall be waterproofed for protection during decontamination efforts.
- Fixtures and outlets shall be sealed.
- Drains and similar piping shall have physical provisions for cleaning.
- Piping systems shall be sloped and free of traps except as required for retrieval process isolation.
- Adequate clearance shall be provided for transfer of equipment.
- Lifting lugs shall be used on large tanks or equipment.
- Modular radiation shielding shall be used in lieu of, or in addition to, monolithic shielding walls.

16.4 REFERENCES

ANSI N300-1975, 1975, *Design Criteria for Decommissioning of Nuclear Fuel Reprocessing Plants*, American National Standards Institute, Inc., New York, New York.

DOE 5400.5, 1993, *Radiation Protection of the Public and the Environment*, Change 2, U.S. Department of Energy, Washington, D.C.

DOE 5820.2A, 1988, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.

DOE 6430.1A, 1989, *General Design Criteria*, U.S. Department of Energy, Washington, D.C.

HNF-SD-W320-FDC-001, 1998, *Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320*, Rev. 5, Numatec Hanford Company, Richland, Washington.

CHAPTER 17.0
MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

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CHAPTER 17.0
MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

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17.0 MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

17.1 INTRODUCTION

The Waste Retrieval Sluicing System design and operations will be in accordance with the Tank Waste Remediation System organization structures, policies, and programs that ensure safety is the fundamental principle guiding all Tank Waste Remediation System operations.

17.2 REQUIREMENTS

The requirements for management, organization, and institutional safety provisions are contained in the main text of Chapter 17.0, "Management, Organization, and Institutional Safety Provisions," of the FSAR.

17.3 PROJECT IMPLEMENTATION

There are no project-specific requirements related to management, organization, and institutional safety provisions for the Waste Retrieval Sluicing System activities.

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APPENDIX A

HAZARD TOPOGRAPHY

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APPENDIX A

HAZARD TOPOGRAPHY

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A-4 TWRS Tank Unique Phenomena A-10

LIST OF TERMS

ALC	Air lift circulator
COB	cleanout box
HAS	Hazards Assessment
HEPA	high-efficiency particulate air (filter)
MAR	material at risk
N/A	not applicable
NCAW	neutralized current acid waste
NHW	neutralized high-level waste
PHA	preliminary hazards analysis
PNNL	Pacific Northwest National Laboratory
RMW	radioactive mixed waste
SARA	Superfund Amendments and Reauthorization Act
TOC	total organic carbon
TWRS	Tank Waste Remediation System

Table A-1. Applicable Hazard Evaluations for Tank Waste Remediation System Facilities.

Facility Name	Facility Type	Applicable Hazard Evaluation	Hazard Evaluation Identifier
241-AY TANK FARM			
241-AY-102	Double shell tank, air lift circulators, active ventilation	HAS: W-320	W-320
241-C TANK FARM			
241-C-106	Single shell tank, high heat load, active ventilation	HAS: W-320	W-320

HAS = Hazards Assessment (LANL)

Table A-2. Material at Risk Table. (7 sheets)

Field name	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
241-AY-102	Tank Contents	AY-102	D [D1]'	1.16M gal [D3]'	Supernate Solid [D2]'	Liquid Solid [D2]'	694 Kgal 32 Kgal [D2]'	No	N/A	N/A
241-AY-102	Tank Headspace	AY-102	N/A	N/A	N/A	Vapor	1572 M3. No NH3 present. [D4]' See radionuclides concentrations, 'Note 1.	No	N/A	N/A
241-AY*	Ventilation Filter Contents	Primary	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
241-AY*	Ventilation Filter Contents	Annulus	N/A	200 mR/hr maximum for all HEPA filters [D3]'	N/A	Particulate	200 mR/hr maximum [D3]' WHC-SD-WM-EMP-031, Rev 2, summarizes the assay results of HEPA filters for stack 296-A-17.	Yes - disposed in accordance w/WHC-EP-0063-4 (9/93)	N/A	HEPA filters monitored for DP drop/loading in accordance w/manufacturer's specs
241-AY*	Ventilation Filter Contents	Breather	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
241-AY*	Contamination In Ventilation System	De-entrainers	Process condensate	N/A	N/A	Liquid	Residual	N/A	N/A	N/A
241-AY*	Contamination In Ventilation System	Seal loop	Process condensate	N/A	N/A	Liquid	Residual	N/A	N/A	N/A
241-AY*	Contents of Pipeline and/or Source Tank During Transfer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Refer to transfer line 'Table 7

Table A-2. Material at Risk Table. (7 sheets)

Field name	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
241-AY*	Contents of Sump or Encasement	Encasement: From 101-AY to 102-AY	Residual contamination	1.2 K gal [AY24]'	N/A	Residue	Unknown	No	N/A	Volume calculations represent available area in pipe encasements.
241-AY*	Contents of Sump or Encasement	Encasement: Between tanks to 241-AX-152 diversion box	Residual contamination	9.9 K gal [AY24,25]'	N/A	Residue	Unknown	No	N/A	Volume calculations represent available area in pipe encasements.
241-AY-01A	Contamination in Pit or Box	Pump pit 01A	Residual contamination	3.6 K gal [AY2]'	N/A	Residue	Unknown	No	1 pump pit	N/A
241-AY-01F	Contamination in Pit or Box	Annulus pumpout pit 01F	Residual contamination	1.6 K gal [AY3]'	N/A	Residue	Unknown	No	1 pumpout pit	N/A
241-AY-01B-E	Contamination in Pit or Box	Sluice pits 01B,C,D,E	Residual contamination	2.5 K gal ea. [AY6]'	N/A	Residue	Unknown	No	4 sluice pits	N/A
241-AY*	Contamination in Pit or Box	Leak detection pit	Residual contamination	3.1 K gal [AY17]'	N/A	Residue	Unknown	No	1 leak det. pit includes: lk det well, lk det pit, rad det well, rad dry well [AY17]'	N/A
241-AY*	Contamination in Pit or Box	Encasement leak detection pit	Residual contamination	3.1 K gal [AY17]'	N/A	Residue	Unknown	No	1 enc pit includes: lk det pit, enc drain well, rad det well [AY17]'	Volume calculations represent available area in pipe encasements.
241-AY*	Contamination in Pit or Box	Encasement on side of tank	Residual contamination	26.7 K gal [AY17]'	N/A	Residue	Unknown	No	1 encasement	Volume calculations represent available area in pipe encasements.

Table A-2. Material at Risk Table. (7 sheets)

Field name	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
241-AY-02A	Contamination in Pit or Box	Pump pit 02A	Residual contamination	3.6 K gal [AY1][1]	N/A	Residue	Unknown	No	1 pump pit	N/A
241-AY*	Contamination in Pit or Box	Annulus pumpout pit	Residual contamination	9.6 K gal [AY3][1]	N/A	Residue	Unknown	No	1 pumpout pit	N/A
241-AY-02B-E	Contamination in Pit or Box	Sluice pits 02B,C,D,E	Residual contamination	2.5 K gal ea. [AY6][1]	N/A	Residue	Unknown	No	4 sluice pits	N/A
241-AY*	Contamination in Pit or Box	Leak detection pit	Residual contamination	3 K gal [AY12,13][1]	N/A	Residue	Unknown	No	1 leak det pit includes: lk det well, lk det pit, rad dry well, rad det well [AY12,13][1]	N/A
241-AY*	Contamination in Pit or Box	Encasement S side of tank	Residual contamination	.3 K gal [AY24][1]	N/A	Residue	Unknown	No	1 encasement	N/A
241-AY-501	Contamination in Pit or Box	Condensate valve pit AY-501	Residual contamination	4 K gal [AY4][1]	N/A	Residue	Unknown	No	1 valve pit	N/A
241-AY-151	Contamination in Pit or Box	Pumpout pit AY-151	Residual contamination	1.3 K gal [AY8][1]	N/A	Residue	Unknown	No	1 pumpout pit	N/A
241-AY-152	Contamination in Pit or Box	Transfer box AY-152	Residual contamination	4.9 K gal [AY9,11][1]	N/A	Residue	Unknown	No	1 transfer box	N/A
241-AY*	Contamination in Pit or Box	Raw water pits	Residual contamination	2 @ 1.2 K gal ea; 8 @ .2 K gal ea; 1 @ .6 K gal [AY19/1][1]	N/A	Residue	Unknown	No	11 Raw water pits	N/A
241-AY*	Contamination in Pit or Box	Condensate drain valve pit	Residual contamination	.1 K gal [AY19][1]	N/A	Residue	Unknown	No	1 cond dr pit	N/A

Table A-2. Material at Risk Table. (7 sheets)

Field name	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
241-AY-1	Contamination in Pit or Box	Cleanout box AY-1	Residual contamination	.07 K gal [AY23]'	N/A	Residue	Unknown	No	1 COB	N/A
241-C-105	Tank Contents	C-105	NCPLX [d1]'	530 kgal [d4]'	Supernatant [d1]' Sludge [d1]'	Liquid [d1]' Solid [d1]'	2 kgal [d1]' 132 kgal [d1]'	No	N/A	Interim stabilized 10/95 [d9]'
241-C-106	Tank Contents	C-106	NCPLX [d1]'	530 kgal [d4]'	Supernatant [d1]' Sludge [d1]'	Liquid [d1]' Solid [d1]'	32 kgal [d1]' 197 kgal [d1]'	No	N/A	C-106 will be sluiced in the future [i4]' Treated cooling water (pH 9-10) is added to tank, about 6000 gallons/month [i1]'
241-C-105	Tank Headspace	C-105	N/A	N/A	N/A	vapor	2728 cubic meters [d6]' 5.2 g ammonia [d6]' See radionuclides concentrations 'note 1	No	N/A	N/A
241-C-106	Tank Headspace	C-106	N/A	N/A	N/A	vapor	2373 cubic meters [d6]' 4.5 g ammonia [d6]' See radionuclides concentrations 'note 1	No	N/A	Tank C-106 will be sluiced in the future; headspace will change [i4]'
241-C	Ventilation Filter Contents	Primary - C-105/C-106 Exhaust System	N/A	1 R/hr at six inches** [d10, i5]'	N/A	particulate	<100 mR/hr*, 70 mr/hr on top of C-105 inlet filter [rad survey report 221830, 5/2/96]	yes, filters disposed of in accordance with EP-0063-4 (9/93)	N/A	*Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area (except C-105 inlet filter) [rad survey report 221830, 5/2/96] **SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference f

Table A-2. Material at Risk Table. (7 sheets)

Field name	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
241-C	Ventilation Filter Contents	Annulus Exhaust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
241-C	Ventilation Filter Contents	Breathers	N/A	1 R/hr at six inches** [d10, i5]'	N/A	Particulates	<100 mR/hr*	yes, filters disposed of in accordance with EP-0063-4 (9/93)	N/A	*Not identified by East Tank Farms High/Very High Radiation Area Log as a high rad area [rad survey report 221830, 5/2/96] **SAR for DSTs indicates 200 mR/hr limit on HEPA filters through administrative controls. No reference found that indicates this lim
241-C	Contamination In Ventilation System	De-entrainer	Process condensate	N/A	N/A	liquid	residual	No	N/A	For the C-105/C-106 exhaust system.
241-C	Contamination In Ventilation System	Seal loops	condensate	<1 gal [i6]	N/A	liquid	residual	No	One per tank, except C-105 and C-106	Seal loops on breather filters for all tanks except C-105 and C-106.
241-C	Contents of Pipeline and/or Source Tank During Transfer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	See transfer line study.
241-C	Contamination in Pit or Box	Inactive pits*	residual contamination [i1]'	N/A	N/A	residue	N/A	No	N/A	*All pits except those noted below are isolated and inactive [c11-c29, wd]'.

Table A-2. Material at Risk Table. (7 sheets)

Field name	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
241-C	Contamination in Pit or Box	Pump pits*	residual contamination [i1]'	10,000 gal (11' x 14'-6" x 8'-8" [c1]'	N/A	residue	N/A	No	N/A	*Pump pits not isolated on C-102, C-103, C-105, and C-106. Isolated on Tanks C-104 and C-101. See salt well pump pits for C-107 through C-112.
241-C	Contamination in Pit or Box	Heel pits*	residual contamination [i1]'	2000 gal (9' x 6' x 4'-10") [c3]'	N/A	residue	N/A	No	N/A	*Isolated on Tanks C-101 and C-104. C-105 is weather covered. Only expected to be used on C-103 (for salt well pumping) and possibly C-106 in the future. [i4]'
241-C	Contamination in Pit or Box	Salt well pump pits*	residual contamination [i1]'	1000 gal (6' dia x 5' deep) [c4, c5]'	N/A	residue	N/A	No	N/A	*Only potentially active (not weather covered) on C-107, 110, and 112 (see heel pits above) C-110 and C-112 not expected to be used. [i4]'
241-C	Contamination in Pit or Box	Sluice pit*	residual contamination [i1]'	4000 gal (9' x 8'-6" x 7') [c10]'	N/A	residue	N/A	No	N/A	*Potentially active on Tank C-106, which will be sluiced. [i4]'
241-C	Contamination in Pit or Box	Valve pit 241-C	residual contamination [i1]'	5600 gal (10' dia x 9'-6") [c6]'	N/A	residue	N/A	No	N/A	May be used in the future for pumping C-103 [i4]'
241-C	Contamination in Pit or Box	Raw water service pit	raw water	N/A	N/A	liquid	N/A	No	N/A	Service pit only has raw water in it. No longer in use [i1, i4]'

Table A-2. Material at Risk Table. (7 sheets)

Field name	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
241-C	Contamination in Pit or Box	Diversion boxes	residual contamination [i1][1]	N/A	N/A	residue	N/A	No	N/A	All diversion boxes are isolated and inactive [rb, wd][1]

[1]Note defined in WHC-SD-WM-HIE-007, 1996, Tank Waste Remediation System FSAR Hazard Identification Facility Configuration Verification Report, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

*Refer to comment items in the same data row.

**Refer to comment items in the same data Row.

COB = cleanout box.
HEPA = high-efficiency particulate air (filter).
MAR = material at risk.
N/A = not applicable.
NCAW = neutralized current acid waste.
NHW = neutralized high-level waste.
RMW = radioactive mixed waste.
SARA = Superfund Amendments and Reauthorization Act of 1986.
TWRS = Tank Waste Remediation System.

Table A-3. Project W-320 Facility Configurations.

Facility Name	Type	Ventilation	Comment Ventilation	Air Lift Circulator	Comment ALC	Steam Coils	Comment Steam Coils	Mixer Pumps	Comments Mixer Pumps
241-AY-102	Double shell tank	Active	Tank farm A primary ventilation system	Yes		No	Steam coils in tank, steam to facility is blanked off	No	
241-C-105	Single shell tank	Active	Exhauster	No		No	No steam to C Tank Farm	No	
241-C-106	Single shell tank	Active	Exhauster	No		No	No steam to C Tank Farm	No	

ALC = Air lift circulator

Table A-4. TWRS Tank Unique Phenomena. (2 sheets)

Field Name	Type	Flammable Gas	Ferrocyanide	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
				Separable Phase	TOC in liquids (>10 g/L)	TOC in solids >4.5 wt% (dry basis)	Heat generation rate >26,000 BTU				
Legend Boxes->		Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does it exist? (yes/no) Provide reference.	Does potential exist? Provide reference.	Does potential exist? Provide reference.	Does potential exist? Provide reference.
AY FARM											
241-AY-102	Double shell tank	GRE - No, OSD-T-151-30 Steady State - Yes, HNF-SD-WM-BIO-001, Rev. 1, Appendix E	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	Yes, Brevick, 1995, WHC-SD-ER-350, Rev. 0	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0

Table A-4. TWRS Tank Unique Phenomena. (2 sheets)

Field Name	Type	Flammable Gas	Ferrocyanide	Organics Separable Phase	TOC in Liquids	TOC in Solids	High Heat	Pyrophorics	Syphoning	Criticality	Corrosivity
C FARM											
241-C-105	Single shell tank	GRE - No, OSD-T-151-30 Steady State - Yes, HNF-SD-WM-BIO-001, Rev. 1, Appendix E	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	No, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994, WHC-EP-0772
241-C-106	Single shell tank	GRE - No, OSD-T-151-30 Steady State - Yes, HNF-SD-WM-BIO-001, Rev. 1, Appendix E	No, Meacham, 1996, WHC-SD-WM-SARR-038, Rev 1.	Yes, PNNL Letter, from Huckaby to Meacham OT: 073096.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Webb, 1996, WHC-SD-WM-SARR-033, Rev 1	Yes, Kummerer, 1995, WHC-SD-WM-SARR-010, Rev 1.	No, SAIC, 1996, WHC-SD-WM-HIE-007, Rev. 0	No, Syphoning PHA, 1996, WHC-SD-WM-TI-759, Rev. 0	No, Bratzel 1996, WHC-SD-WM-TI-725	Yes, Anantatmula 1994, WHC-EP-0772

HNF-SD-WM-BIO-001, 1998, Tank Waste Remediation System Basis for Interim Operation, Rev. 1, Fluor Daniel Hanford, Inc., Richland, Washington.

Huckaby, J. L., 1996, Technical Basis for Orgscm Spreadsheet (PNNL Letter OT:073096 to J. E. Meacham, Westinghouse Hanford Company, July 30), Pacific Northwest National Laboratory, Richland, Washington.

WHC, 1996, Operating Specifications For Watch List Tanks, Rev. B-23, OSD-T-151-30, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0772, 1994, Characterization of the Corrosion Behavior of the Carbon Steel Liner in Hanford Site Single Shell Tanks, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-350, 1995, Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 Areas, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-HIE-007, 1996, Tank Waste Remediation System FSAR Hazards Identification/Facility Configuration Verification Report, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-010, 1995, Heat Removal Characteristics of Waste Storage Tanks, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-015, 1996, Topical Report on Steady-State Flammable Gas Generation in Waste Tanks, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-033, 1995, Preliminary Safety Criteria for Organic Watch List Tanks at the Hanford Site, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-038, 1996, Assessment of the Potential for Ferrocyanide Propagating Reaction Accidents, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-725, 1996, Tank Farm Nuclear Criticality Review, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-759, 1996, Hazard Evaluations for Tank Waste Remediation System Final Safety Analysis Report, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

N/A = Not Applicable.
PHA = preliminary hazards analysis.
PNNL = Pacific Northwest National Laboratory.
TOC = total organic carbon.

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APPENDIX B

REPRESENTATIVE/ANALYZED ACCIDENTS

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APPENDIX B

REPRESENTATIVE/ANALYZED ACCIDENTS

LIST OF TABLES

B-1 Representative Hazards of Analyzed Accidents B-1
B-2 Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions B-5

LIST OF TERMS

CPS	criticality prevention specification
HEPA	high-efficiency particulate air (filter)
NC	no controls
RP	radiation protection
SST	single-shell tank
TRU	transuranic

Table B-1. Representative Hazards of Analyzed Accidents. (4 sheets)

Bin	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ACCIDENT NUMBER 1 - Nuclear Criticality: WRSS Specific Analysis								
RP	W320-BCD-TRANS01	Tank 241-C-106 Plutonium Inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank pump vortices	1. Natural occurrence if conditions are met	F1	S2	A04	01
ACCIDENT NUMBER 2 - HEPA Filter Failure: WRSS Specific Analysis								
B-1-a	W320-D-ALL01	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to a steam bump	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	F3	S2	D14	02
ACCIDENT NUMBER 3 - Unfiltered Release: WRSS Specific Analysis								
C-1-a	W320-D-VENT07	Tank Dome Space Inventory	Release of low energy radioactive aerosol from Tank 241-C-105/ Tank 241-C-106 ventilation system due to failure to determine ventilation leak during sluicing.	1. Ducting corrosion 2. Seal deterioration	F3	S2	D14	03
ACCIDENT NUMBER 4 - Fire in Contaminated Area: BIO Analysis Bounding								
A-1-a	W320-ABCD-TRANS11	Tank Inventory	Release of energetic radioactive aerosol release from line break due to flammable gas ignition in pit with cover block falling onto piping.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	S3	B08	04
ACCIDENT NUMBER 5 - Caustic Spray Leak: BIO Analysis Bounding								
	Covered by the analysis in Section 3.4.2.5 which will be incorporated into the main text of the TWRS BIO in a future revision							05
ACCIDENT NUMBER 6 - Tank Failure - Due to Excessive Loads: WRSS Specific Analysis								
A-1-a	W320-ABCD-ALL01	Tank Inventory	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome	1. Raw water line rupture 2. Heavy rainfall	F1	S3	C19	06A
A-1-a	W320-ABCD-ALL02	Tank Inventory	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 dome	1. Raw water line rupture 2. Heavy rainfall	F1	S3	C19	06B

Table B-1. Representative Hazards of Analyzed Accidents. (4 sheets)

Bin	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ACCIDENT NUMBER 7 - Tank Failure - Due to Excessive Vacuum: WRSS Specific Analysis, bounded by 6, above								
B-1-a	W320-BCD-ALL03	Tank Inventory	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan over speed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F1	S3	C11	07A
A-1-a	W320-BCD-ALL02	Tank Inventory	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F0	S3	C11	07B
ACCIDENT NUMBER 8 - Flammable Gas Deflagrations - DST/SST: BIO analysis adopted (qualitatively)								
A-1-a	W320-D-ALL07	Tank Inventory	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	F2	S3	B18	08A
A-1-a	W320-BCD-PUMP04	Tank 241-AY-102 Inventory	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	S3	B08	08B
A-1-a	W320-A-TRANS05	Tank 241-C-106 inventory	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	F0	S3	B08	08C

Table B-1. Representative Hazards of Analyzed Accidents. (4 sheets)

Bin	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ACCIDENT NUMBER 9 - Organic Solvent Fire: WRSS Specific Analysis, different organic solvent than BIO								
A-1-a	W320-B-ALL09	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	S3	B04	09A
A-1-a	W320-B-ALL10	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	S3	B04	09B
ACCIDENT NUMBER 10 - In-Tank Fuel Fire/Deflagration: Consequences bounded by accident 9 above								
A-1-a	W320-D-CHILL01	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	F0	S3	B12	10
ACCIDENT NUMBER 11 - Steam Bump: WRSS Specific Analysis								
C-1-a	W320-D-TRANS08	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters due to excessive fluffing of waste in Tank 241-AY-102 resulting in large steam bump and unfiltered release.	1. Inadequate prediction of waste behavior	F1	S2	D01	11
ACCIDENT NUMBER 12 - Steam Explosion between Steel Liner and Concrete Shell: WRSS Specific Analysis								
B-1-a	W320-ABCD-TRANS01	Tank Inventory	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	F3	S2	D04	12
ACCIDENT NUMBER 13 - Subsurface Leak Remaining Subsurface: WRSS Specific Analysis								
C-3-b	W320-B-TRANS19	Transfer Line Inventory	Release of radioactive liquid from breached transfer line due to a leak from primary transfer line and a defective secondary line resulting in an underground spill.	1. Line corrosion 2. ground movement 3. Aging	F1	S0	D12	13

Table B-1. Representative Hazards of Analyzed Accidents. (4 sheets)

Bin	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
ACCIDENT NUMBER 14 - Subsurface Leak Resulting in Pool: WRSS Specific Analysis								
C-2-b	W320-B-TRANS22	Tank 241-AY-102 inventory	Release of radioactive liquid from transfer line due to local flooding during transfer which results in line being uncovered and breached.	1. Raw water leak 2. Natural flow	F3	S2	D19	14
ACCIDENT NUMBER 15 - Surface Leak Resulting in Pool: WRSS Specific Analysis								
C-2-b	W320-B-FLUSH06	Flushing water in Tank 241-AY-102 Pit	Release of radioactive liquid from transfer line due to a pipe break in Tank 241-AY-102 pit with the high capacity drain cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	F2	S2	D12	15A
C-2-b	W320-BCD-TRANS10	Tank 241-AY-102 inventory	Release of radioactive liquid release from sluice transfer line due to the blank flange being left off flushing connection in Tank 241-AY-102 pit and drain cover left on resulting in overflow of pit onto the ground during sluicing.	1. Maintenance error 2. Communications error between different groups using the pit	F2	S2	E06	15B
ACCIDENT NUMBER 16 - Spray Leak in Structure or from Overground Waste Transfer: WRSS Specific Analysis								
A-1-a	W320-BCD-TRANS11	Transfer Line Inventory	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	S3	E06	16A
A-1-a	W320-BCD-TRANS12	Transfer Line Inventory	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	S3	E06	16B
ACCIDENT NUMBER 17 - Spray Leak from Underground Waste Transfer Line: WRSS Specific Analysis								
B-1-a	W320-D-TRANS11	Transfer Line Inventory	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	F1	S3	D18	17

CPS = criticality prevention specifications.
DST = double-shell tank.
HEPA = high-efficiency particulate air.
SST = single-shell tank.

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 1 - Nuclear Criticality								
RP	W320-BCD-TRANS 01	Tank 241-C-106 Plutonium Inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank pump vortices	1. Natural occurrence if conditions are met	F1	S2	A04	01
HAZARDOUS CONDITIONS								
RP	W320-BCD-TRANS 04	Tank 241-C-106 Plutonium Inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank during sluicing	1. Natural occurrence if conditions are met	F1	S2	A04	01X
RP	W320-D-TERM01	Tank 241-C-106 and Tank 241-AY-102 Plutonium Inventory	Release of ionizing radiation and radioactive gas from Tank 241-AY-102 due to a criticality event in the tank	1. Natural occurrence if conditions are met	F1	S2	A04	01X
RP	W320-BCD-TRANS 02	Tank 241-C-106 Plutonium Inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Flushing valve misposition 2. Pump controller fault 3. Excessive solids in slurry flow	F0	S2	A04	01X
RP	W320-BCD-TRANS 03	Tank 241-C-106 Plutonium Inventory	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	S2	A04	01X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 2 - HEPA Filter Failure								
B-1-a	W320-D-ALL01	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to a steam bump	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	F3	S2	D14	02
HAZARDOUS CONDITIONS								
C-1-a	W320-ALL-TRANS 01	Duct and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to moisture buildup on ventilation system HEPA filters	1. Natural occurrence under proper conditions	F2	S2	D14	02X
C-1-a	W320-D-TRANS02	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to excessive sluicer flow which results in radioactive air release through HEPAs.	1. Natural outcome if conditions are met	F2	S2	D04	02X
C-1-a	W320-D-VENT04	Tank Dome Space Inventory	Release of small low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to cold water spray into tank, tank vacuum and resulting tank bump	1. Possible result of slurry distribution	F1	S2	D11	02X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-B-FLUSH01	Tank Inventory	Release of energetic radioactive aerosol from damaged Tank 241-C-106 single shell tank due to ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank.	1. Maintenance error 2. Communications error between different groups using the pit	F0	S2	D07	02X
B-1-a	W320-B-FLUSH02	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters due to a large steam bump in Tank 241-C-106 as a result of high tank vacuum resulting from flushing water spray condensing dome vapors.	1. Planned	F0	S2	D07	02X
C-1-a	W320-B-FLUSH03	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to a large steam bump as a result of high tank vacuum due to high condensation rate in tank from flushing water spray through antisiphon holes.	1. Planned	F0	S2	D07	02X
B-1-a	W320-B-TRANS01	Tank 241-AY-102 inventory	Release of small low energy aerosolized waste from the annulus of Tank 241-AY-102 due to steam pulses from boiling waste in annulus region which results in the failure of annulus filters. Waste leaks into annulus due to corrosion of primary tank from new waste composition.	1. Inadequate prediction of waste behavior	F0	S2	D16	02X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 3 - Unfiltered Release								
C-1-a	W320-D-VENT07	Tank Dome Space Inventory	Release of low energy radioactive aerosol from Tank 241-C-105/Tank 241-C-106 ventilation system due to failure to determine ventilation leak during sluicing.	1. Ducting corrosion 2. Seal deterioration	F3	S2	D14	03
HAZARDOUS CONDITIONS								
C-1-a	W320-D-VENT08	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from new ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	F3	S2	D11	03X
C-1-a	W320-D-VENT11	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from current ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	F3	S2	D11	03X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-ABCD-CHILL01	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact tank due to excessive cooling from process chiller and vacuum in Tank 241-C-106 from ventilation system which results in exceedance of loop seal vacuum and unfiltered release.	1. Chiller control fault 2. High humidity	F2	S2	D11	03X
C-1-a	W320-B-TRANS06	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive slurry flow resulting in increased aerosol generation and errant flow release.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	F2	S2	D15	03X
C-1-a	W320-B-TRANS07	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to startup of slurry flow to distributor resulting in air being bubbled through waste and release of vapor.	1. Normal procedure	F2	S2	D04	03X
C-1-a	W320-B-TRANS11	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive corrosion and heat loading from new waste.	1. Inadequate prediction of waste behavior	F2	S2	D16	03X
C-1-a	W320-B-TRANS12	Tank Dome Space Inventory	Release of low energy radioactive aerosol from interconnected tanks due to increased heat loading of Tank 241-AY-102 and loss of vacuum.	1. Inadequate prediction of waste behavior 2. Existing system cannot control flow rates from different tanks. Depends on inleakage 3. W030 system has lower exhaust capabilities	F2	S2	D01	03X
C-1-a	W320-D-TRANS04	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to high temperature sluice water which increases head space pressure with increased errant flow.	1. High temperature in Tank 241-AY-102	F2	S2	D04	03X
C-1-a	W320-B-TRANS08	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of distributor 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F1	S2	D15	03X
C-1-a	W320-B-TRANS10	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F1	S2	D04	03X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-E-TERM01	Tank Inventory	Release of large high energy radioactive aerosol from Tank 241-AY-102 due to excessive fluffing of waste which results in tank structural damage and unfiltered release.	1. Inadequate prediction of waste behavior	F1	S2	D01	03X
C-1-a	W320-D-PURGE01	Tank Dome Space Inventory	Release of low energy aerosolized waste from largely intact Tank 241-C-106 due to nitrogen line break and loss of vacuum.	1. Tube failure 2. Improper Assembly 3. Regulator fault	F0	S2	D12	03X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 4 - Fire in Contaminated Area								
A-1-a	W320-ABCD-TRANS11	Tank Inventory	Release of energetic radioactive aerosol release from line break due to flammable gas ignition in pit with cover block falling onto piping.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	S3	B08	04
HAZARDOUS CONDITIONS								
A-1-a	W320-ABCD-CHILL02	Pit radionuclide inventory	Release of energetic radioactive aerosol from covered pit or dead end pipe due to propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome.	1. Piping or tubing leak	F1	S2	B12	04X
A-1-a	W320-BCD-ALL01	Pit radionuclide inventory	Release of energetic radioactive aerosol from covered pit on Tank 241-C-106 due to propylene glycol leak into pit with ignition.	1. Piping or tubing leak	F1	S2	B12	04X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 5 - Caustic Spray Leak								
COVERED BY THE ANALYSIS IN SECTION 3.4.2.5 WHICH WILL BE INCORPORATED INTO THE MAIN TEXT OF THE TWRS BIO IN A FUTURE REVISION								
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 6 - Tank Failure - Due to Excessive Loads								
A-1-a	W320-ABCD-ALL01	Tank Inventory	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome	1. Raw water line rupture 2. Heavy rainfall	F1	S3	C19	06A
A-1-a	W320-ABCD-ALL02	Tank Inventory	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 dome	1. Raw water line rupture 2. Heavy rainfall	F1	S3	C19	06B
HAZARDOUS CONDITIONS								
A-1-a	W320-ABCD-ALL03	Tank Inventory	Release of energetic radioactive aerosol from tank dome collapse due to flooding on top of tank dome	1. Raw water line rupture 2. Heavy rainfall	F0	S3	C19	06X
A-1-a	W320-B-ALL01	Tank Inventory	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	F0	S3	C18	06X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-B-ALL02	Tank Inventory	Release of a large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to volcanic ashfall.	1. Natural phenomena	F0	S3	C18	06X
A-1-a	W320-B-ALL03	Tank Inventory	Release of high energy aerosolized waste to the atmosphere from Tank 241-C-106 dome collapse due to extreme snow fall.	1. Natural phenomena	F0	S3	C10	06X
A-1-a	W320-B-ALL04	Tank Inventory	Release of large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to extreme snow fall.	1. Natural phenomena	F0	S3	C10	06X
A-1-a	W320-B-ALL05	Tank Inventory	Release of energetic radioactive aerosol from Tank 241-C-106 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	F0	S3	C11	06X
A-1-a	W320-B-ALL06	Tank Inventory	Release of energetic radioactive aerosol from Tank 241-AY-102 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	F0	S3	C11	06X
C-1-a	W320-D-TRANS03	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to sluicer moving debris impacting drop leg in tank which breaches dome.	1. Expected outcome of high velocity sluicing Many objects are in the waste	F2	S2	D04	06X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 7 - Tank Failure - Due to Excessive Vacuum								
B-1-a	W320-BCD-ALL03	Tank Inventory	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan over speed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F1	S3	C11	07A
A-1-a	W320-BCD-ALL02	Tank Inventory	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F0	S3	C11	07B
HAZARDOUS CONDITIONS								
A-1-a	W320-ABCD-CHILL03	Tank Inventory	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to excessive cooling from process chiller which restricts inflow and loop seal fails to operate.	1. Chiller control fault 2. High humidity	F1	S3	D11	07X
C-1-a	W320-B-FLUSH04	Tank Dome Space Inventory	Release of low energy radioactive aerosol from breached Tank 241-C-106 due to flushing water spray through sluice nozzle resulting in excessive tank vacuum.	1. Planned	F1	S3	D11	07X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-VENT12	Tank Inventory	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	F1	S3	C11	07X
A-1-a	W320-D-VENT20	Tank Inventory	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	F1	S3	C11	07X
C-1-a	W320-B-VENT03	Tank Dome Space Inventory	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through W030 ventilation upgrade and results in excessive vacuum.	1. Natural phenomena	F2	S2	D20	07X
C-1-a	W320-B-VENT04	Tank Dome Space Inventory	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing exhaust system with W030 intake and results in excessive vacuum.	1. Natural phenomena	F2	S2	D24	07X
C-1-a	W320-B-VENT06	Tank Dome Space Inventory	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing ventilation system and results in excessive vacuum.	1. Natural phenomena	F2	S2	D11	07X
C-1-a	W320-B-VENT07	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact tank due to volcanic ashfall preventing air inflow into Tank 241-AY-102 through existing ventilation system resulting in tank breach.	1. Natural phenomena	F1	S2	D18	07X
C-1-a	W320-BCD-ALL04	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to fan controller failure resulting in excessive vacuum in tank and loop seal actuation.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F1	S2	D11	07X
C-1-a	W320-B-FLUSH05	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to flushing water spray through antisiphon holes resulting in excessive vacuum in tank and tank breach.	1. Planned	F0	S2	D11	07X
C-1-a	W320-B-VENT01	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through existing ventilation system with W030 intake resulting in excessive vacuum and tank breach.	1. Natural phenomena	F0	S2	D18	07X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-B-VENT02	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through W030 ventilation upgrade system resulting in excessive vacuum and tank breach.	1. Natural phenomena	F0	S2	D18	07X
C-1-a	W320-B-VENT05	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to cold water spray into tank which results in excessive vacuum and tank breach.	1. Possible result of slurry distribution	F0	S2	D11	07X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 8 - Flammable Gas Deflagrations - DST/SST								
A-1-a	W320-D-ALL07	Tank Inventory	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	F2	S3	B18	08A
A-1-a	W320-BCD-PUMP04	Tank 241-AY-102 Inventory	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	S3	B08	08B
A-1-a	W320-A-TRANS05	Tank 241-C-106 inventory	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	F0	S3	B08	08C
HAZARDOUS CONDITIONS								
A-1-a	W320-ABCDF-ALL01*	Tank Inventory	Release of energetic radioactive aerosol to atmosphere due to buildup of flammable gas in Tank 241-AY-102 pit drain pipe which is then ignited.	1. Flammable gas generation from tank waste	F1	S3	B08	08X
A-1-a	W320-D-ALL08	Tank Inventory	Release of energetic radioactive aerosol to atmosphere due to start of air lift circulators in Tank 241-AY-102 resulting in a release of flammable gas plume which is then ignited.	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	F1	S3	B08	08X
A-1-a	W320-D-TRANS05	Tank Inventory	Release of energetic radioactive aerosol to atmosphere due to head space gas concentration above LFL in Tank 241-AY-102 with the start of pumping which ignites the flammable gas.	1. Spontaneous GRE 2. Induced GRE	F1	S3	B08	08X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-TRANS07	Tank 241-AY-102 inventory	Release of high energetic aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-AY-102 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with ignition.	1. Operator mistake 2. Level indication fault 3. Pump controller fault	F1	S3	B08	08X
A-1-a	W320-D-VENT17	Tank 241-AY-102 Inventory	Release of high energy aerosolized release to the atmosphere due to an ice storm which prevents air inflow into Tank 241-AY-102 resulting in an excessive tank vacuum. This results in a flammable gas release with ignition.	1. Natural phenomena	F1	S3	B08	08X
A-1-a	W320-B-ALL08	Tank Inventory	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 due to a large water intrusion which induces a flammable gas release event. It is then ignited resulting in a dome space fire.	1. Raw water leak 2. Surface water flood	F0	S3	B08	08X
A-1-a	W320-B-TRANS14	Tank Inventory	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to low slurry flow to distributor which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	F0	S3	B08	08X
A-1-a	W320-B-TRANS15	Tank Inventory	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to air injected into the waste from the startup of slurry flow from the distributor. Gas is scrubbed from the waste and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Normal procedure	F0	S3	B08	08X
A-1-a	W320-B-TRANS16	Tank Inventory	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to distributor nozzle breaking off which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	S3	B08	08X
A-1-a	W320-D-VENT13	Tank Inventory	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to influx of cold water spray into tank which results in an excessive vacuum. A large flammable gas release is induced. It is then ignited resulting in a dome space fire.	1. Possible result of slurry distribution	F0	S3	B08	08X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-VENT16	Tank 241-AY-102 Inventory	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas builds up in the dome space to the LFL. It is then ignited resulting in a dome space fire.	1. Extended loss of power 2. Severe ventilation casualty	F0	S3	B08	08X
A-1-a	W320-D-VENT18	Tank 241-AY-102 Inventory	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to volcanic ashfall which prevents air inflow to tank. Excessive vacuum results and flammable gas is released to the dome space. It is then ignited resulting in a dome space fire.	1. Natural phenomena	F0	S3	B18	08X
A-1-a	W320-E-TERM03	Tank Inventory	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to lack of controls on operation of tank after it has been turned into a FG group 1 tank. It is ignited from a lightning strike or other event resulting in a dome space fire.	1. Inadequate prediction of waste behavior	F0	S3	D01	08X
C-1-a	W320-B-TERM01	Tank Toxic Gas Inventory	Release of toxic ammonia gas from tank due to burp which exposes facility personnel to toxic gases.	1. Inadequate prediction of waste behavior	F2	S2	D01	08X
C-1-a	W320-B-TRANS13	Tank Dome Space Inventory	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-AY-102 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	S2	B08	08X
A-1-a	W320-D-VENT15	Pit radionuclide inventory	Small low energy radioactive aerosolized waste release from standpipes in Tank 241-AY-102 due to flammable gas buildup where it is ignited resulting in the pipe being breached resulting in an unfiltered release.	1. Natural occurrence under proper conditions	F2	S2	B08	08X
A-1-a	W320-BCD-ALL10	Transfer Line Inventory	Small high energy aerosolized waste release to the atmosphere due to plugging and buildup of flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	F1	S2	B08	08X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-BCD-PUMP03	Tank 241-AY-102 inventory	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	S2	B08	08X
A-1-a	W320-D-VENT14	Pit radionuclide inventory	Small high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas leaks into annulus. It is then ignited resulting in the annulus being breached.	1. Extended loss of power 2. Severe ventilation casualty	F0	S2	B08	08X
A-1-a	W320-D-PUMP04	Tank Inventory	Release of energetic radioactive aerosol from damaged Tank 241-AY-102 due to pumping of more solids than anticipated. Annulus cooling mod not completed resulting in overheating of waste and a tank bump. Bump induces large flammable gas release. It is then ignited resulting in a dome space fire.	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning slurry pump 3. Inadvertent or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump Tank 241-C-106 fault 6. Pump controller fault	F0	S3	B08	08X
C-1-a	W320-B-ALL07	Tank Dome Space Inventory	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-C-106 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F3	S2	B08	08X
A-1-a	W320-BCD-ALL05	Transfer Line Inventory	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	F1	S2	B08	08X
A-1-a	W320-BCD-ALL06	Transfer Line Inventory	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited and detonates resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	F1	S2	B08	08X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-BCD-PUMP05	Tank Inventory	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-C-106, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F1	S2	B08	08X
A-1-a	W320-A-TRANS04	Tank Inventory	Release of large high energy aerosolized waste from Tank 241-C-106 due to high waste temperature during slurry transfer which results in a steam bump. Bump induces flammable gas release which is ignited resulting in a dome burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F0	S2	B08	08X
A-1-a	W320-B-TRANS17	Tank Inventory	Release of high energy aerosolized waste from damaged Tank 241-C-106 due to the sluicer hose breaking which then impinges into the solids releasing a region of retained flammable gas. The gas is then ignited and a plume fire results.	1. Primary failure of Hose 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Fatigue from vibration	F0	S2	B08	08X
A-1-a	W320-B-TRANS18	Tank Inventory	Release of large high energy aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-C-106 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with a plume burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F0	S2	B08	08X
A-1-a	W320-BCD-PUMP09	Tank Inventory	Release of large high energy aerosolized waste to atmosphere due to immersible pump being raised too high in Tank 241-C-106, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	S2	B08	08X
A-1-a	W320-D-TRANS06	Tank Inventory	Release of large high energy aerosolized waste to the atmosphere due to slurry transfer rate being excessive resulting in a rapid reduction in the hydrostatic pressure in Tank 241-C-106. This results in a flammable gas release. Gas is ignited and a dome space fire results.	1. Sluice flow control fault	F0	S2	B04	08X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 9 - Organic Solvent Fire								
A-1-a	W320-B-ALL09	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	S3	B04	09A
A-1-a	W320-B-ALL10	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	S3	B04	09B
HAZARDOUS CONDITIONS								
A-1-a	W320-A-TRANS06	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to waste temperature being out of specification during start of slurry transfer in Tank 241-C-106 and subsequent ignition of organics.	1. Operator mistake 2. Temperature measurement fault	F0	S3	B08	09X
A-1-a	W320-B-VENT08	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-C-106 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	F0	S3	B07	09X
A-1-a	W320-B-VENT09*	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-AY-102 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	F0	S3	B07	09X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 10 - In-Tank Fuel Fire/Deflagration								
A-1-a	W320-D-CHILL01	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	F0	S3	B12	10
HAZARDOUS CONDITIONS								
A-1-a	W320-D-CHILL02	Tank Inventory and Filter Burden	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from ventilation chiller into Tank 241-C-106.	1. Piping or tubing leak	F0	S3	B12	10X
A-1a	W320-ALL-VENT01	Duct and Filter Burden	Release of energetic radioactive aerosol from breached ventilation duct for Tank 241-AY-102 due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	F1	S2	B08	10X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1a	W320-D-VENT01	Tank Dome Space Inventory and Filter Burden	Release of energetic radioactive aerosol from filter breach due to a buildup of ammonium nitrate in ventilation ducting of Tank 241-AY-102 and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	F1	S2	B08	10X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 11 - Steam Bump								
C-1-a	W320-D-TRANS08	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters due to excessive fluffing of waste in Tank 241-AY-102 resulting in large steam bump and unfiltered release.	1. Inadequate prediction of waste behavior	F1	S2	D01	11
HAZARDOUS CONDITIONS								
B-1-a	W320-A-TRANS03	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to high waste temperature during slurry transfer and resulting steam bump.	1. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump	F3	S2	D14	11X
B-1-a	W320-A-TRANS01	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to a large steam bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F2	S2	D14	11X
B-1-a	W320-D-ALL05	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to long term loss of ventilation system resulting in tank bump and blowout of filters.	1. Loss of power 2. Equipment casualty	F2	S2	D14	11X
C-1-a	W320-D-VENT03	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters in the 702A ventilation system of Tank 241-AY-102 due to severe ice storm, excessive tank vacuum and resulting tank bump.	1. Natural phenomena	F2	S2	D11	11X
C-1-a	W320-D-VENT05	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters in the W030 ventilation system due to severe ice storm, excessive tank vacuum and resulting tank bump.	1. Natural phenomena	F2	S2	D11	11X
C-1-a	W320-B-TRANS02	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to low slurry flow, piling of waste at base of distributor and resulting tank bump.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	F1	S2	D07	11X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-B-TRANS04	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to high slurry transfer rate, high waste temperature and resulting tank bump.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F1	S2	D14	11X
C-1-a	W320-B-TRANS05	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of low slurry flow which results in steam bump and increased head space vapor pressure.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	F1	S2	D14	11X
C-1-a	W320-B-TRANS09	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of the distributor nozzle breaking off which results in steam bump and increased head space vapor pressure.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F1	S2	D16	11X
C-1-a	W320-BCD-TRANS 08	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to undetected high waste temperature and resulting tank bump	1. Expected outcome of high pressure sluice. Many objects are in the waste.	F1	S2	D04	11X
A-1-a	W320-D-ALL02	Tank Inventory	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to barometric pressure change, high waste temperature and resulting tank bump	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	F1	S2	D07	11X
C-1-a	W320-D-TRANS01	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to rapid waste level change, high waste temperature and resulting tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-AY-102 pump 3. Inadvertent or accidental actuation of Tank 241-AY-102 pump but not Tank 241-C-106 pump 4. ENRAF level indication fault 5. Pump controller fault	F1	S2	D14	11X
C-1-a	W320-D-VENT09	Tank Dome Space Inventory	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to loss of primary or annulus ventilation which results in steam release.	1. Extended loss of power 2. Severe ventilation casualty	F1	S2	D07	11X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-A-TRANS02	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to lowering of tank level with temperature out of spec resulting in tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. ENRAF level indication fault 4. Pump controller fault 5. Tank 241-C-106 T/C fault	F0	S2	D14	11X
C-1-a	W320-B-PUMP01	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to overheating of waste and subsequent steam bump	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning 3. Inadvertent or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump fault 6. Pump controller fault	F0	S2	D14	11X
C-1-a	W320-B-TRANS03	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters due to condensation of vapor in head space of Tank 241-C-106 which resulted from the breaking off of sluicer head.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	S2	D07	11X
C-1-a	W320-BCD-TRANS 05	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters due to tank bump in Tank 241-AY-102 resulting from the vacuum developed in the head space from the condensation of vapor which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	S2	D16	11X
C-1-a	W320-BCD-TRANS 06	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to tank bump resulting from the which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	S2	D16	11X
C-1-a	W320-BCD-TRANS 07	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters of Tank 241-C-106 due to failure of T/C Tree, sluicing outside of temperature specs, atmospheric change, and large steam bump resulting in filter breach.	1. Sluice flow control fault 2. Operator error	F0	S2	D04	11X
A-1-a	W320-D-ALL03	Tank Inventory	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	F0	S2	D07	11X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-D-ALL04	Tank Inventory	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	F0	S2	D07	11X
B-1-a	W320-D-VENT02	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to inadequate ventilation from W030 resulting in increased waste temperature, steam bump and filter breach.	1. Error in calculations 2. Design error 3. Construction fault	F0	S2	D14	11X
C-1-a	W320-D-VENT06	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to volcanic ashfall , excessive vacuum resulting in large steam bump and filter blowout.	1. Natural phenomena	F0	S2	D18	11X
B-1-a	W320-D-VENT19	Tank Dome Space Inventory and Filter Burden	Release of low energy radioactive aerosol through failed filters due to loss of primary or annulus ventilation for extended period of time resulting in rise in waste temperature and large bump in Tank 241-AY-102.	1. Extended loss of power 2. Severe ventilation casualty	F0	S2	D14	11X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 12 - Steam Explosion between Steel Liner and Concrete Shell								
B-1-a	W320-ABCD-TRANS01	Tank Inventory	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	F3	S2	D04	12
HAZARDOUS CONDITIONS								
B-3-b	W320-ABCD-ALL04	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F3	S2	D12	12X
B-3-b	W320-ABCD-ALL05	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F2	S2	D12	12X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-ABCD-TRAN S02	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to loss of sluicer arm control in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Unavoidable operator action	F2	S2	D04	12X
B-1-a	W320-ABCD-TRAN S05	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer hose break in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breaching of tank bottom.	1. Primary failure of Hose 2. Severe Water hammer 3. Fatigue from vibration	F2	S2	D04	12X
B-1-a	W320-ABCD-TRAN S07	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	F2	S2	D04	12X
B-1-a	W320-ABCD-TRAN S08	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	F2	S2	D04	12X
B-1-a	W320-BCD-ALL08	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to excessive corrosion because of waste disturbance in Tank 241-C-106 resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Inadequate prediction of waste behavior	F2	S2	D16	12X
B-3-b	W320-BCD-TRANS 09	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 water exceeds maximum operating level resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Loss of power 2. Equipment casualty	F2	S2	D12	12X
C-3-b	W320-D-ALL09	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to seismic event Tank 241-C-106 liner is breached resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Natural Phenomena	F2	S2	D18	12X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-D-TRANS09	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to movement of debris during sluicing which impacts and breaches the Tank 241-C-106 liner, resulting in water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Expected outcome of high pressure sluice. Many objects are in the waste.	F2	S2	D04	12X
A-1-a	W320-ABCD-TRAN S03	Tank 241-C-106 inventory	Release of liquid waste below grade and aerosol release to atmosphere due to siphoning of waste from Tank 241-AY-102 after the stoppage of pumping water exceeds maximum operating level in Tank 241-C-106 resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Buildup of solids in openings 2. Equipment casualty	F1	S2	D04	12X
B-1-a	W320-ABCD-TRAN S09	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to excessive waste temperature change rate Tank 241-C-106 liner breaches, resulting in water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. High temperature in Tank 241-AY-102	F1	S2	D04	12X
A-1-a	W320-BCD-ALL07	Tank 241-C-106 Overflow Volume	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, bulging of tank bottom, ripping of liner and steam bump.	1. Raw water leak 2. Surface water flood	F1	S2	D06	12X
B-1-a	W320-F-TERM05	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to high heat load after completion of sluicing process resulting in the need for water addition to Tank 241-C-106 with a deteriorated tank liner, water leakage into liner gap, steam formation, liner breach and steam bump.	1. Error in calculations	F1	S2	D12	12X
B-1-a	W320-ABCD-TRAN S06	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to sluicing arm breaking off and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner breach and steam bump.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	S2	D04	12X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
B-1-a	W320-BCD-PUMP08	Tank Inventory	Release of liquid waste below grade and aerosol release to atmosphere due to submersible pump being raised too high, winch lifting strap breaking, pump falling and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner bulges/rips and steam bump occurs.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	S2	D14	12X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 13 - Subsurface Leak Remaining Subsurface								
C-3-b	W320-B-TRANS19	Transfer Line Inventory	Release of radioactive liquid from breached transfer line due to a leak from primary transfer line and a defective secondary line resulting in an underground spill.	1. Line corrosion 2. ground movement 3. Aging	F1	S0	D12	13
HAZARDOUS CONDITIONS								
C-3-b	W320-B-ALL11	Tank Inventory	Release of liquid waste due to large water intrusion into Tank 241-C-106 resulting in high hydrostatic pressure and tank breach.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F2	S2	D19	13X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 14 - Subsurface Leak Resulting in Pool								
C-2-b	W320-B-TRANS22	Tank 241-AY-102 inventory	Release of radioactive liquid from transfer line due to local flooding during transfer which results in line being uncovered and breached.	1. Raw water leak 2. Natural flow	F3	S2	D19	14
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 15 - Surface Leak Resulting in Pool								
C-2-b	W320-B-FLUSH06	Flushing water in Tank 241-AY-102 Pit	Release of radioactive liquid from transfer line due to a pipe break in Tank 241-AY-102 pit with the high capacity drain cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	F2	S2	D12	15A
C-2-b	W320-BCD-TRANS10	Tank 241-AY-102 inventory	Release of radioactive liquid release from sluice transfer line due to the blank flange being left off flushing connection in Tank 241-AY-102 pit and drain cover left on resulting in overflow of pit onto the ground during sluicing.	1. Maintenance error 2. Communications error between different groups using the pit	F2	S2	E06	15B

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
HAZARDOUS CONDITIONS								
C-2-b	W320-ABCD-ALL07	Tank 241-C-106 Overflow Volume	Release of radioactive liquid from Tank 241-C-106 onto the ground due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F1	S3	D06	15X
C-2-b	W320-ABCD-ALL08*	Tank 241-C-106 Overflow Volume	Release of radioactive liquid from Tank 241-C-106 due to siphoning of waste from Tank 241-AY-102 into Tank 241-C-106.	1. Plugging of antisiphon holes 2. Loss of electrical power to the pumps 3. Shutdown from operations	F1	S3	D06	15X
C-2-b	W320-B-FLUSH07	Flushing water in transfer line	Release of radioactive liquid from transfer line due to pipe break in pit during flushing and drain plug cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	F2	S2	D12	15X
C-2-b	W320-B-ALL13	Tank 241-AY-102 Overflow Volume	Release of radioactive liquid from Tank 241-AY-102 due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage	F1	S2	D06	15X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 16 Spray Leak in Structure or from Overground Waste Transfer								
A-1-a	W320-BCD-TRANS11	Transfer Line Inventory	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	S3	E06	16A
A-1-a	W320-BCD-TRANS12	Transfer Line Inventory	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	S3	E06	16B
HAZARDOUS CONDITIONS								
A-1-a	W320-BCD-FLUSH01	Transfer Line Inventory	Release of energetic radioactive aerosol from transfer line due to 3 way valve left in flush position after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	S3	E06	16X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-BCD-FLUSH 02*	Transfer Line Inventory	Release of energetic radioactive aerosol from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled and pressurized resulting in rupture of tank or transfer line.	1. Human error 2. Communications error between different groups	F3	S3	E06	16X
A-1-a	W320-ABCD-TRAN S11	Tank Inventory	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	S3	B08	16X
B-1-a	W320-ABCD-TRAN S12	Transfer Line Inventory	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in distributor pit of Tank 241-AY-102 with cover block off during slurry transfer.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	S3	D12	16X
A-1-a	W320-B-TRANS23	Transfer Line Inventory	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-AY-102 with cover block off during sluicing.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	S3	D12	16X
A-1-a	W320-B-TRANS24	Transfer Line Inventory	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	S3	D12	16X
A-1-a	W320-B-TRANS25	Transfer Line Inventory	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in sluice pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	S3	D12	16X
A-1-a	W320-B-TRANS26	Transfer Line Inventory	Release of energetic radioactive aerosol from transfer line in Tank 241-C-106 pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	S3	B08	16X
B-1-a	W320-D-TRANS10	Transfer Line Inventory	Release of energetic radioactive aerosol from jumper in pit due to seismic event. Cover block breached by ground motion resulting in spray release.	1. Natural Phenomena	F2	S3	D18	16X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-B-TRANS27	Transfer Line Inventory	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F1	S3	B08	16X
B-1-a	W320-D-PUMP01	Tank 241-AY-102 Inventory	Release of energetic radioactive aerosol from line break in Tank 241-AY-102 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertent or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	F1	S3	D12	16X
B-1-a	W320-D-PUMP03	Transfer Line Inventory	Release of energetic radioactive aerosol from line break in Tank 241-C-106 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertent or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	F1	S3	D12	16X
B-1-a	W320-B-TRANS28	Tank 241-C-106 inventory	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 distributor pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	S2	D12	16X
B-1-a	W320-B-TRANS29	Tank 241-AY-102 inventory	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	S2	D12	16X
B-1-a	W320-B-TRANS30	Tank 241-C-106 inventory	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	S2	D12	16X
B-1-a	W320-B-TRANS31	Tank 241-AY-102 inventory	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 sluice pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	S2	D12	16X

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
A-1-a	W320-BCD-TRANS 13	Tank 241-C-106 inventory	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection and 3 way valve left in flush position after flushing. Cover plug remains in place on initiation of sluicing process. High capacity drain cover left on and pit overflows.	1. Maintenance error 2. Communications error between different groups using the pit	F3	S2	E06	16X
HAZARDOUS CONDITION OF ANALYZED ACCIDENT: 17 - Spray Leak from Underground Waste Transfer Line								
B-1-a	W320-D-TRANS11	Transfer Line Inventory	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	F1	S3	D18	17
HAZARDOUS CONDITIONS								
A-1-a	W320-B-TRANS32	Transfer Line Inventory	Release of large high energy aerosolized radioactive waste from a spray leak from transfer line break due to aircraft strike on underground transfer line berm.	1. Light aircraft crash	F1	S3	D23	17X
HAZARDOUS CONDITIONS: 18a - Natural Phenomena - Seismic Events								
C-1-a	W320-D-ALL06	Tank Dome Space Inventory and Filter Burden	Release of a small amount of low energy aerosolized waste through failed filters due to seismic event which induces a steam bump in Tank 241-AY-102, and failure of filters or ducting.	1. Natural Phenomena	F1	S2	D18	18F
HAZARDOUS CONDITIONS: 18e - Natural Phenomena - Volcanic Activity								
A-1-a	W320-B-ALL01-d up	Tank Inventory	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	F0	S3	C18	06X
A-1-a	W320-D-VENT18-dup	Tank 241-AY-102 Inventory	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to volcanic ashfall which prevents air inflow to tank. Excessive vacuum results and flammable gas is released to the dome space. It is then ignited resulting in a dome space fire.	1. Natural phenomena	F0	S3	B18	08X
HAZARDOUS CONDITIONS: 18f - Natural Phenomena - High Winds/Dust Devils								
C-1-a	W320-ALL-TRANS 02	Duct and Filter Burden	Release of small high energy aerosolized waste due to high winds or tornado resulting in failed ventilation ducting and unfiltered release.	1. Natural occurrence under proper conditions	F2	S2	D20	18A

Table B-2. Representative Hazards of Analyzed Accidents and the Represented Hazardous Conditions. (24 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	Rep Acc
C-1-a	W320-B-ALL14	Tank Dome Space Inventory	Release of small low energy aerosolized waste to the atmosphere from intact pit due to high winds/dust devils during plug removal from pit cover.	1. High winds	F1	S2	D20	18A
Radiation Protection								
RP	W320-BCD-FLUSH 03*	Transfer Line Inventory	Personnel exposure to ionizing radiation from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled with radioactive material.	1. Operator Error 2. Failure in submersible pump circuitry	F3	S2	F06	21X

APPENDIX C

HAZARD EVALUATION RESULTS

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APPENDIX C

HAZARD EVALUATION RESULTS

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APPENDIX C
LIST OF TERMS

ALC	air lift circulator
GRE	gas release event
IOSR	Interim Operational Safety Requirements
LFL	lower flammability limit

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (6 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-FLUSH01	Release of energetic radioactive aerosol from transfer line due to 3-way valve left in flush position after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	E2
W320-BCD-FLUSH02*	Release of energetic radioactive aerosol from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled and pressurized resulting in rupture of tank or transfer line.	1. Human error 2. Communications error between different groups	F3	E2
W320-BCD-TRANS11	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	E2
W320-BCD-TRANS12	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	E2
W320-ABCD-TRANS11	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	E2
W320-ABCD-TRANS11	Release of energetic radioactive aerosol release from line break due to flammable gas ignition in pit with cover block falling onto piping.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	E2
W320-ABCD-TRANS12	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in distributor pit of Tank 241-AY-102 with cover block off during slurry transfer.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2
W320-B-TRANS23	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-AY-102 with cover block off during sluicing.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2
W320-B-TRANS24	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2
W320-B-TRANS25	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in sluice pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (6 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS26	Release of energetic radioactive aerosol from transfer line in Tank 241-C-106 pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	E2
W320-D-ALL07	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	F2	E2
W320-D-TRANS10	Release of energetic radioactive aerosol from jumper in pit due to seismic event. Cover block breached by ground motion resulting in spray release.	1. Natural Phenomena	F2	E2
W320-B-ALL09	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	E3
W320-B-ALL10	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	E3
W320-ABCD-ALL01	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome	1. Raw water line rupture 2. Heavy rainfall	F1	E2
W320-ABCD-ALL02	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 dome	1. Raw water line rupture 2. Heavy rainfall	F1	E2
W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 onto the ground due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F1	E2
W320-ABCD-ALL08*	Release of radioactive liquid from Tank 241-C-106 due to siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	1. Plugging of antisiphon holes 2. Loss of electrical power to the pumps 3. Shutdown from operations	F1	E2
W320-ABCD-CHILL03	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to excessive cooling from process chiller which restricts inflow and loop seal fails to operate.	1. Chiller control fault 2. High humidity	F1	E2
W320-ABCDF-ALL01*	Release of energetic radioactive aerosol to atmosphere due to buildup of flammable gas in Tank 241-AY-102 pit drain pipe which is then ignited.	1. Flammable gas generation from tank waste	F1	E2

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (6 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-FLUSH04	Release of low energy radioactive aerosol from breached Tank 241-C-106 due to flushing water spray through sluice nozzle resulting in excessive tank vacuum.	1. Planned	F1	E2
W320-B-TRANS27	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F1	E2
W320-B-TRANS32	Release of large high energy aerosolized radioactive waste from a spray leak from transfer line break due to aircraft strike on underground transfer line berm.	1. Light aircraft crash	F1	E2
W320-BCD-ALL03	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan overspeed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F1	E2
W320-D-ALL08	Release of energetic radioactive aerosol to atmosphere due to start of air lift circulators in Tank 241-AY-102 resulting in a release of flammable gas plume which is then ignited.	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	F1	E2
W320-D-PUMP01	Release of energetic radioactive aerosol from line break in Tank 241-AY-102 transfer pit due to immersible pump being positioned to high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertent or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	F1	E2
W320-D-PUMP03	Release of energetic radioactive aerosol from line break in Tank 241-C-106 transfer pit due to immersible pump being positioned to high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertent or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	F1	E2
W320-D-TRANS05	Release of energetic radioactive aerosol to atmosphere due to head space gas concentration above LFL in Tank 241-AY-102 with the start of pumping which ignites the flammable gas.	1. Spontaneous GRE 2. Induced GRE	F1	E2
W320-D-TRANS07	Release of high energetic aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-AY-102 waste level being lowered quickly with the waste temperature to high. This results in a large steam bump and flammable gas release with ignition.	1. Operator mistake 2. Level indication fault 3. Pump controller fault	F1	E2
W320-D-TRANS11	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	F1	E2

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (6 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT12	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	F1	E2
W320-D-VENT17	Release of high energy aerosolized release to the atmosphere due to an ice storm which prevents air inflow into Tank 241-AY-102 resulting in an excessive tank vacuum. This results in a flammable gas release with ignition.	1. Natural phenomena	F1	E2
W320-D-VENT20	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	F1	E2
W320-A-TRANS06	Release of energetic radioactive aerosol from damaged tank due to waste temperature being out of specification during start of slurry transfer in Tank 241-C-106 and subsequent ignition of organics.	1. Operator mistake 2. Temperature measurement fault	F0	E3
W320-B-VENT08	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-C-106 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	F0	E3
W320-B-VENT09*	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-AY-102 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	F0	E3
W320-D-CHILL01	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	F0	E3
W320-D-CHILL02	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from ventilation chiller into Tank 241-C-106.	1. Piping or tubing leak	F0	E3
W320-A-TRANS05	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	F0	E2
W320-ABCD-ALL03	Release of energetic radioactive aerosol from tank dome collapse due to flooding on top of tank dome	1. Raw water line rupture 2. Heavy rainfall	F0	E2
W320-B-ALL01	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	F0	E2
W320-B-ALL02	Release of a large amount of high energy aerosolized waste from 241-AY-102 Tank dome collapse due to volcanic ashfall.	1. Natural phenomena	F0	E2

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (6 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-ALL03	Release of high energy aerosolized waste to the atmosphere from Tank 241-C-106 dome collapse due to extreme snow fall.	1. Natural phenomena	F0	E2
W320-B-ALL04	Release of large amount of high energy aerosolized waste from 241-AY-102 Tank dome collapse due to extreme snow fall.	1. Natural phenomena	F0	E2
W320-B-ALL05	Release of energetic radioactive aerosol from Tank 241-C-106 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	F0	E2
W320-B-ALL06	Release of energetic radioactive aerosol from 241-AY-102 Tank dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	F0	E2
W320-B-ALL08	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 due to a large water intrusion which induces a flammable gas release event. It is then ignited resulting in a dome space fire.	1. Raw water leak 2. Surface water flood	F0	E2
W320-B-TRANS14	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to low slurry flow to distributor which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	F0	E2
W320-B-TRANS15	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to air injected into the waste from the startup of slurry flow from the distributor. Gas is scrubbed from the waste and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Normal procedure	F0	E2
W320-B-TRANS16	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to distributor nozzle breaking off which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E2
W320-BCD-ALL02	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F0	E2
W320-BCD-PUMP04	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised to high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (6 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-PUMP04	Release of energetic radioactive aerosol from damaged Tank 241-AY-102 due to pumping of more solids than anticipated. Annulus cooling mod not completed resulting in overheating of waste and a tank bump. Bump induces large flammable gas release. It is then ignited resulting in a dome space fire.	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning slurry pump 3. Inadvertent or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump Tank 241-C-106 fault 6. Pump controller fault	F0	E2
W320-D-VENT13	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to influx of cold water spray into tank which results in an excessive vacuum. A large flammable gas release is induced. It is then ignited resulting in a dome space fire.	1. Possible result of slurry distribution	F0	E2
W320-D-VENT16	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas builds up in the dome space to the LFL. It is then ignited resulting in a dome space fire.	1. Extended loss of power 2. Severe ventilation casualty	F0	E2
W320-D-VENT18	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to volcanic ashfall which prevents air inflow to tank. Excessive vacuum results and flammable gas is released to the dome space. It is then ignited resulting in a dome space fire.	1. Natural phenomena	F0	E2
W320-E-TERM03	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to lack of controls on operation of tank after it has been turned into a FG group 1 tank. It is ignited from a lightning strike or other event resulting in a dome space fire.	1. Inadequate prediction of waste behavior	F0	E2

ALC = air lift circulator.
GRE = gas release event.
HEPA = high efficiency particulate air (filter).
IOSR = Interim Operational Safety Requirements.
LFL = lower flammability limit.

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-ALL04	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F3	E2
W320-ABCD-TRANS01	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	F3	E2
W320-A-TRANS03	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to high waste temperature during slurry transfer and resulting steam bump.	1. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump	F3	E1
W320-B-ALL07	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-C-106 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F3	E1
W320-B-TRANS22	Release of radioactive liquid from transfer line due to local flooding during transfer which results in line being uncovered and breached.	1. Raw water leak 2. Natural flow	F3	E1
W320-B-TRANS28	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 distributor pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	E1
W320-B-TRANS29	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	E1
W320-B-TRANS30	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	E1
W320-B-TRANS31	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 sluice pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F3	E1
W320-BCD-TRANS13	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection and 3 way valve left in flush position after flushing. Cover plug remains in place on initiation of sluicing process. High capacity drain cover left on and pit overflows.	1. Maintenance error 2. Communications error between different groups using the pit	F3	E1
W320-D-ALL01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to a steam bump	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	F3	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT07	Release of low energy radioactive aerosol from Tank 241-C-105/Tank 241-C-106 ventilation system due to failure to determine ventilation leak during sluicing.	1. Ducting corrosion 2. Seal deterioration	F3	E1
W320-D-VENT08	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from new ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	F3	E1
W320-D-VENT11	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from current ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	F3	E1
W320-BCD-FLUSH03*	Personnel exposure to ionizing radiation from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled with radioactive material.	1. Operator Error 2. Failure in submersible pump circuitry	F3	E0
W320-ABCD-ALL05	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F2	E2
W320-ABCD-TRANS02	Release of liquid waste below grade and aerosol release to atmosphere due to loss of sluicer arm control in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Unavoidable operator action	F2	E2
W320-ABCD-TRANS05	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer hose break in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breaching of tank bottom.	1. Primary failure of Hose 2. Severe Water hammer 3. Fatigue from vibration	F2	E2
W320-ABCD-TRANS07	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	F2	E2
W320-ABCD-TRANS08	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	F2	E2
W320-BCD-ALL08	Release of liquid waste below grade and aerosol release to atmosphere due to excessive corrosion because of waste disturbance in Tank 241-C-106 resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Inadequate prediction of waste behavior	F2	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 water exceeds maximum operating level resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Loss of power 2. Equipment casualty	F2	E2
W320-D-ALL09	Release of liquid waste below grade and aerosol release to atmosphere due to seismic event Tank 241-C-106 liner is breached resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Natural Phenomena	F2	E2
W320-D-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to movement of debris during sluicing which impacts and breaches the Tank 241-C-106 liner, resulting in water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Expected outcome of high pressure sluice. Many objects are in the waste.	F2	E2
W320-A-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to a large steam bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F2	E1
W320-ABCD-CHILL01	Release of low energy radioactive aerosol from largely intact tank due to excessive cooling from process chiller and vacuum in Tank 241-C-106 from ventilation system which results in excedance of loop seal vacuum and unfiltered release.	1. Chiller control fault 2. High humidity	F2	E1
W320-ALL-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to moisture buildup on ventilation system HEPA filters	1. Natural occurrence under proper conditions	F2	E1
W320-ALL-TRANS02	Release of small high energy aerosolized waste due to high winds or tornado resulting in failed ventilation ducting and unfiltered release.	1. Natural occurrence under proper conditions	F2	E1
W320-B-ALL11	Release of liquid waste due to large water intrusion into Tank 241-C-106 resulting in high hydrostatic pressure and tank breach.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F2	E1
W320-B-FLUSH06	Release of radioactive liquid from transfer line due to a pipe break in 241-AY-102 pit with the high capacity drain cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	F2	E1
W320-B-FLUSH07	Release of radioactive liquid from transfer line due to pipe break in pit during flushing and drain plug cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	F2	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS06	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive slurry flow resulting in increased aerosol generation and errant flow release.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	F2	E1
W320-B-TRANS07	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to startup of slurry flow to distributor resulting in air being bubbled through waste and release of vapor.	1. Normal procedure	F2	E1
W320-B-TRANS11	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive corrosion and heat loading from new waste.	1. Inadequate prediction of waste behavior	F2	E1
W320-B-TRANS12	Release of low energy radioactive aerosol from interconnected tanks due to increased heat loading of Tank 241-AY-102 and loss of vacuum.	1. Inadequate prediction of waste behavior 2. Existing system cannot control flow rates from different tanks. Depends on inleakage 3. W030 system has lower exhaust capabilities	F2	E1
W320-B-TRANS13	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-AY-102 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	E1
W320-B-VENT03	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through W030 ventilation upgrade and results in excessive vacuum.	1. Natural phenomena	F2	E1
W320-B-VENT04	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing exhaust system with W030 intake and results in excessive vacuum.	1. Natural phenomena	F2	E1
W320-B-VENT06	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing ventilation system and results in excessive vacuum.	1. Natural phenomena	F2	E1
W320-BCD-TRANS10	Release of radioactive liquid release from sluice transfer line due to the blank flange being left off flushing connection in Tank 241-AY-102 pit and drain cover left on resulting in overflow of pit onto the ground during sluicing.	1. Maintenance error 2. Communications error between different groups using the pit	F2	E1
W320-D-ALL05	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to long term loss of ventilation system resulting in tank bump and blowout of filters.	1. Loss of power 2. Equipment casualty	F2	E1
W320-D-TRANS02	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to excessive sluicer flow which results in radioactive air release through HEPAs.	1. Natural outcome if conditions are met	F2	E1
W320-D-TRANS03	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to sluicer moving debris impacting drop leg in tank which breaches dome.	1. Expected outcome of high velocity sluicing Many objects are in the waste	F2	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-TRANS04	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to high temperature sluice water which increases head space pressure with increased errant flow.	1. High temperature in Tank 241-AY-102	F2	E1
W320-D-VENT03	Release of low energy radioactive aerosol through failed filters in the 702A ventilation system of Tank 241-AY-102 due to severe ice storm, excessive tank vacuum and resulting tank bump	1. Natural phenomena	F2	E1
W320-D-VENT05	Release of low energy radioactive aerosol through failed filters in the W030 ventilation system due to severe ice storm, excessive tank vacuum and resulting tank bump.	1. Natural phenomena	F2	E1
W320-D-VENT15	Small low energy radioactive aerosolized waste release from standpipes in Tank 241-AY-102 due to flammable gas buildup where it is ignited resulting in the pipe being breached resulting in an unfiltered release.	1. Natural occurrence under proper conditions	F2	E1
W320-B-TERM01	Release of toxic ammonia gas from tank due to burp which exposes facility personnel to toxic gases.	1. Inadequate prediction of waste behavior	F2	E0
W320-ABCD-CHILL02	Release of energetic radioactive aerosol from covered pit or deadend pipe due to propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome.	1. Piping or tubing leak	F1	E2
W320-ABCD-TRANS03	Release of liquid waste below grade and aerosol release to atmosphere due to siphoning of waste from Tank 241-AY-102 after the stoppage of pumping water exceeds maximum operating level in Tank 241-C-106 resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Buildup of solids in openings 2. Equipment casualty	F1	E2
W320-ABCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to excessive waste temperature change rate Tank 241-C-106 liner breaches, resulting in water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. High temperature in Tank 241-AY-102	F1	E2
W320-ALL-VENT01	Release of energetic radioactive aerosol from breached ventilation duct for Tank 241-AY-102 due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	F1	E2
W320-BCD-ALL07	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, bulging of tank bottom, ripping of liner and steam bump.	1. Raw water leak 2. Surface water flood	F1	E2
W320-BCD-PUMP05	Release of small high energy aerosol to atmosphere due to immersible pump being raised to high in Tank 241-C-106, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F1	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons.
W320-D-ALL06	Release of a small amount of low energy aerosolized waste through failed filters due to seismic event which induces a steam bump in Tank 241-AY-102, and failure of filters or ducting.	1. Natural Phenomena	F1	E2
W320-F-TERM05	Release of liquid waste below grade and aerosol release to atmosphere due to high heat load after completion of sluicing process resulting in the need for water addition to Tank 241-C-106 with a deteriorated tank liner, water leakage into liner gap, steam formation, liner breach and steam bump.	1. Error in calculations	F1	E2
W320-B-ALL13	Release of radioactive liquid from Tank 241-AY-102 due to large water intrusion into tank	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage	F1	E1
W320-B-ALL14	Release of small low energy aerosolized waste to the atmosphere from intact pit due to high winds/dust devils during plug removal from pit cover.	1. High winds	F1	E1
W320-B-TRANS02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to low slurry flow, piling of waste at base of distributor and resulting tank bump	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	F1	E1
W320-B-TRANS04	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to high slurry transfer rate, high waste temperature and resulting tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F1	E1
W320-B-TRANS05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of low slurry flow which results in steam bump and increased head space vapor pressure.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	F1	E1
W320-B-TRANS08	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of distributor 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F1	E1
W320-B-TRANS09	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of the distributor nozzle breaking off which results in steam bump and increased head space vapor pressure.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F1	E1
W320-B-TRANS10	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F1	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-VENT07	Release of low energy radioactive aerosol from largely intact tank due to volcanic ashfall preventing air inflow into Tank 241-AY-102 through existing ventilation system resulting in tank breach.	1. Natural phenomena	F1	E1
W320-BCD-ALL01	Release of energetic radioactive aerosol from covered pit on Tank 241-C-106 due to propylene glycol leak into pit with ignition.	1. Piping or tubing leak	F1	E1
W320-BCD-ALL04	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to fan controller failure resulting in excessive vacuum in tank and loop seal actuation.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F1	E1
W320-BCD-ALL05	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	F1	E1
W320-BCD-ALL06	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited and detonates resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	F1	E1
W320-BCD-ALL10	Small high energy aerosolized waste release to the atmosphere due to plugging and buildup of flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	F1	E1
W320-BCD-TRANS01	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank pump vortices	1. Natural occurrence if conditions are met	F1	E1
W320-BCD-TRANS04	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank during sluicing	1. Natural occurrence if conditions are met	F1	E1
W320-BCD-TRANS08	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to undetected high waste temperature and resulting tank bump	1. Expected outcome of high pressure sluice. Many objects are in the waste.	F1	E1
W320-D-ALL02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to barometric pressure change, high waste temperature and resulting tank bump	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	F1	E1
W320-D-TERM01	Release of ionizing radiation and radioactive gas from Tank 241-AY-102 due to a criticality event in the tank	1. Natural occurrence if conditions are met	F1	E1
W320-D-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to rapid waste level change, high waste temperature and resulting tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-AY-102 pump 3. Inadvertent or accidental actuation of Tank 241-AY-102 pump but not Tank 241-C-106 pump 4. ENRAF level indication fault 5. Pump controller fault	F1	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-TRANS08	Release of low energy radioactive aerosol through failed filters due to excessive fluffing of waste in Tank 241-AY-102 resulting in large steam bump and unfiltered release.	1. Inadequate prediction of waste behavior	F1	E1
W320-D-VENT01	Release of energetic radioactive aerosol from filter breach due to a buildup of ammonium nitrate in ventilation ducting of Tank 241-AY-102 and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	F1	E1
W320-D-VENT04	Release of small low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to cold water spray into tank, tank vacuum and resulting tank bump	1. Possible result of slurry distribution	F1	E1
W320-D-VENT09	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to loss of primary or annulus ventilation which results in steam release.	1. Extended loss of power 2. Severe ventilation casualty	F1	E1
W320-E-TERM01	Release of large high energy radioactive aerosol from Tank 241-AY-102 due to excessive fluffing of waste which results in tank structural damage and unfiltered release.	1. Inadequate prediction of waste behavior	F1	E1
W320-A-TRANS04	Release of large high energy aerosolized waste from Tank 241-C-106 due to high waste temperature during slurry transfer which results in a steam bump. Bump induces flammable gas release which is ignited resulting in a dome burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F0	E2
W320-ABCD-TRANS06	Release of liquid waste below grade and aerosol release to atmosphere due to sluicing arm breaking off and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner breach and steam bump.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E2
W320-B-FLUSH01	Release of energetic radioactive aerosol from damaged Tank 241-C-106 single shell tank due to ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank.	1. Maintenance error 2. Communications error between different groups using the pit	F0	E2
W320-B-TRANS17	Release of high energy aerosolized waste from damaged Tank 241-C-106 due to the sluicer hose breaking which then impinges into the solids releasing a region of retained flammable gas. The gas is then ignited and a plume fire results.	1. Primary failure of Hose 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Fatigue from vibration	F0	E2
W320-B-TRANS18	Release of large high energy aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-C-106 waste level being lowered quickly with the waste temperature to high. This results in a large steam bump and flammable gas release with a plume burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F0	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-PUMP03	Release of small high energy aerosol to atmosphere due to immersible pump being raised to high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2
W320-BCD-PUMP08	Release of liquid waste below grade and aerosol release to atmosphere due to submersible pump being raised to high, winch lifting strap breaking, pump falling and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner bulges/rips and steam bump occurs.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2
W320-BCD-PUMP09	Release of large high energy aerosolized waste to atmosphere due to immersible pump being raised to high in Tank 241-C-106, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2
W320-D-TRANS06	Release of large high energy aerosolized waste to the atmosphere due to slurry transfer rate being excessive resulting in a rapid reduction in the hydrostatic pressure in Tank 241-C-106. This results in a flammable gas release. Gas is ignited and a dome space fire results.	1. Sluice flow control fault	F0	E2
W320-A-TRANS02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to lowering of tank level with temperature out of spec resulting in tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. ENRAF level indication fault 4. Pump controller fault 5. Tank 241-C-106 T/C fault	F0	E1
W320-B-FLUSH02	Release of low energy radioactive aerosol through failed filters due to a large steam bump in Tank 241-C-106 as a result of high tank vacuum resulting from flushing water spray condensing dome vapors.	1. Planned	F0	E1
W320-B-FLUSH03	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to a large steam bump as a result of high tank vacuum due to high condensation rate in tank from flushing water spray through antisiphon holes.	1. Planned	F0	E1
W320-B-FLUSH05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to flushing water spray through antisiphon holes resulting in excessive vacuum in tank and tank breach.	1. Planned	F0	E1
W320-B-PUMP01	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to overheating of waste and subsequent steam bump	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning 3. Inadvertent or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump fault 6. Pump controller fault	F0	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS01	Release of small low energy aerosolized waste from the annulus of Tank 241-AY-102 due to steam pulses from boiling waste in annulus region which results in the failure of annulus filters. Waste leaks into annulus due to corrosion of primary tank from new waste composition.	1. Inadequate prediction of waste behavior	F0	E1
W320-B-TRANS03	Release of low energy radioactive aerosol through failed filters due to condensation of vapor in head space of Tank 241-C-106 which resulted from the breaking off of sluicer head.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E1
W320-B-VENT01	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through existing ventilation system with W030 intake resulting in excessive vacuum and tank breach.	1. Natural phenomena	F0	E1
W320-B-VENT02	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through W030 ventilation upgrade system resulting in excessive vacuum and tank breach.	1. Natural phenomena	F0	E1
W320-B-VENT05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to cold water spray into tank which results in excessive vacuum and tank breach.	1. Possible result of slurry distribution	F0	E1
W320-BCD-TRANS02	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Flushing valve misposition 2. Pump controller fault 3. Excessive solids in slurry flow	F0	E1
W320-BCD-TRANS03	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E1
W320-BCD-TRANS05	Release of low energy radioactive aerosol through failed filters due to tank bump in Tank 241-AY-102 resulting from the vacuum developed in the head space from the condensation of vapor which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E1
W320-BCD-TRANS06	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to tank bump resulting from the which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E1
W320-BCD-TRANS07	Release of low energy radioactive aerosol through failed filters of Tank 241-C-106 due to failure of T/C Tree, sluicing outside of temperature specs, atmospheric change, and large steam bump resulting in filter breach.	1. Sluice flow control fault 2. Operator error	F0	E1
W320-D-ALL03	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	F0	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-ALL04	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	F0	E1
W320-D-PURGE01	Release of low energy aerosolized waste from largely intact Tank 241-C-106 due to nitrogen line break and loss of vacuum.	1. Tube failure 2. Improper Assembly 3. Regulator fault	F0	E1
W320-D-VENT02	Release of low energy radioactive aerosol from 241-AY-102 through failed filters due to inadequate ventilation from W030 resulting in increased waste temperature, steam bump and filter breach.	1. Error in calculations 2. Design error 3. Construction fault	F0	E1
W320-D-VENT06	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to volcanic ashfall , excessive vacuum resulting in large steam bump and filter blowout.	1. Natural phenomena	F0	E1
W320-D-VENT14	Small high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas leaks into annulus. It is then ignited resulting in the annulus being breached.	1. Extended loss of power 2. Severe ventilation casualty	F0	E1
W320-D-VENT19	Release of low energy radioactive aerosol through failed filters due to loss of primary or annulus ventilation for extended period of time resulting in rise in waste temperature and large bump in Tank 241-AY-102.	1. Extended loss of power 2. Severe ventilation casualty	F0	E1

ALC = air lift circulator
IOSR = Interim Operational Safety Requirements

Table C-3. Hazardous Conditions With Potential Significant Worker Consequences (S1).

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-TRANS14	Personnel exposure to Ionizing radiation due to flooding which uncovers transfer lines.	1. Raw water line rupture 2. Natural flooding	F2	E0
W320-ABCD-TRANS16	Personnel exposure to Ionizing radiation due to excavation which uncovers transfer lines.	1. Mistake in excavation location 2. Failure to determine transfer line location	F1	E0
W320-ABCD-VENT01	Release of toxic gas from Tank 241-AY-102 due to failure of ventilation system and gradual rise in waste temperature resulting in toxic gas release from tank and to workers.	1. Loss of power 2. Equipment casualty	F1	E0
W320-D-VENT10	Release of toxic gas from Tank 241-AY-102 due to inadequate ventilation from W030 which results in high waste temperature , increased toxic gas release and facility worker inhalation of toxic gases.	1. Error in calculations 2. Design error 3. Construction fault	F1	E0
W320-E-TERM02	Release of toxic hydrogen cyanide gas from Tank 241-AY-102 due to burp	1. Inadequate prediction of waste behavior	F1	E0
W320-ABCD-TRANS15	Personnel exposure to Ionizing radiation due to high winds which uncovers transfer lines.	1. Natural phenomena	F0	E0

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-ALL09	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	E3
W320-B-ALL10	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	F1	E3
W320-A-TRANS06	Release of energetic radioactive aerosol from damaged tank due to waste temperature being out of specification during start of slurry transfer in Tank 241-C-106 and subsequent ignition of organics.	1. Operator mistake 2. Temperature measurement fault	F0	E3
W320-B-VENT08	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-C-106 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	F0	E3
W320-B-VENT09*	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-AY-102 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	F0	E3
W320-D-CHILL01	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	F0	E3
W320-D-CHILL02	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from ventilation chiller into Tank 241-C-106.	1. Piping or tubing leak	F0	E3
W320-ABCD-ALL04	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F3	E2
W320-ABCD-TRANS01	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	F3	E2
W320-BCD-FLUSH01	Release of energetic radioactive aerosol from transfer line due to 3 way valve left in flush position after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	E2
W320-BCD-FLUSH02*	Release of energetic radioactive aerosol from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled and pressurized resulting in rupture of tank or transfer line.	1. Human error 2. Communications error between different groups	F3	E2
W320-BCD-TRANS11	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-TRANS12	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	F3	E2
W320-ABCD-ALL05	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F2	E2
W320-ABCD-TRANS02	Release of liquid waste below grade and aerosol release to atmosphere due to loss of sluicer arm control in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Unavoidable operator action	F2	E2
W320-ABCD-TRANS05	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer hose break in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breaching of tank bottom.	1. Primary failure of Hose 2. Severe Water hammer 3. Fatigue from vibration	F2	E2
W320-ABCD-TRANS07	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	F2	E2
W320-ABCD-TRANS08	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	F2	E2
W320-ABCD-TRANS11	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	E2
W320-ABCD-TRANS11	Release of energetic radioactive aerosol release from line break due to flammable gas ignition in pit with cover block falling onto piping.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	E2
W320-ABCD-TRANS12	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in distributor pit of Tank 241-AY-102 with cover block off during slurry transfer.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2
W320-B-TRANS23	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-AY-102 with cover block off during sluicing.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-TRANS24	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2
W320-B-TRANS25	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in sluice pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	F2	E2
W320-B-TRANS26	Release of energetic radioactive aerosol from transfer line in Tank 241-C-106 pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F2	E2
W320-BCD-ALL08	Release of liquid waste below grade and aerosol release to atmosphere due to excessive corrosion because of waste disturbance in Tank 241-C-106 resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Inadequate prediction of waste behavior	F2	E2
W320-BCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 water exceeds maximum operating level resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Loss of power 2. Equipment casualty	F2	E2
W320-D-ALL07	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	F2	E2
W320-D-ALL09	Release of liquid waste below grade and aerosol release to atmosphere due to seismic event Tank 241-C-106 liner is breached resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Natural Phenomena	F2	E2
W320-D-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to movement of debris during sluicing which impacts and breaches the Tank 241-C-106 liner, resulting in water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Expected outcome of high pressure sluice. Many objects are in the waste.	F2	E2
W320-D-TRANS10	Release of energetic radioactive aerosol from jumper in pit due to seismic event. Cover block breached by ground motion resulting in spray release.	1. Natural Phenomena	F2	E2
W320-ABCD-ALL01	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome.	1. Raw water line rupture 2. Heavy rainfall	F1	E2
W320-ABCD-ALL02	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 dome.	1. Raw water line rupture 2. Heavy rainfall	F1	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 onto the ground due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	F1	E2
W320-ABCD-ALL08*	Release of radioactive liquid from Tank 241-C-106 due to siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	1. Plugging of antisiphon holes 2. Loss of electrical power to the pumps 3. Shutdown from operations	F1	E2
W320-ABCD-CHILL02	Release of energetic radioactive aerosol from covered pit or deadend pipe due to propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome.	1. Piping or tubing leak	F1	E2
W320-ABCD-CHILL03	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to excessive cooling from process chiller which restricts inflow and loop seal fails to operate.	1. Chiller control fault 2. High humidity	F1	E2
W320-ABCD-TRANS03	Release of liquid waste below grade and aerosol release to atmosphere due to siphoning of waste from Tank 241-AY-102 after the stoppage of pumping water exceeds maximum operating level in Tank 241-C-106 resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Buildup of solids in openings 2. Equipment casualty	F1	E2
W320-ABCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to excessive waste temperature change rate Tank 241-C-106 liner breaches, resulting in water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. High temperature in Tank 241-AY-102	F1	E2
W320-ABCDF-ALL01*	Release of energetic radioactive aerosol to atmosphere due to buildup of flammable gas in Tank 241-AY-102 pit drain pipe which is then ignited.	1. Flammable gas generation from tank waste 2. 3.	F1	E2
W320-ALL-VENT01	Release of energetic radioactive aerosol from breached ventilation duct for Tank 241-AY-102 due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	F1	E2
W320-B-FLUSH04	Release of low energy radioactive aerosol from breached Tank 241-C-106 due to flushing water spray through sluice nozzle resulting in excessive tank vacuum.	1. Planned	F1	E2
W320-B-TRANS27	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	F1	E2
W320-B-TRANS32	Release of large high energy aerosolized radioactive waste from a spray leak from transfer line break due to aircraft strike on underground transfer line berm.	1. Light aircraft crash	F1	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-ALL03	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan overspeed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F1	E2
W320-BCD-ALL07	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, bulging of tank bottom, ripping of liner and steam bump.	1. Raw water leak 2. Surface water flood	F1	E2
W320-BCD-PUMP05	Release of small high energy aerosol to atmosphere due to immersible pump being raised to high in Tank 241-C-106, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F1	E2
W320-D-ALL06	Release of a small amount of low energy aerosolized waste through failed filters due to seismic event which induces a steam bump in Tank 241-AY-102, and failure of filters or ducting.	1. Natural Phenomena	F1	E2
W320-D-ALL08	Release of energetic radioactive aerosol to atmosphere due to start of air lift circulators in Tank 241-AY-102 resulting in a release of flammable gas plume which is then ignited.	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	F1	E2
W320-D-PUMP01	Release of energetic radioactive aerosol from line break in Tank 241-AY-102 transfer pit due to immersible pump being positioned to high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertent or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	F1	E2
W320-D-PUMP03	Release of energetic radioactive aerosol from line break in Tank 241-C-106 transfer pit due to immersible pump being positioned to high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertent or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	F1	E2
W320-D-TRANS05	Release of energetic radioactive aerosol to atmosphere due to head space gas concentration above LFL in Tank 241-AY-102 with the start of pumping which ignites the flammable gas.	1. Spontaneous GRE 2. Induced GRE	F1	E2
W320-D-TRANS07	Release of high energetic aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-AY-102 waste level being lowered quickly with the waste temperature to high. This results in a large steam bump and flammable gas release with ignition.	1. Operator mistake 2. Level indication fault 3. Pump controller fault	F1	E2
W320-D-TRANS11	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	F1	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT12	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	F1	E2
W320-D-VENT17	Release of high energy aerosolized release to the atmosphere due to an ice storm which prevents air inflow into Tank 241-AY-102 resulting in an excessive tank vacuum. This results in a flammable gas release with ignition.	1. Natural phenomena	F1	E2
W320-D-VENT20	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	F1	E2
W320-F-TERM05	Release of liquid waste below grade and aerosol release to atmosphere due to high heat load after completion of sluicing process resulting in the need for water addition to Tank 241-C-106 with a deteriorated tank liner, water leakage into liner gap, steam formation, liner breach and steam bump.	1. Error in calculations	F1	E2
W320-A-TRANS04	Release of large high energy aerosolized waste from Tank 241-C-106 due to high waste temperature during slurry transfer which results in a steam bump. Bump induces flammable gas release which is ignited resulting in a dome burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F0	E2
W320-A-TRANS05	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	F0	E2
W320-ABCD-ALL03	Release of energetic radioactive aerosol from tank dome collapse due to flooding on top of tank dome	1. Raw water line rupture 2. Heavy rainfall	F0	E2
W320-ABCD-TRANS06	Release of liquid waste below grade and aerosol release to atmosphere due to sluicing arm breaking off and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner breach and steam bump.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E2
W320-B-ALL01	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	F0	E2
W320-B-ALL02	Release of a large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to volcanic ashfall.	1. Natural phenomena	F0	E2
W320-B-ALL03	Release of high energy aerosolized waste to the atmosphere from Tank 241-C-106 dome collapse due to extreme snow fall.	1. Natural phenomena	F0	E2
W320-B-ALL04	Release of large amount of high energy aerosolized waste from 241-AY-102 Tank dome collapse due to extreme snow fall.	1. Natural phenomena	F0	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-B-ALL05	Release of energetic radioactive aerosol from Tank 241-C-106 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	F0	E2
W320-B-ALL06	Release of energetic radioactive aerosol from Tank 241-AY-102 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	F0	E2
W320-B-ALL08	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 due to a large water intrusion which induces a flammable gas release event. It is then ignited resulting in a dome space fire.	1. Raw water leak 2. Surface water flood	F0	E2
W320-B-FLUSH01	Release of energetic radioactive aerosol from damaged Tank 241-C-106 single shell tank due to ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank.	1. Maintenance error 2. Communications error between different groups using the pit	F0	E2
W320-B-TRANS14	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to low slurry flow to distributor which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	F0	E2
W320-B-TRANS15	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to air injected into the waste from the startup of slurry flow from the distributor. Gas is scrubbed from the waste and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Normal procedure	F0	E2
W320-B-TRANS16	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to distributor nozzle breaking off which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	F0	E2
W320-B-TRANS17	Release of high energy aerosolized waste from damaged Tank 241-C-106 due to the sluicer hose breaking which then impinges into the solids releasing a region of retained flammable gas. The gas is then ignited and a plume fire results.	1. Primary failure of Hose 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Fatigue from vibration	F0	E2
W320-B-TRANS18	Release of large high energy aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-C-106 waste level being lowered quickly with the waste temperature to high. This results in a large steam bump and flammable gas release with a plume burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertent or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	F0	E2
W320-BCD-ALL02	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertent adjustment	F0	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-BCD-PUMP03	Release of small high energy aerosol to atmosphere due to immersible pump being raised to high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2
W320-BCD-PUMP04	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised to high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2
W320-BCD-PUMP08	Release of liquid waste below grade and aerosol release to atmosphere due to submersible pump being raised to high, winch lifting strap breaking, pump falling and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner bulges/rips and steam bump occurs.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2
W320-BCD-PUMP09	Release of large high energy aerosolized waste to atmosphere due to immersible pump being raised to high in Tank 241-C-106, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertent or accidental actuation 3. Winch controller fault	F0	E2
W320-D-PUMP04	Release of energetic radioactive aerosol from damaged Tank 241-AY-102 due to pumping of more solids than anticipated. Annulus cooling mod not completed resulting in overheating of waste and a tank bump. Bump induces large flammable gas release. It is then ignited resulting in a dome space fire.	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning slurry pump 3. Inadvertent or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump Tank 241-C-106 fault 6. Pump controller fault	F0	E2
W320-D-TRANS06	Release of large high energy aerosolized waste to the atmosphere due to slurry transfer rate being excessive resulting in a rapid reduction in the hydrostatic pressure in Tank 241-C-106. This results in a flammable gas release. Gas is ignited and a dome space fire results.	1. Sluice flow control fault	F0	E2
W320-D-VENT13	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to influx of cold water spray into tank which results in an excessive vacuum. A large flammable gas release is induced. It is then ignited resulting in a dome space fire.	1. Possible result of slurry distribution	F0	E2
W320-D-VENT16	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas builds up in the dome space to the LFL. It is then ignited resulting in a dome space fire.	1. Extended loss of power 2. Severe ventilation casualty	F0	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (9 sheets)

ID	Hazardous Condition	Cause	Initial Freq NC	Env Cons
W320-D-VENT18	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to volcanic ashfall which prevents air inflow to tank. Excessive vacuum results and flammable gas is released to the dome space. It is then ignited resulting in a dome space fire.	1. Natural phenomena	F0	E2
W320-E-TERM03	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to lack of controls on operation of tank after it has been turned into a FG group 1 tank. It is ignited from a lightning strike or other event resulting in a dome space fire.	1. Inadequate prediction of waste behavior	F0	E2

Table C-5. Hazardous Conditions With Potential Radiation Exposure Consequences (RP).

ID	Hazardous Condition	Cause
W320-ABCD-TRANS14	Personnel exposure to Ionizing radiation due to flooding which uncovers transfer lines.	1. Raw water line rupture 2. Natural flooding
W320-ABCD-TRANS15	Personnel exposure to Ionizing radiation due to high winds which uncovers transfer lines.	1. Natural phenomena
W320-ABCD-TRANS16	Personnel exposure to Ionizing radiation due to excavation which uncovers transfer lines.	1. Mistake in excavation location 2. Failure to determine transfer line location
W320-BCD-FLUSH03	Personnel exposure to ionizing radiation from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled with radioactive material.	1. Operator Error 2. Failure in submersible pump circuitry

Table C-6. Hazardous Conditions With Potential Occupational Safety Consequences (OCC).

ID	Hazardous Condition	Cause
W320-ABCD-VENT01	Release of toxic gas from Tank 241-AY-102 due to failure of ventilation system and gradual rise in waste temperature resulting in toxic gas release from tank and to workers.	1. Loss of power 2. Equipment casualty
W320-D-VENT10	Release of toxic gas from Tank 241-AY-102 due to inadequate ventilation from W030 which results in high waste temperature , increased toxic gas release and facility worker inhalation of toxic gases.	1. Error in calculations 2. Design error 3. Construction fault
W320-E-TERM02	Release of toxic hydrogen cyanide gas from Tank 241-AY-102 due to burp	1. Inadequate prediction of waste behavior

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APPENDIX D
CONTROL ALLOCATION TABLES

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APPENDIX D
CONTROL ALLOCATION TABLES

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D-4 Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences D4-1

APPENDIX D
LIST OF TERMS

AC	Administrative Control
ALC	air lift circulator
AWF	Aging Waste Facility
DST	double-shell tank
GRE	gas release event
HASP	Tank Farms Health and Safety Plan
HEPA	high-efficiency particulate air (filter)
IOSR	Interim Operational Safety Requirements
JCO	Justification for Continued Operation
JCS	Job Control System
LCO	limiting condition for operation
LCS	limiting control setting
LFL	lower flammability limit
SC	Safety-Class
SST	single-shell tank
TWRS	Tank Waste Remediation System
WRSS	waste retrieval sluicing system

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
01	W320-BCD-TRANS01	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank pump vortices	1. Natural occurrence if conditions are met	None required	AC: Nuclear Criticality Safety (CPS)	None required	None required	Controls based on accident analysis (Nuclear Criticality)
01X	W320-BCD-TRANS02	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Flushing valve misposition 2. Pump controller fault 3. Excessive solids in slurry flow	None required	AC: Nuclear Criticality Safety (CPS)	None required	None required	Controls based on accident analysis (Nuclear Criticality)
01X	W320-BCD-TRANS03	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	None required	AC: Nuclear Criticality Safety (CPS)	None required	None required	Controls based on accident analysis (Nuclear Criticality)
01X	W320-BCD-TRANS04	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank during sluicing	1. Natural occurrence if conditions are met	None required	AC: Nuclear Criticality Safety (CPS)	None required	None required	Controls based on accident analysis (Nuclear Criticality)
01X	W320-D-TERM01	Release of ionizing radiation and radioactive gas from Tank 241-AY-102 due to a criticality event in the tank	1. Natural occurrence if conditions are met	None required	AC: Nuclear Criticality Safety (CPS)	None required	None required	Controls based on accident analysis (Nuclear Criticality)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
02	W320-D-ALL01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to a steam bump	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	SC: Tank 241-AY-102 annulus ventilation sys	AC: Trans cntrls (material balance) LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans ctrls (mat balance and topography) AC: Proc instr and meas and test equip AC: Vent cntrls (annulus)	SS: CAM interlk on 702-A ventilation sys SS: CAM interlk on W-030 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)
02X	W320-ALL-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to moisture buildup on ventilation system HEPA filters	1. Natural occurrence under proper conditions	None required	AC: Trans cntrls (material balance)	SS: CAM interlk on 702-A ventilation sys SS: CAM interlk on W-030 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)
02X	W320-B-FLUSH01	Release of energetic radioactive aerosol from damaged Tank 241-C-106 single shell tank due to ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank.	1. Maintenance error 2. Communications error between different groups using the pit	None required	AC: Trans cntrls (material balance)	SS: CAM interlk on 296-P-16 ventilation sys SS: CAM interlk on 296-C-006 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
02X	W320-B-FLUSH02	Release of low energy radioactive aerosol through failed filters due to a large steam bump in Tank 241-C-106 as a result of high tank vacuum resulting from flushing water spray condensing dome vapors.	1. Planned	None required	None required	SS: CAM interlk on 296-P-16 ventilation sys SS: CAM interlk on 296-C-006 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)
02X	W320-B-FLUSH03	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to a large steam bump as a result of high tank vacuum due to high condensation rate in tank from flushing water spray through antisiphon holes.	1. Planned	SC: Tank 241-AY-102 annulus ventilation sys	AC: Trans cntrls (material balance) LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans ctrls (mat balance and topography) AC: Proc instr and meas and test equip AC: Vent cntrls (annulus)	SS: CAM interlk on 702-A ventilation sys SS: CAM interlk on W-030 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)
02X	W320-B-TRANS01	Release of small low energy aerosolized waste from the annulus of Tank 241-AY-102 due to steam pulses from boiling waste in annulus region which results in the failure of annulus filters. Waste leaks into annulus due to corrosion of primary tank from new waste composition.	1. Inadequate prediction of waste behavior	SC: Tank 241-AY-102 annulus ventilation sys SC: Primary tank leak detection syss	AC: Trans cntrls (material balance) LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans ctrls (mat balance and topography) AC: Proc instr and meas and test equip AC: Vent cntrls (annulus) LCO: Primary tank leak detection sys	SS: CAM interlk on 702-A ventilation sys SS: CAM interlk on W-030 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
02X	W320-D-TRANS02	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to excessive sluicer flow which results in radioactive air release through HEPAs.	1. Natural outcome if conditions are met	None required	AC: Trans cntrls (material balance)	SS: CAM interlk on 296-P-16 ventilation sys SS: CAM interlk on 296-C-006 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)
02X	W320-D-VENT04	Release of small low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to cold water spray into tank, tank vacuum and resulting tank bump	1. Possible result of slurry distribution	SC: Tank 241-AY-102 annulus ventilation sys	AC: Trans cntrls (material balance) LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans ctrls (mat balance and topography) AC: Proc instr and meas and test equip AC: Vent cntrls (annulus)	SS: CAM interlk on 702-A ventilation sys SS: CAM interlk on W-030 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)
03	W320-D-VENT07	Release of low energy radioactive aerosol from Tank 241-C-105/ Tank 241-C-106 ventilation system due to failure to determine ventilation leak during sluicing.	1. Ducting corrosion 2. Seal deterioration	None required	AC: Ventilation cntrls	None required	None required	Controls based on accident analysis (Unfiltered Release)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
03X	W320-ABCD-CHILL01	Release of low energy radioactive aerosol from largely intact tank due to excessive cooling from process chiller and vacuum in Tank 241-C-106 from ventilation system which results in excedance of loop seal vacuum and unfiltered release.	1. Chiller control fault 2. High humidity	None required	AC:Ventilation cntrls	SS: Ventilation CAM interlk sys	LCO: Ventilation stack CAM interlk syss	Controls based on accident analysis (Unfiltered Release)
03X	W320-B-TRANS06	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive slurry flow resulting in increased aerosol generation and errant flow release.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	None required	AC: Ventilation cntrls	SS: Ventilation CAM interlk sys	LCO: Ventilation stack CAM interlk syss	Controls based on accident analysis (Unfiltered Release)
03X	W320-B-TRANS07	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to startup of slurry flow to distributor resulting in air being bubbled through waste and release of vapor.	1. Normal procedure	None required	AC: Ventilation cntrls	SS: Ventilation CAM interlk sys	LCO: Ventilation stack CAM interlk syss	Controls based on accident analysis (Unfiltered Release)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
03X	W320-B-TRANS08	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	None required	AC: Ventilation cntrls	SS: Ventilation CAM interlk sys	LCO: Ventilation stack CAM interlk syss	Controls based on accident analysis (Unfiltered Release)
03X	W320-B-TRANS10	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of sluicer 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	None required	AC: Ventilation cntrls	SS: Ventilation CAM interlk sys	LCO: Ventilation stack CAM interlk syss	Controls based on accident analysis (Unfiltered Release)
03X	W320-B-TRANS11	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive corrosion and heat loading from new waste.	1. Inadequate prediction of waste behavior	SC: Annulus ventilation syss	AC: Ventilation cntrls LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Proc instr and meas and test equip AC: Vent cntrls (annulus)	SS: Ventilation CAM interlk sys	LCO: Ventilation stack CAM interlk syss	Controls based on accident analysis (Unfiltered Release)
03X	W320-B-TRANS12	Release of low energy radioactive aerosol from interconnected tanks due to increased heat loading of Tank 241-AY-102 and loss of vacuum.	1. Inadequate prediction of waste behavior 2. Existing system cannot control flow rates from different tanks. Depends on inleakage 3. W030 system has lower exhaust capabilities	SC: Annulus ventilation syss	AC: Ventilation cntrls LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Proc instr and meas and test equip AC: Vent cntrls (annulus)	SS: Ventilation CAM interlk sys	LCO: Ventilation stack CAM interlk syss	Controls based on accident analysis (Unfiltered Release)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
03X	W320-D-PURGE01	Release of low energy aerosolized waste from largely intact Tank 241-C-106 due to nitrogen line break and loss of vacuum.	1. Tube failure 2. Improper Assembly 3. Regulator fault	None required	None required	None required	None required	No controls required based on F0 frequency with no controls
03X	W320-D-TRANS04	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to high temperature sluice water which increases head space pressure with increased errant flow.	1. High temperature in Tank 241-AY-102	None required	AC: Ventilation cntrls LCS/LCO: SST waste temp cntrls AC: Proc instr and meas and test equip	SS: Ventilation CAM interlk sys	None required	Controls based on accident analysis (Unfiltered Release)
03X	W320-D-VENT08	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from new ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	None required	AC: Ventilation cntrls TSR controls in BIO addendum section 3.4.2.2 and 3.4.2.11 also apply	SS: Ventilation CAM interlk sys	None required	Controls based on accident analysis (Unfiltered Release)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
03X	W320-D-VENT11	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from current ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	None required	AC: Ventilation cntrls TSR controls in BIO addendum section 3.4.2.2 and 3.4.2.11 also apply	SS: Ventilation CAM interlk sys	None required	Controls based on accident analysis (Unfiltered Release)
03X	W320-E-TERM01	Release of large high energy radioactive aerosol from Tank 241-AY-102 due to excessive fluffing of waste which results in tank structural damage and unfiltered release.	1. Inadequate prediction of waste behavior	SC: Annulus ventilation syss	AC: Ventilation cntrls TSR controls in BIO addendum section 3.4.2.2 and 3.4.2.11 also apply	SS: Ventilation CAM interlk sys	None required	Controls based on accident analysis (Unfiltered Release)
04	W320-ABCD-TRANS11	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	None required	AC: Ignition cntrls (vehicle)	None required	AC: Emergency prep (response procedures)	Controls based on accident analysis (Fire in Contaminated Area)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
04X	W320-ABCD-CHILL02	Release of energetic radioactive aerosol from covered pit or deadend pipe due to propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome.	1. Piping or tubing leak	None required	None required	None required	AC: Emergency prep (response procedures)	Controls based on accident analysis (Fire in Contaminated Area)
04X	W320-BCD-ALL01	Release of energetic radioactive aerosol from covered pit on Tank 241-C-106 due to propylene glycol leak into pit with ignition.	1. Piping or tubing leak	None required	None required	None required	AC: Emergency prep (response procedures)	Controls based on accident analysis (Fire in Contaminated Area)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
05X	ANALYZED ACCIDENT: 5 - Caustic Spray Leak	This accident is analyzed and the results presented in the current BIO. An additional control has been included for Sodium Hydroxide cargo tanks to meet applicable DOT specifications.		None required	AC: Caustic trans cntrls (sleeving - system pressure - piping thickness - cargo tank DOT specifications)	None required	None required	No specific TSR controls were identified because the hazard is solely toxicological . A non-TSR control is established requiring 4 mil thickness plastic sleeving around delivery piping; limitation on the caustic delivery system to be less than or equal to 125 psi, and use of schedule 10 steel pipe as a minimum thickness for caustic delivery if used.
06A	W320-ABCD-ALL01	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome	1. Raw water line rupture 2. Heavy rainfall	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
06B	W320-ABCD-ALL02	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 dome	1. Raw water line rupture 2. Heavy rainfall	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
06X	W320-ABCD-ALL03	Release of energetic radioactive aerosol from tank dome collapse due to flooding on top of tank dome	1. Raw water line rupture 2. Heavy rainfall	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
06X	W320-B-ALL01	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
06X	W320-B-ALL02	Release of a large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to volcanic ashfall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
06X	W320-B-ALL03	Release of high energy aerosolized waste to the atmosphere from Tank 241-C-106 dome collapse due to extreme snow fall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
06X	W320-B-ALL04	Release of large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to extreme snow fall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
06X	W320-B-ALL05	Release of energetic radioactive aerosol from Tank 241-C-106 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
06X	W320-B-ALL06	Release of energetic radioactive aerosol from Tank 241-AY-102 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
06X	W320-D-TRANS03	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to sluicer moving debris impacting drop leg in tank which breaches dome.	1. Expected outcome of high velocity sluicing Many objects are in the waste	None required	None required	SC: SST ventilation SC: DST ventilation	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active	Controls derived from flammable gas deflagration analysis. Hazardous condition results in breach of confinement integrity. The ventilation system mitigates the effects by maintaining filtered confinement.
07A	W320-BCD-ALL03	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan overspeed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
07B	W320-BCD-ALL02	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-ABCD-CHILL03	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to excessive cooling from process chiller which restricts inflow and loop seal fails to operate.	1. Chiller control fault 2. High humidity	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-B-FLUSH04	Release of low energy radioactive aerosol from breached Tank 241-C-106 due to flushing water spray through sluice nozzle resulting in excessive tank vacuum.	1. Planned	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
07X	W320-B-FLUSH05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to flushing water spray thru antisiphon holes resulting in excessive vacuum in tank and tank breach.	1. Planned	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-B-VENT01	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through existing ventilation system with W030 intake resulting in excessive vacuum and tank breach.	1. Natural phenomena	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-B-VENT02	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through W030 ventilation upgrade system resulting in excessive vacuum and tank breach.	1. Natural phenomena	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
07X	W320-B-VENT03	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through W030 ventilation upgrade and results in excessive vacuum.	1. Natural phenomena	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-B-VENT04	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing exhaust system with W030 intake and results in excessive vacuum.	1. Natural phenomena	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-B-VENT05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to cold water spray into tank which results in excessive vacuum and tank breach.	1. Possible result of slurry distribution	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
07X	W320-B-VENT06	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing ventilation system and results in excessive vacuum.	1. Natural phenomena	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-B-VENT07	Release of low energy radioactive aerosol from largely intact tank due to volcanic ashfall preventing air inflow into Tank 241-AY-102 through existing ventilation system resulting in tank breach.	1. Natural phenomena	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-BCD-ALL04	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to fan controller failure resulting in excessive vacuum in tank and loop seal actuation.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
07X	W320-D-VENT12	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
07X	W320-D-VENT20	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
08A	W320-D-ALL07	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO and LA-UR-92-3196 , with additional controls on primary tank leak Detect Syss

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08B	W320-BCD-PUMP04	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08C	W320-A-TRANS05	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-A-TRANS04	Release of large high energy aerosolized waste from Tank 241-C-106 due to high waste temperature during slurry transfer which results in a steam bump. Bump induces flammable gas release which is ignited resulting in a dome burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-ABCDF-ALL01*	Release of energetic radioactive aerosol to atmosphere due to buildup of flammable gas in Tank 241-AY-102 pit drain pipe which is then ignited.	1. Flammable gas generation from tank waste	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-B-ALL07	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-C-106 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: SST ventilation	LCO: SST ventilation sys - active and passive AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-B-ALL08	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 due to a large water intrusion which induces a flammable gas release event. It is then ignited resulting in a dome space fire.	1. Raw water leak 2. Surface water flood	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-B-TERM01	Release of toxic ammonia gas from tank due to burp which exposes facility personnel to toxic gases.	1. Inadequate prediction of waste behavior	SC: SST ventilation SC: DST ventilation	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active and passive AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-B-TRANS13	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-AY-102 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-B-TRANS14	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to low slurry flow to distributor which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-B-TRANS15	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to air injected into the waste from the startup of slurry flow from the distributor. Gas is scrubbed from the waste and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Normal procedure	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-B-TRANS16	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to distributor nozzle breaking off which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-B-TRANS17	Release of high energy aerosolized waste from damaged Tank 241-C-106 due to the sluicer hose breaking which then impinges into the solids releasing a region of retained flammable gas. The gas is then ignited and a plume fire results.	1. Primary failure of hose 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Fatigue from vibration	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-B-TRANS18	Release of large high energy aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-C-106 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with a plume burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-BCD-ALL05	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	None	AC: Trans cntrls (configuration management)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-BCD-ALL06	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited and detonates resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	None	AC: Trans cntrls (configuration management)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-BCD-ALL10	Small high energy aerosolized waste release to the atmosphere due to plugging and buildup of flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	None	AC: Trans cntrls (configuration management)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-BCD-PUMP03	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-BCD-PUMP05	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-C-106, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-BCD-PUMP09	Release of large high energy aerosolized waste to atmosphere due to immersible pump being raised too high in Tank 241-C-106, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-D-ALL08	Release of energetic radioactive aerosol to atmosphere due to start of air lift circulators in Tank 241-AY-102 resulting in a release of flammable gas plume which is then ignited.	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-D-PUMP04	Release of energetic radioactive aerosol from damaged Tank 241-AY-102 due to pumping of more solids than anticipated. Annulus cooling mod not completed resulting in overheating of waste and a tank bump. Bump induces large flammable gas release. It is then ignited resulting in a dome space fire.	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning slurry pump 3. Inadvertant or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump Tank 241-C-106 fault 6. Pump controller fault	SC: DST ventilation SC: Annulus ventilation syss	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active and passive LCO: Primary tank leak detection sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-D-TRANS05	Release of energetic radioactive aerosol to atmosphere due to head space gas concentration above LFL in Tank 241-AY-102 with the start of pumping which ignites the flammable gas.	1. Spontaneous GRE 2. Induced GRE	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-D-TRANS06	Release of large high energy aerosolized waste to the atmosphere due to slurry transfer rate being excessive resulting in a rapid reduction in the hydrostatic pressure in Tank 241-C-106. This results in a flammable gas release. Gas is ignited and a dome space fire results.	1. Sluice flow control fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-D-TRANS07	Release of high energetic aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-AY-102 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with ignition.	1. Operator mistake 2. Level indication fault 3. Pump controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-D-VENT13	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to influx of cold water spray into tank which results in an excessive vacuum. A large flammable gas release is induced. It is then ignited resulting in a dome space fire.	1. Possible result of slurry distribution	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-D-VENT14	Small high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas leaks into annulus. It is then ignited resulting in the annulus being breached.	1. Extended loss of power 2. Severe ventilation casualty	SC: DST ventilation SC: Annulus ventilation syss	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-D-VENT15	Small low energy radioactive aerosolized waste release from standpipes in Tank 241-AY-102 due to flammable gas buildup where it is ignited resulting in the pipe being breached resulting in an unfiltered release.	1. Natural occurrence under proper conditions	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-D-VENT16	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas builds up in the dome space to the LFL. It is then ignited resulting in a dome space fire.	1. Extended loss of power 2. Severe ventilation casualty	SC: DST ventilation SC: Annulus ventilation syss	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
08X	W320-D-VENT17	Release of high energy aerosolized release to the atmosphere due to an ice storm which prevents air inflow into Tank 241-AY-102 resulting in an excessive tank vacuum. This results in a flammable gas release with ignition.	1. Natural phenomena	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-D-VENT18	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to volcanic ashfall which prevents air inflow to tank. Excessive vacuum results and flammable gas is released to the dome space. It is then ignited resulting in a dome space fire.	1. Natural phenomena	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO
08X	W320-E-TERM03	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to lack of controls on operation of tank after it has been turned into a FG group 1 tank. It is ignited from a lightning strike or other event resulting in a dome space fire.	1. Inadequate prediction of waste behavior	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on Flammable Gas JCO

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
09A	W320-B-ALL09	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	None required	AC: Ign cntrls (organic solvent) AC: Trans cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
09B	W320-B-ALL10	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	None required	AC: Ign cntrls (organic solvent) AC: Trans cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
09X	W320-A-TRANS06	Release of energetic radioactive aerosol from damaged tank due to waste temperature being out of specification during start of slurry transfer in Tank 241-C-106 and subsequent ignition of organics.	1. Operator mistake 2. Temperature measurement fault	None required	AC: Ign cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
09X	W320-B-VENT08	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-C-106 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	None required	AC: Ign cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
09X	W320-B-VENT09*	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-AY-102 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	None required	AC: Ign cntrls (organic solvent) AC: Trans cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
10	W320-D-CHILL01	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	None required	AC: Ign cntrls	None required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (In-Tank Fuel Fire/Deflagration)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
10X	W320-ALL-VENT01	Release of energetic radioactive aerosol from breached ventilation duct for Tank 241-AY-102 due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	None required	AC: Ign cntrls	None required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (In-Tank Fuel Fire/Deflagration)
10X	W320-D-CHILL02	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from ventilation chiller into Tank 241-C-106.	1. Piping or tubing leak	None required	AC: Ign cntrls	None required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (In-Tank Fuel Fire/Deflagration)
10X	W320-D-VENT01	Release of energetic radioactive aerosol from filter breach due to a buildup of ammonium nitrate in ventilation ducting of Tank 241-AY-102 and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	None required	AC: Ign cntrls	None required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (In-Tank Fuel Fire/Deflagration)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11	W320-D-TRANS08	Release of low energy radioactive aerosol through failed filters due to excessive fluffing of waste in Tank 241-AY-102 resulting in large steam bump and unfiltered release.	1. Inadequate prediction of waste behavior	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-A-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to a large steam bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	None required	LCS/LCO: SST waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-A-TRANS02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to lowering of tank level with temperature out of spec resulting in tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. ENRAF level indication fault 4. Pump controller fault 5. Tank 241-C-106 T/C fault	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-A-TRANS03	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to high waste temperature during slurry transfer and resulting steam bump.	1. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-B-PUMP01	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to overheating of waste and subsequent steam bump	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning 3. Inadvertant or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump fault 6. Pump controller fault	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-B-TRANS02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to low slurry flow, piling of waste at base of distributor and resulting tank bump	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-B-TRANS03	Release of low energy radioactive aerosol through failed filters due to condensation of vapor in head space of Tank 241-C-106 which resulted from the breaking off of sluicer head.	1. Primary failure of sluicer 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	None required	LCS/LCO: SST waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-B-TRANS04	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to high slurry transfer rate, high waste temperature and resulting tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	None required	LCS/LCO: SST waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-B-TRANS05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of low slurry flow which results in steam bump and increased head space vapor pressure.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-B-TRANS09	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of the distributor nozzle breaking off which results in steam bump and increased head space vapor pressure.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-BCD-TRANS05	Release of low energy radioactive aerosol through failed filters due to tank bump in Tank 241-AY-102 resulting from the vacuum developed in the head space from the condensation of vapor which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-BCD-TRANS06	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to tank bump resulting from the which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-BCD-TRANS07	Release of low energy radioactive aerosol through failed filters of Tank 241-C-106 due to failure of T/C Tree, sluicing outside of temperature specs, atmospheric change, and large steam bump resulting in filter breach.	1. Sluice flow control fault 2. Operator error	None required	LCS/LCO: SST waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-BCD-TRANS08	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to undetected high waste temperature and resulting tank bump	1. Expected outcome of high pressure sluice. Many objects are in the waste.	None required	LCS/LCO: SST waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-D-ALL02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to barometric pressure change, high waste temperature and resulting tank bump	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-D-ALL03	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-D-ALL04	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-D-ALL05	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to long term loss of ventilation system resulting in tank bump and blowout of filters.	1. Loss of power 2. Equipment casualty	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-D-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to rapid waste level change, high waste temperature and resulting tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-AY-102 pump 3. Inadvertant or accidental actuation of Tank 241-AY-102 pump but not Tank 241-C-106 pump 4. ENRAF level indication fault 5. Pump controller fault	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-D-VENT02	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to inadequate ventilation from W030 resulting in increased waste temperature, steam bump and filter breach.	1. Error in calculations 2. Design error 3. Construction fault	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-D-VENT03	Release of low energy radioactive aerosol through failed filters in the 702A ventilation system of Tank 241-AY-102 due to severe ice storm, excessive tank vacuum and resulting tank bump	1. Natural phenomena	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-D-VENT05	Release of low energy radioactive aerosol through failed filters in the W030 ventilation system due to severe ice storm, excessive tank vacuum and resulting tank bump.	1. Natural phenomena	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-D-VENT06	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to volcanic ashfall, excessive vacuum resulting in large steam bump and filter blowout.	1. Natural phenomena	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
11X	W320-D-VENT09	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to loss of primary or annulus ventilation which results in steam release.	1. Extended loss of power 2. Severe ventilation casualty	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
11X	W320-D-VENT19	Release of low energy radioactive aerosol through failed filters due to loss of primary or annulus ventilation for extended period of time resulting in rise in waste temperature and large bump in Tank 241-AY-102.	1. Extended loss of power 2. Severe ventilation casualty	SC: Tank 241-AY-102 annulus ventilation sys	LCS/LCO: DST and AWF Tanks waste temp cntrls AC: Trans Cntrls (mat balance and topography) AC: Proc Instr and Meas and Test Equip AC: Vent cntrls (annulus)	None required	None required	Controls based on accident analysis (Tank Bump)
12	W320-ABCD-TRANS01	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
12X	W320-ABCD-ALL04	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakeage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls AC: Tank service water intru monitor prog	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting In Pool for water intrusion

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
12X	W320-ABCD-ALL05	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls AC: Tank service water intru monitor prog	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting In Pool for water intrusion
12X	W320-ABCD-TRANS02	Release of liquid waste below grade and aerosol release to atmosphere due to loss of sluicer arm control in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Unavoidable operator action	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
12X	W320-ABCD-TRANS03	Release of liquid waste below grade and aerosol release to atmosphere due to siphoning of waste from Tank 241-AY-102 after the stoppage of pumping water exceeds maximum operating level in Tank 241-C-106 resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Buildup of solids in openings 2. Equipment casualty	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting in Pool for level monitoring
12X	W320-ABCD-TRANS05	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer hose break in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breaching of tank bottom.	1. Primary failure of hose 2. Severe water hammer 3. Fatigue from vibration	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
12X	W320-ABCD-TRANS06	Release of liquid waste below grade and aerosol release to atmosphere due to sluicing arm breaking off and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner breach and steam bump.	1. Primary failure of sluicer 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
12X	W320-ABCD-TRANS07	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
12X	W320-ABCD-TRANS08	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
12X	W320-ABCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to excessive waste temperature change rate Tank 241-C-106 liner breaches, resulting in water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. High temperature in Tank 241-AY-102	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
12X	W320-BCD-ALL07	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, bulging of tank bottom, ripping of liner and steam bump.	1. Raw water leak 2. Surface water flood	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting in Pool for level monitoring

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
12X	W320-BCD-ALL08	Release of liquid waste below grade and aerosol release to atmosphere due to excessive corrosion because of waste disturbance in Tank 241-C-106 resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Inadequate prediction of waste behavior	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
12X	W320-BCD-PUMP08	Release of liquid waste below grade and aerosol release to atmosphere due to submersible pump being raised too high, winch lifting strap breaking, pump falling and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner bulges/rips and steam bump occurs.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
12X	W320-BCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 water exceeds maximum operating level resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Loss of power 2. Equipment casualty	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting in Pool for level monitoring
12X	W320-D-ALL09	Release of liquid waste below grade and aerosol release to atmosphere due to seismic event Tank 241-C-106 liner is breached resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Natural Phenomena	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	AC: Emergency prep (seismic)	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
12X	W320-D-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to movement of debris during sluicing which impacts and breaches the Tank 241-C-106 liner, resulting in water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Expected outcome of high pressure sluice. Many objects are in the waste.	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
12X	W320-F-TERM05	Release of liquid waste below grade and aerosol release to atmosphere due to high heat load after completion of sluicing process resulting in the need for water addition to Tank 241-C-106 with a deteriorated tank liner, water leakage into liner gap, steam formation, liner breach and steam bump.	1. Error in calculations	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
13X	W320-B-ALL11	Release of liquid waste due to large water intrusion into Tank 241-C-106 resulting in high hydrostatic pressure and tank breach.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	None required	AC: Trans cntrls (config/route verif and indep trans route verif) AC: Encasement seal loop cntrls AC: Trans Pump Admin Lock Cntrls AC: Tank service water intru monitor prog	SS: Tank level detection syss	LCO: Trans leak detect syss AC: Trans cntrls (mat bal)	Controls based on accident analysis (Subsurface Leak Remaining Subsurface)
14	W320-B-TRANS22	Release of radioactive liquid from transfer line due to local flooding during transfer which results in line being uncovered and breached.	1. Raw water leak 2. Natural flow	SC: Pipe encasements	AC: Trans cntrls (config/route verif and indep trans route verif)	SC: Tank level detection syss	AC: Emergency Preparednes s	Controls based on accident analysis (Subsurface Leak Resulting in Pool)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
15A	W320-B-FLUSH06	Release of radioactive liquid from transfer line due to a pipe break in Tank 241-AY-102 pit with the high capactiy drain cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	SC: Leak detectors in interfacing pits and their alarms	AC: Trans cntrls (commun/config/route ver/caps-blanks) AC: Trans pump admin lock cntrls	SC: Trans sys covers SC: Trans leak detector alarms SS: Tank level detection syss	LCO: Trans leak detect syss AC: Trans cntrls (mat balance) AC: Emergency prep (leak) C: Trans sys cover removal cntrls	Controls based on accident analysis (Surface Leak Resulting in Pool)
15B	W320-BCD-TRANS10	Release of radioactive liquid release from sluice transfer line due to the blank flange being left off flushing connection in Tank 241-AY-102 pit and drain cover left on resulting in overflow of pit onto the ground during sluicing.	1. Maintenance error 2. Communications error between different groups using the pit	SC: Leak detectors in interfacing pits and their alarms SS: Primary tank leak detection sys	AC: Trans cntrls (commun/config/route ver/caps-blanks)	SC: Trans sys covers SC: Trans leak detector alarms	LCO: Trans leak detect syss AC: Trans cntrls (mat balance) AC: Emergency prep (leak) AC: Trans sys cover removal cntrls	Controls based on accident analysis (Surface Leak Resulting in Pool)
15X	W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 onto the ground due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	None required	AC: Tank service water intru monitor prog	SS: Tank level detection syss	AC: Emergency prep (leak)	Controls based on accident analysis (Surface Leak Resulting in Pool)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
15X	W320-ABCD-ALL08*	Release of radioactive liquid from Tank C-106 due to siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	1. Plugging of antisiphon holes 2. Loss of electrical power to the pumps 3. Shutdown from operations	SC: Leak detectors in interfacing pits and their alarms	AC: Trans cntrls (commun/config/route ver/caps-blanks) AC: Trans pump admin lock cntrls	SC: Trans sys covers SC: Trans leak detector alarms SS: Tank level detection syss	LCO: Trans leak detect syss AC: Trans cntrls (mat balance) AC: Emergency prep (leak) AC: Trans sys cover removal cntrls	Controls based on accident analysis (Surface Leak Resulting in Pool)
15X	W320-B-ALL13	Release of radioactive liquid from Tank 241-AY-102 due to large water intrusion into tank	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage	None required	AC: Tank service water intru monitor prog	SS: Tank level detection syss	AC: Emergency prep (leak)	Controls based on accident analysis (Surface Leak Resulting in Pool)
15X	W320-B-FLUSH07	Release of radioactive liquid from transfer line due to pipe break in pit during flushing and drain plug cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	SC: Leak detectors in interfacing pits and their alarms	AC: Trans cntrls (commun/config/route ver/caps-blanks) AC: Tank service water intru monitor prog	SC: Trans sys covers SC: Trans leak detector alarms SS: Tank level detection syss	LCO: Trans leak detect syss AC: Trans cntrls (mat balance) AC: Emergency prep (leak) AC: Trans sys cover removal cntrls	Controls based on accident analysis (Surface Leak Resulting in Pool)
16A	W320-BCD-TRANS11	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
16B	W320-BCD-TRANS12	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	SC: Pipe-in-pipe encasements	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-ABCD-TRANS11 *	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: SST ventilation SC: DST ventilation	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on analysis for Flammable Gas Deflagration
16X	W320-ABCD-TRANS12	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in distributor pit of Tank 241-AY-102 with cover block off during slurry transfer.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver)	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
16X	W320-B-TRANS23	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-AY-102 with cover block off during sluicing.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-B-TRANS24	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-B-TRANS25	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in sluice pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-B-TRANS26	Release of energetic radioactive aerosol from transfer line in Tank 241-C-106 pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on analysis for Flammable Gas Deflagration

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
16X	W320-B-TRANS27	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: SST ventilation SC: DST ventilation	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active and passive AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparednes s	Controls based on analysis for Flammable Gas Deflagration
16X	W320-B-TRANS28	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 distributor pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-B-TRANS29	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-B-TRANS30	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
16X	W320-B-TRANS31	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 sluice pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-BCD-FLUSH01	Release of energetic radioactive aerosol from transfer line due to 3 way valve left in flush position after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	SS: Backflow preventers	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Stack CAM and interlk SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-BCD-FLUSH02*	Release of energetic radioactive aerosol from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled and pressurized resulting in rupture of tank or transfer line.	1. Human error 2. Communications error between different groups	SS: Backflow preventers	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	None required	None required	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
16X	W320-BCD-TRANS13	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection and 3 way valve left in flush position after flushing. Cover plug remains in place on initiation of sluicing process. High capacity drain cover left on and pit overflows.	1. Maintenance error 2. Communications error between different groups using the pit	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-D-PUMP01	Release of energetic radioactive aerosol from line break in Tank 241-AY-102 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
16X	W320-D-PUMP03	Release of energetic radioactive aerosol from line break in Tank 241-C-106 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
16X	W320-D-TRANS10	Release of energetic radioactive aerosol from jumper in pit due to seismic event. Cover block breached by ground motion resulting in spray release.	1. Natural Phenomena	None required	None required	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls AC: Emergency prep (seismic)	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
17	W320-D-TRANS11	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	None required	None	None required	AC: Emergency prep (seismic)	Controls based on accident analysis (Spray Leak from Underground Waste Transfer Lines)

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
17X	W320-B-TRANS32	Release of large high energy aerosolized radioactive waste from a spray leak from transfer line break due to aircraft strike on underground transfer line berm.	1. Light aircraft crash	None required	None required	None required	None required	No controls required based on TWRS BIO assigned frequency of F0 for aircraft crash.
18A	W320-D-ALL06	Release of a small amount of low energy aerosolized waste through failed filters due to seismic event which induces a steam bump in Tank 241-AY-102, and failure of filters or ducting.	1. Natural Phenomena	None required	None required	None required	AC: Emergency prep (seismic)	Controls based on accident analysis (Natural Phenomena - Seismic)
18F	W320-ALL-TRANS02	Release of small high energy aerosolized waste due to high winds or tornado resulting in failed ventilation ducting and unfiltered release.	1. Natural occurrence under proper conditions	None required	None required	SS: CAM interlk on 702-A ventilation sys SS: CAM interlk on W-030 ventilation sys SS: CAM interlk on 296-P-16 ventilation sys SS: CAM interlk on 296-C-006 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on HEPA Filter Failure - exposure to high temperature or pressure. Hazardous condition could result in damage or destruction of HEPA filters necessitating source term control. Indication of failure comes from CAMs. Additional controls are provided by DID for same accident in the Delta P alarms and interlocks.

Table D-1. Safety SSCs and TSRs for Potential S3 and S2 Consequences. (58 sheets)

Rep Acc W320	ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
18F	W320-B-ALL14	Release of small low energy aerosolized waste to the atmosphere from intact pit due to high winds/dust devils during plug removal from pit cover.	1. High winds	None required	AC: Dome loading cntrls (high wind)	None required	None required	Controls base on accident analysis (Natural Phenomena - High Wind)

AC = Administrative Control
AWF = Aging Waste Facility
DST = double-shell tank
HEPA = high-efficiency particulate air (filter)
JCO = Justification for Continued Operation
LCO = limiting condition for operation
LCS = limiting control setting
LFL = lower flammability limit
SC = Safety-Class
SST = single-shell tank
T/C = thermocouple

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
ANALYZED ACCIDENT: 5 - Caustic Spray Leak	This accident is analyzed and the results presented in the current BIO. An additional control has been included for Sodium Hydroxide cargo tanks to meet applicable DOT specifications.		None required	AC: Caustic trans cntrls (sleeving - system pressure - piping thickness - cargo tank DOT specifications)	None required	None required	No specific TSR controls were identified because the hazard is solely toxicological. A non-TSR control is established requiring 4 mil thickness plastic sleeving around delivery piping; limitation on the caustic delivery system to be less than or equal to 125 psi, and use of schedule 10 steel pipe as a minimum thickness for caustic delivery if used.
W320-A-TRANS04	Release of large high energy aerosolized waste from Tank 241-C-106 due to high waste temperature during slurry transfer which results in a steam bump. Bump induces flammable gas release which is ignited resulting in a dome burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-A-TRANS05	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-A-TRANS06	Release of energetic radioactive aerosol from damaged tank due to waste temperature being out of specification during start of slurry transfer in Tank 241-C-106 and subsequent ignition of organics.	1. Operator mistake 2. Temperature measurement fault	None required	AC: Ign cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
W320-ABCD-ALL01	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome	1. Raw water line rupture 2. Heavy rainfall	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads).
W320-ABCD-ALL02	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 dome	1. Raw water line rupture 2. Heavy rainfall	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
W320-ABCD-ALL03	Release of energetic radioactive aerosol from tank dome collapse due to flooding on top of tank dome	1. Raw water line rupture 2. Heavy rainfall	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-ABCD-ALL04	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakeage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls AC: Tank service water intru monitor prog	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting In Pool for water intrusion
W320-ABCD-ALL05	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls AC: Tank service water intru monitor prog	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting In Pool for water intrusion
W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 onto the ground due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	None required	AC: Tank service water intru monitor prog	SS: Tank level detection syss	AC: Emergency prep (leak)	Controls based on accident analysis (Surface Leak Resulting in Pool)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-ABCD-ALL08 *	Release of radioactive liquid from Tank 241-C-106 due to siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	1. Plugging of antisiphon holes 2. Loss of electrical power to the pumps 3. Shutdown from operations	SC: Leak detectors in interfacing pits and their alarms	AC: Trans cntrls (commun/config/route ver/caps-blanks) AC: Trans pump admin lock cntrls	SC: Trans sys covers SC: Trans leak detector alarms SS: Tank level detection syss	LCO: Trans leak detect syss AC: Trans cntrls (mat balance) AC: Emergency prep (leak) AC: Trans sys cover removal cntrls	Controls based on accident analysis (Surface Leak Resulting in Pool)
W320-ABCD-CHILL 02	Release of energetic radioactive aerosol from covered pit or deadend pipe due to propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome.	1. Piping or tubing leak	None required	None required	None required	AC: Emergency prep (response procedures))	Controls based on accident analysis (Fire in Contaminated Area)
W320-ABCD-CHILL 03	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to excessive cooling from process chiller which restricts inflow and loop seal fails to operate.	1. Chiller control fault 2. High humidity	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
W320-ABCD-TRANS 01	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-ABCD-TRANS 02	Release of liquid waste below grade and aerosol release to atmosphere due to loss of sluicer arm control in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Unavoidable operator action	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-ABCD-TRANS 03	Release of liquid waste below grade and aerosol release to atmosphere due to siphoning of waste from Tank 241-AY-102 after the stoppage of pumping water exceeds maximum operating level in Tank 241-C-106 resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Buildup of solids in openings 2. Equipment casualty	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting in Pool for level monitoring
W320-ABCD-TRANS 05	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer hose break in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breaching of tank bottom.	1. Primary failure of Hose 2. Severe Water hammer 3. Fatigue from vibration	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-ABCD-TRANS 06	Release of liquid waste below grade and aerosol release to atmosphere due to sluicing arm breaking off and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner breach and steam bump.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-ABCD-TRANS 07	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-ABCD-TRANS 08	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-ABCD-TRANS 09	Release of liquid waste below grade and aerosol release to atmosphere due to excessive waste temperature change rate Tank 241-C-106 liner breaches, resulting in water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. High temperature in Tank 241-AY-102	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-ABCD-TRANS 11	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	None required	AC: Ignition cntrls (vehicle)	None required	AC: Emergency prep (response procedures)	Controls based on accident analysis (Fire in Contaminated Area)
W320-ABCD-TRANS 11*	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: SST ventilation SC: DST ventilation	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on analysis for Flammable Gas Deflagration

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-ABCD-TRANS 12	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in distributor pit of Tank 241-AY-102 with cover block off during slurry transfer.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver)	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
W320-ABCDF-ALL0 1*	Release of energetic radioactive aerosol to atmosphere due to buildup of flammable gas in Tank 241-AY-102 pit drain pipe which is then ignited.	1. Flammable gas generation from tank waste	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-ALL-VENT01	Release of energetic radioactive aerosol from breached ventilation duct for Tank 241-AY-102 due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	None required	AC: Ign cntrls	None required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (In-Tank Fuel Fire/Deflagratio n)
W320-B-ALL01	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
W320-B-ALL02	Release of a large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to volcanic ashfall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
W320-B-ALL03	Release of high energy aerosolized waste to the atmosphere from Tank 241-C-106 dome collapse due to extreme snow fall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-B-ALL04	Release of large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to extreme snow fall.	1. Natural phenomena	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
W320-B-ALL05	Release of energetic radioactive aerosol from Tank 241-C-106 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
W320-B-ALL06	Release of energetic radioactive aerosol from Tank 241-AY-102 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	None required	AC: Dome loading cntrls (excessive loads)	None required	None required	Controls based on accident analysis (Tank Failure Due to Excessive Loads)
W320-B-ALL08	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 due to a large water intrusion which induces a flammable gas release event. It is then ignited resulting in a dome space fire.	1. Raw water leak 2. Surface water flood	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-B-ALL09	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	None required	AC: Ign cntrls (organic solvent) AC: Trans cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
W320-B-ALL10	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	None required	AC: Ign cntrls (organic solvent) AC: Trans cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-B-FLUSH01	Release of energetic radioactive aerosol from damaged Tank 241-C-106 single shell tank due to ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank.	1. Maintenance error 2. Communications error between different groups using the pit	None required	AC: Trans cntrls (material balance)	SS: CAM interlk on 296-P-16 ventilation sys SS: CAM interlk on 296-C-006 ventilation sys	LCO: Ventilation stack CAM interlk syss AC: HEPA Filter cntrls (source term)	Controls based on accident analysis (HEPA Filter Failure - Exposure to High Temperature or Pressure)
W320-B-FLUSH04	Release of low energy radioactive aerosol from breached Tank 241-C-106 due to flushing water spray through sluice nozzle resulting in excessive tank vacuum.	1. Planned	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
W320-B-TRANS14	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to low slurry flow to distributor which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-B-TRANS15	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to air injected into the waste from the startup of slurry flow from the distributor. Gas is scrubbed from the waste and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Normal procedure	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-B-TRANS16	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to distributor nozzle breaking off which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-B-TRANS17	Release of high energy aerosolized waste from damaged Tank 241-C-106 due to the sluicer hose breaking which then impinges into the solids releasing a region of retained flammable gas. The gas is then ignited and a plume fire results.	1. Primary failure of Hose 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Fatigue from vibration	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-B-TRANS18	Release of large high energy aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-C-106 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with a plume burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-B-TRANS23	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-AY-102 with cover block off during sluicing.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
W320-B-TRANS24	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
W320-B-TRANS25	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in sluice pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
W320-B-TRANS26	Release of energetic radioactive aerosol from transfer line in Tank 241-C-106 pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on analysis for Flammable Gas Deflagration
W320-B-TRANS27	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	SC: SST ventilation SC: DST ventilation	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active and passive AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on analysis for Flammable Gas Deflagration

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-B-TRANS32	Release of large high energy aerosolized radioactive waste from a spray leak from transfer line break due to aircraft strike on underground transfer line berm.	1. Light aircraft crash	None required	None required	None required	None required	No controls required based on TWRS BIO assigned frequency of F0 for aircraft crash.
W320-B-VENT08	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-C-106 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	None required	AC: Ign cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
W320-B-VENT09*	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-AY-102 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	None required	AC: Ign cntrls (organic solvent) AC: Trans cntrls (organic solvent)	None Required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (Organic Solvent Fire)
W320-BCD-ALL02	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
W320-BCD-ALL03	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan overspeed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-BCD-ALL07	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, bulging of tank bottom, ripping of liner and steam bump.	1. Raw water leak 2. Surface water flood	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting in Pool for level monitoring
W320-BCD-ALL08	Release of liquid waste below grade and aerosol release to atmosphere due to excessive corrosion because of waste disturbance in Tank 241-C-106 resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Inadequate prediction of waste behavior	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-BCD-FLUSH01	Release of energetic radioactive aerosol from transfer line due to 3 way valve left in flush position after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	SS: Backflow preventers	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Stack CAM and interlk SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
W320-BCD-FLUSH02*	Release of energetic radioactive aerosol from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled and pressurized resulting in rupture of tank or transfer line.	1. Human error 2. Communications error between different groups	SS: Backflow preventers	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	None required	None required	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-BCD-PUMP03	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-BCD-PUMP04	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-BCD-PUMP05	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-C-106, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-BCD-PUMP08	Release of liquid waste below grade and aerosol release to atmosphere due to submersible pump being raised too high, winch lifting strap breaking, pump falling and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner bulges/rips and steam bump occurs.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-BCD-PUMP09	Release of large high energy aerosolized waste to atmosphere due to immersible pump being raised too high in Tank 241-C-106, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-BCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 water exceeds maximum operating level resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Loss of power 2. Equipment casualty	SS: Tank level detection syss	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106) and controls from Surface Leak Resulting in Pool for level monitoring
W320-BCD-TRANS11	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-BCD-TRANS1 2	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	SC: Pipe-in-pipe encasements	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
W320-D-ALL06	Release of a small amount of low energy aerosolized waste through failed filters due to seismic event which induces a steam bump in Tank 241-AY-102, and failure of filters or ducting.	1. Natural Phenomena	None required	None required	None required	AC: Emergency prep (seismic)	Controls based on accident analysis (Natural Phenomena - Seismic)
W320-D-ALL07	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E , with additional controls on primary tank leak Detect Syss
W320-D-ALL08	Release of energetic radioactive aerosol to atmosphere due to start of air lift circulators in Tank 241-AY-102 resulting in a release of flammable gas plume which is then ignited.	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-D-ALL09	Release of liquid waste below grade and aerosol release to atmosphere due to seismic event Tank 241-C-106 liner is breached resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Natural Phenomena	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	AC: Emergency prep (seismic)	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-D-CHILL01	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	None required	AC: Ign cntrls	None required	AC: HEPA Filter cntrl program (source Term)	Controls based on accident analysis (In-Tank Fuel Fire/Deflagration)
W320-D-CHILL02	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from ventilation chiller into Tank 241-C-106.	1. Piping or tubing leak	None required	AC: Ign cntrls	None required	AC: HEPA filter cntrl program (source Term)	Controls based on accident analysis (In-Tank Fuel Fire/Deflagration)
W320-D-PUMP01	Release of energetic radioactive aerosol from line break in Tank 241-AY-102 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-D-PUMP03	Release of energetic radioactive aerosol from line break in Tank 241-C-106 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None required	LCO: Trans cntrls (config man/route ver) AC: Trans pump admin lock cntrls	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)
W320-D-PUMP04	Release of energetic radioactive aerosol from damaged Tank 241-AY-102 due to pumping of more solids than anticipated. Annulus cooling mod not completed resulting in overheating of waste and a tank bump. Bump induces large flammable gas release. It is then ignited resulting in a dome space fire.	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning slurry pump 3. Inadvertant or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump Tank 241-C-106 fault 6. Pump controller fault	SC: DST ventilation SC: Annulus ventilation syss	LCO: DST and AWF ventilation sys LCO: SST ventilation sys - active and passive LCO: Primary tank leak detection sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-D-TRANS05	Release of energetic radioactive aerosol to atmosphere due to head space gas concentration above LFL in Tank 241-AY-102 with the start of pumping which ignites the flammable gas.	1. Spontaneous GRE 2. Induced GRE	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-D-TRANS06	Release of large high energy aerosolized waste to the atmosphere due to slurry transfer rate being excessive resulting in a rapid reduction in the hydrostatic pressure in Tank 241-C-106. This results in a flammable gas release. Gas is ignited and a dome space fire results.	1. Sluice flow control fault	SC: SST ventilation	LCO: SST ventilation sys - active AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-D-TRANS07	Release of high energetic aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-AY-102 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with ignition.	1. Operator mistake 2. Level indication fault 3. Pump controller fault	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-D-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to movement of debris during sluicing which impacts and breaches the Tank 241-C-106 liner, resulting in water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Expected outcome of high pressure sluice. Many objects are in the waste.	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)
W320-D-TRANS10	Release of energetic radioactive aerosol from jumper in pit due to seismic event. Cover block breached by ground motion resulting in spray release.	1. Natural Phenomena	None required	None required	SC: Trans sys covers	LCO: Trans sys covers AC: Trans sys cover removal cntrls AC: Emergency prep (seismic)	Controls based on accident analysis (Spray Leak in Structure or from Overground Waste Transfer Lines)

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-D-TRANS11	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	None required	None	None required	AC: Emergency prep (seismic)	Controls based on accident analysis (Spray Leak from Underground Waste Transfer Lines)
W320-D-VENT12	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
W320-D-VENT13	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to influx of cold water spray into tank which results in an excessive vacuum. A large flammable gas release is induced. It is then ignited resulting in a dome space fire.	1. Possible result of slurry distribution	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-D-VENT16	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas builds up in the dome space to the LFL. It is then ignited resulting in a dome space fire.	1. Extended loss of power 2. Severe ventilation casualty	SC: DST ventilation SC: Annulus ventilation syss	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-D-VENT17	Release of high energy aerosolized release to the atmosphere due to an ice storm which prevents air inflow into Tank 241-AY-102 resulting in an excessive tank vacuum. This results in a flammable gas release with ignition.	1. Natural phenomena	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-D-VENT18	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to volcanic ashfall which prevents air inflow to tank. Excessive vacuum results and flammable gas is released to the dome space. It is then ignited resulting in a dome space fire.	1. Natural phenomena	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E
W320-D-VENT20	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	None required	None required	None required	None required	No controls required based on accident analysis (Tank Failure Due to Vacuum or Degradation)
W320-E-TERM03	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to lack of controls on operation of tank after it has been turned into a FG group 1 tank. It is ignited from a lightning strike or other event resulting in a dome space fire.	1. Inadequate prediction of waste behavior	SC: DST ventilation	LCO: DST and AWF ventilation sys AC: Flammability cntrls AC: Ignition cntrls AC: Flammable gas mon cntrls AC: Trans cntrls (mat balance and supernate removal)	None required	AC: Emergency Preparedness	Controls based on Appendix E

Table D-2. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Candidate Causes	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Cont Memo
W320-F-TERM05	Release of liquid waste below grade and aerosol release to atmosphere due to high heat load after completion of sluicing process resulting in the need for water addition to Tank 241-C-106 with a deteriorated tank liner, water leakage into liner gap, steam formation, liner breach and steam bump.	1. Error in calculations	None required	LCS/LCO: SST Waste Temp Cntrls AC: Trans Cntrls (topog) AC: Proc Instru and Meas and Test Equip AC: Tank 241-C-106 Waste Temp Cntrls	None required	None required	Controls based on accident analysis (Steam Explosion between Steel Liner and Concrete Shell in Tank 241-C-106)

AC = Administrative control
AWF = Aging Waste Facility
DST = double-shell tank
LCS/LCO = limiting control setting/limiting condition for operation
SC = Safety-Class
SS = Safety-Significant
SST = single-shell tank

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-TRANS01	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank pump vortices	1. Natural occurrence if conditions are met	None	None	01
W320-BCD-TRANS02	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Flushing valve misposition 2. Pump controller fault 3. Excessive solids in slurry flow	None	None	01X
W320-BCD-TRANS03	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	None	None	01X
W320-BCD-TRANS04	Release of ionizing radiation and radioactive gas from Tank 241-C-106 due to a criticality event in the tank during sluicing	1. Natural occurrence if conditions are met	None	None	01X
W320-D-TERM01	Release of ionizing radiation and radioactive gas from Tank 241-AY-102 due to a criticality event in the tank	1. Natural occurrence if conditions are met	None	None	01X
W320-D-ALL01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to a steam bump	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	HEPA filter Delta P alarm - where provided HEPA filter testing Heater over temperature - interlock/alarm where provided	HEPA Filter Delta P - low Delta P interlock HEPA Filter Replacement Sampler recorder	02
W320-ALL-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to moisture buildup on ventilation system HEPA filters	1. Natural occurrence under proper conditions	HEPA filter Delta P alarm - where provided HEPA filter testing Heater over temperature - interlock/alarm where provided	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder	02X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-FLUSH01	Release of energetic radioactive aerosol from damaged Tank 241-C-106 single shell tank due to ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank.	1. Maintenance error 2. Communications error between different groups using the pit	HEPA filter Delta P alarm - where provided HEPA filter testing	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder	02X
W320-B-FLUSH02	Release of low energy radioactive aerosol through failed filters due to a large steam bump in Tank 241-C-106 as a result of high tank vacuum resulting from flushing water spray condensing dome vapors.	1. Planned	HEPA filter Delta P alarm - where provided HEPA filter testing	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder	02X
W320-B-FLUSH03	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to a large steam bump as a result of high tank vacuum due to high condensation rate in tank from flushing water spray through antisiphon holes.	1. Planned	HEPA filter Delta P alarm - where provided HEPA filter testing	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder	02X
W320-B-TRANS01	Release of small low energy aerosolized waste from the annulus of Tank 241-AY-102 due to steam pulses from boiling waste in annulus region which results in the failure of annulus filters. Waste leaks into annulus due to corrosion of primary tank from new waste composition.	1. Inadequate prediction of waste behavior	HEPA filter Delta P alarm - where provided HEPA filter testing	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder	02X
W320-D-TRANS02	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to excessive sluicer flow which results in radioactive air release through HEPAs.	1. Natural outcome if conditions are met	HEPA filter Delta P alarm - where provided HEPA filter testing	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder	02X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-VENT04	Release of small low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to cold water spray into tank, tank vacuum and resulting tank bump	1. Possible result of slurry distribution	HEPA filter Delta P alarm - where provided HEPA filter testing Heater over temperature - interlock/alarm where provided	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder	02X
W320-D-VENT07	Release of low energy radioactive aerosol from Tank 241-C-105/ Tank 241-C-106 ventilation system due to failure to determine ventilation leak during sluicing.	1. Ducting corrosion 2. Seal deterioration	Trans cntrls - waste compatibility cntrls Ign cntrls - vehicle speed limit cntrls	Plastic sleeves on aboveground ventilation flanges	03
W320-ABCD-CHILL01	Release of low energy radioactive aerosol from largely intact tank due to excessive cooling from process chiller and vacuum in Tank 241-C-106 from ventilation system which results in excedance of loop seal vacuum and unfiltered release.	1. Chiller control fault 2. High humidity	None	None	03X
W320-B-TRANS06	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive slurry flow resulting in increased aerosol generation and errant flow release.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	None	Plastic sleeves on aboveground ventilation flanges	03X
W320-B-TRANS07	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to startup of slurry flow to distributor resulting in air being bubbled through waste and release of vapor.	1. Normal procedure	Trans cntrls - waste compatibility cntrls	Plastic sleeves on aboveground ventilation flanges	03X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-TRANS08	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of distributor 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Trans cntrls - waste compatibility cntrls	Plastic sleeves on aboveground ventilation flanges	03X
W320-B-TRANS10	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to distributor breaking off which results in excessive aerosol generated in head space and release through HEPAs.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Trans cntrls - waste compatibility cntrls	Plastic sleeves on aboveground ventilation flanges	03X
W320-B-TRANS11	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to excessive corrosion and heat loading from new waste.	1. Inadequate prediction of waste behavior	Trans cntrls - waste compatibility cntrls	Plastic sleeves on aboveground ventilation flanges	03X
W320-B-TRANS12	Release of low energy radioactive aerosol from interconnected tanks due to increased heat loading of Tank 241-AY-102 and loss of vacuum.	1. Inadequate prediction of waste behavior 2. Existing system cannot control flow rates from different tanks. Depends on inleakage 3. W030 system has lower exhaust capabilities	Trans cntrls - waste compatibility cntrls	Plastic sleeves on aboveground ventilation flanges	03X
W320-D-PURGE01	Release of low energy aerosolized waste from largely intact Tank 241-C-106 due to nitrogen line break and loss of vacuum.	1. Tube failure 2. Improper Assembly 3. Regulator fault	None	Plastic sleeves on aboveground ventilation flanges	03X
W320-D-TRANS04	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to high temperature sluice water which increases head space pressure with increased errant flow.	1. High temperature in Tank 241-AY-102	Trans cntrls - waste compatibility cntrls	Plastic sleeves on aboveground ventilation flanges	03X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-VENT08	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from new ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	None	None	03X
W320-D-VENT11	Release of low energy radioactive aerosol from largely intact tank due to excessive vacuum in Tank 241-C-106 from current ventilation system which results in loop seal failure and unfiltered release.	1. Operator error 2. Communications error	None	None	03X
W320-E-TERM01	Release of large high energy radioactive aerosol from Tank 241-AY-102 due to excessive fluffing of waste which results in tank structural damage and unfiltered release.	1. Inadequate prediction of waste behavior	Trans cntrls - waste compatibility cntrls	Plastic sleeves on aboveground ventilation flanges	03X
W320-ABCD-TRANS11	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	Fire prot prog Rad prot prog	Contam cntrl prog	04
W320-ABCD-CHILL02	Release of energetic radioactive aerosol from covered pit or deadend pipe due to propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome.	1. Piping or tubing leak	Fire prot prog Rad prot prog Vehicle position spotters Tank farm fences Vegetation cntrl prog	Contam cntrl prog	04X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-ALL01	Release of energetic radioactive aerosol from covered pit on Tank 241-C-106 due to propylene glycol leak into pit with ignition.	1. Piping or tubing leak	Fire prot prog Rad prot prog Vehicle position spotters Tank farm fences Vegetation cntrl prog	Contam cntrl prog	04X
ANALYZED ACCIDENT: 5 - Caustic Spray Leak	This accident is analyzed and the results presented in the current BIO. An additional control has been included for Sodium Hydroxide cargo tanks to meet applicable DOT specifications.		Oper training TWRS Haz Material Prot Prog	Emerg resp plans and proc	05X
W320-ABCD-ALL01	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome	1. Raw water line rupture 2. Heavy rainfall	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06A
W320-ABCD-ALL02	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 Tank dome	1. Raw water line rupture 2. Heavy rainfall	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06B
W320-ABCD-ALL03	Release of energetic radioactive aerosol from tank dome collapse due to flooding on top of tank dome	1. Raw water line rupture 2. Heavy rainfall	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06X
W320-B-ALL01	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06X
W320-B-ALL02	Release of a large amount of high energy aerosolized waste from Tank 241-AY-102 Tank dome collapse due to volcanic ashfall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06X
W320-B-ALL03	Release of high energy aerosolized waste to the atmosphere from Tank 241-C-106 dome collapse due to extreme snow fall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-ALL04	Release of large amount of high energy aerosolized waste from Tank-241-AY-102 Tank dome collapse due to extreme snow fall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06X
W320-B-ALL05	Release of energetic radioactive aerosol from Tank 241-C-106 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	Shutdown oper during high wind HASP procedure JCS procedure Oper training Oper procedures	Load absorber around riser Rad Prot Prog Emer Resp Plan/Procedures	06X
W320-B-ALL06	Release of energetic radioactive aerosol from Tank 241-AY-102 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	HASP procedure JCS procedure Oper training Oper procedures	Load absorber around riser Rad Prot Prog Emer Resp Plan/Procedures	06X
W320-D-TRANS03	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to sluicer moving debris impacting drop leg in tank which breaches dome.	1. Expected outcome of high velocity sluicing Many objects are in the waste	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures	06X
W320-BCD-ALL03	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan overspeed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None	None	07A
W320-BCD-ALL02	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None	None	07B

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-ABCD-CHILL03	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to excessive cooling from process chiller which restricts inflow and loop seal fails to operate.	1. Chiller control fault 2. High humidity	None	None	07X
W320-B-FLUSH04	Release of low energy radioactive aerosol from breached Tank 241-C-106 due to flushing water spray through sluice nozzle resulting in excessive tank vacuum.	1. Planned	None	None	07X
W320-B-FLUSH05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to flushing water spray thru antisiphon holes resulting in excessive vacuum in tank and tank breach.	1. Planned	None	None	07X
W320-B-VENT01	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through existing ventilation system with W030 intake resulting in excessive vacuum and tank breach.	1. Natural phenomena	None	None	07X
W320-B-VENT02	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to volcanic ashfall which prevents air intake through W030 ventilation upgrade system resulting in excessive vacuum and tank breach.	1. Natural phenomena	None	None	07X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-VENT03	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through W030 ventilation upgrade and results in excessive vacuum.	1. Natural phenomena	None	None	07X
W320-B-VENT04	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing exhaust system with W030 intake and results in excessive vacuum.	1. Natural phenomena	None	None	07X
W320-B-VENT05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to cold water spray into tank which results in excessive vacuum and tank breach.	1. Possible result of slurry distribution	None	None	07X
W320-B-VENT06	Release of low energy radioactive aerosol from breached Tank 241-AY-102 due to ice storm which prevents air inflow through existing ventilation system and results in excessive vacuum.	1. Natural phenomena	None	None	07X
W320-B-VENT07	Release of low energy radioactive aerosol from largely intact tank due to volcanic ashfall preventing air inflow into Tank 241-AY-102 through existing ventilation system resulting in tank breach.	1. Natural phenomena	None	None	07X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-ALL04	Release of low energy radioactive aerosol from largely intact Tank 241-C-106 due to fan controller failure resulting in excessive vacuum in tank and loop seal actuation.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None	None	07X
W320-D-VENT12	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	None	None	07X
W320-D-VENT20	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of new ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	None	None	07X
W320-D-ALL07	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None	08A
W320-BCD-PUMP04	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None	08B

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-A-TRANS05	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	Mon dome pressure in Tank 241-C-106 Meas background conc for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08C
W320-A-TRANS04	Release of large high energy aerosolized waste from Tank 241-C-106 due to high waste temperature during slurry transfer which results in a steam bump. Bump induces flammable gas release which is ignited resulting in a dome burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None	08X
W320-ABCDF-ALL01*	Release of energetic radioactive aerosol to atmosphere due to buildup of flammable gas in Tank 241-AY-102 pit drain pipe which is then ignited.	1. Flammable gas generation from tank waste	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X
W320-B-ALL07	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-C-106 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	Mon dome pressure in Tank 241-C-106 and Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks Mon level growth	None	08X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-ALL08	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 due to a large water intrusion which induces a flammable gas release event. It is then ignited resulting in a dome space fire.	1. Raw water leak 2. Surface water flood	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks Mon level growth	None	08X
W320-B-TERM01	Release of toxic ammonia gas from tank due to burp which exposes facility personnel to toxic gases.	1. Inadequate prediction of waste behavior	Mon dome pressure in Tank 241-C-106 and Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X
W320-B-TRANS13	Small low energy aerosolized waste release from largely intact tank due to flammable gas collecting in a Tank 241-AY-102 pit where it is ignited resulting in the cover blocks being displaced and falling into pit. Cover block strikes riser-liner joint resulting in an unfiltered release from dome space.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	Mon vent flow rate in tanks	None	08X
W320-B-TRANS14	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to low slurry flow to distributor which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-TRANS15	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to air injected into the waste from the startup of slurry flow from the distributor. Gas is scrubbed from the waste and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Normal procedure	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08X
W320-B-TRANS16	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to distributor nozzle breaking off which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks Mon level growth	None	08X
W320-B-TRANS17	Release of high energy aerosolized waste from damaged Tank 241-C-106 due to the sluicer hose breaking which then impinges into the solids releasing a region of retained flammable gas. The gas is then ignited and a plume fire results.	1. Primary failure of Hose 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Fatigue from vibration	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None	08X
W320-B-TRANS18	Release of large high energy aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-C-106 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with a plume burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-Ay-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	Mon dome pressure in Tank 241-C-106 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-ALL05	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None	08X
W320-BCD-ALL06	Small high energy aerosolized waste release to the atmosphere due to buildup of solids and flammable gas in transfer line . Gas is then ignited and detonates resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	None	None	08X
W320-BCD-ALL10	Small high energy aerosolized waste release to the atmosphere due to plugging and buildup of flammable gas in transfer line . Gas is then ignited resulting in a breach of transfer line. Pumping is started without knowledge of breach.	1. Low flow 2. Inadequate flushing	None	None	08X
W320-BCD-PUMP03	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-PUMP05	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-C-106, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None	08X
W320-BCD-PUMP09	Release of large high energy aerosolized waste to atmosphere due to immersible pump being raised too high in Tank 241-C-106, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None	08X
W320-D-ALL08	Release of energetic radioactive aerosol to atmosphere due to start of air lift circulators in Tank 241-AY-102 resulting in a release of flammable gas plume which is then ignited.	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks Mon level growth	None	08X
W320-D-PUMP04	Release of energetic radioactive aerosol from damaged Tank 241-AY-102 due to pumping of more solids than anticipated. Annulus cooling mod not completed resulting in overheating of waste and a tank bump. Bump induces large flammable gas release. It is then ignited resulting in a dome space fire.	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning slurry pump 3. Inadvertant or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump Tank 241-C-106 fault 6. Pump controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-TRANS05	Release of energetic radioactive aerosol to atmosphere due to head space gas concentration above LFL in Tank 241-AY-102 with the start of pumping which ignites the flammable gas.	1. Spontaneous GRE 2. Induced GRE	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08X
W320-D-TRANS06	Release of large high energy aerosolized waste to the atmosphere due to slurry transfer rate being excessive resulting in a rapid reduction in the hydrostatic pressure in Tank 241-C-106. This results in a flammable gas release. Gas is ignited and a dome space fire results.	1. Sluice flow control fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None	08X
W320-D-TRANS07	Release of high energetic aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-AY-102 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with ignition.	1. Operator mistake 2. Level indication fault 3. Pump controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08X
W320-D-VENT13	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to influx of cold water spray into tank which results in an excessive vacuum. A large flammable gas release is induced. It is then ignited resulting in a dome space fire.	1. Possible result of slurry distribution	Mon dome pressure in Tank 241-C-106 and Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-VENT14	Small high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas leaks into annulus. It is then ignited resulting in the annulus being breached.	1. Extended loss of power 2. Severe ventilation casualty	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X
W320-D-VENT15	Small low energy radioactive aerosolized waste release from standpipes in Tank 241-AY-102 due to flammable gas buildup where it is ignited resulting in the pipe being breached resulting in an unfiltered release.	1. Natural occurrence under proper conditions	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X
W320-D-VENT16	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas builds up in the dome space to the LFL. It is then ignited resulting in a dome space fire.	1. Extended loss of power 2. Severe ventilation casualty	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None	08X
W320-D-VENT17	Release of high energy aerosolized release to the atmosphere due to an ice storm which prevents air inflow into Tank 241-AY-102 resulting in an excessive tank vacuum. This results in a flammable gas release with ignition.	1. Natural phenomena	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-VENT18	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to volcanic ashfall which prevents air inflow to tank. Excessive vacuum results and flammable gas is released to the dome space. It is then ignited resulting in a dome space fire.	1. Natural phenomena	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X
W320-E-TERM03	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to lack of controls on operation of tank after it has been turned into a FG group 1 tank. It is ignited from a lightning strike or other event resulting in a dome space fire.	1. Inadequate prediction of waste behavior	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks	None	08X
W320-B-ALL09	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	Vehicle position spotters Tank farm fences	HEPA filter replacement	09A
W320-B-ALL10	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	Vehicle position spotters Tank farm fences	HEPA filter replacement	09B
W320-A-TRANS06	Release of energetic radioactive aerosol from damaged tank due to waste temperature being out of specification during start of slurry transfer in Tank 241-C-106 and subsequent ignition of organics.	1. Operator mistake 2. Temperature measurement fault	Vehicle position spotters Tank farm fences	HEPA filter replacement	09X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-VENT08	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-C-106 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	Vehicle position spotters Tank farm fences	HEPA filter replacement	09X
W320-B-VENT09*	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-AY-102 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	Vehicle position spotters Tank farm fences	HEPA filter replacement	09X
W320-D-CHILL01	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	Vehicle position spotters Tank farm fences	HEPA filter replacement	10
W320-ALL-VENT01	Release of energetic radioactive aerosol from breached ventilation duct for Tank 241-AY-102 due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	None	HEPA filter replacement	10X
W320-D-CHILL02	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from ventilation chiller into Tank 241-C-106.	1. Piping or tubing leak	Vehicle position spotters Tank farm fences	HEPA filter replacement	10X
W320-D-VENT01	Release of energetic radioactive aerosol from filter breach due to a buildup of ammonium nitrate in ventilation ducting of Tank 241-AY-102 and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	Vehicle position spotters Tank farm fences	HEPA filter replacement	10X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-TRANS08	Release of low energy radioactive aerosol through failed filters due to excessive fluffing of waste in Tank 241-AY-102 resulting in large steam bump and unfiltered release.	1. Inadequate prediction of waste behavior	Communications during sluicing Tank 241-C-106 waste to be chilled Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11
W320-A-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to a large steam bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	Communications during sluicing Tank 241-C-106 waste to be chilled Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-A-TRANS02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to lowering of tank level with temperature out of spec resulting in tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. ENRAF level indication fault 4. Pump controller fault 5. Tank 241-C-106 T/C fault	Communications during sluicing Tank 241-C-106 waste to be chilled	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-A-TRANS03	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to high waste temperature during slurry transfer and resulting steam bump.	1. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump	Disable ALCs prior to start of sluicing Communications during sluicing Tank 241-C-106 waste to be chilled Transfer pumps locked out Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-PUMP01	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to overheating of waste and subsequent steam bump	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning 3. Inadvertant or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump fault 6. Pump controller fault	Communications during sluicing Tank 241-C-106 waste to be chilled	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-B-TRANS02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to low slurry flow, piling of waste at base of distributor and resulting tank bump	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	Communications during sluicing Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-B-TRANS03	Release of low energy radioactive aerosol through failed filters due to condensation of vapor in head space of Tank 241-C-106 which resulted from the breaking off of sluicer head.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Communications during sluicing Tank 241-C-106 waste to be chilled	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-B-TRANS04	Release of low energy radioactive aerosol through failed filters from Tank 241-C-106 due to high slurry transfer rate, high waste temperature and resulting tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	Communications during sluicing Tank 241-C-106 waste to be chilled Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-TRANS05	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of low slurry flow which results in steam bump and increased head space vapor pressure.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault 3. Excessive solids in sluicing flow	Communications during sluicing Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-B-TRANS09	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to buildup of solids pile under distributor as a result of the distributor nozzle breaking off which results in steam bump and increased head space vapor pressure.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Communications during sluicing Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-BCD-TRANS05	Release of low energy radioactive aerosol through failed filters due to tank bump in Tank 241-AY-102 resulting from the vacuum developed in the head space from the condensation of vapor which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-BCD-TRANS06	Release of low energy radioactive aerosol through failed filters of Tank 241-AY-102 due to tank bump resulting from the which resulted from the breaking off of distributor head.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-TRANS07	Release of low energy radioactive aerosol through failed filters of Tank C-106 due to failure of T/C Tree, sluicing outside of temperature specs, atmospheric change, and large steam bump resulting in filter breach.	1. Sluice flow control fault 2. Operator error	Communications during sluicing Tank 241-C-106 waste to be chilled	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-BCD-TRANS08	Release of low energy radioactive aerosol through failed filters from Tank C-106 due to undetected high waste temperature and resulting tank bump	1. Expected outcome of high pressure sluice. Many objects are in the waste.	Communications during sluicing Tank 241-C-106 waste to be chilled	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-ALL02	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to barometric pressure change, high waste temperature and resulting tank bump	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	Communications during sluicing Tank 241-C-106 waste to be chilled	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-ALL03	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-ALL04	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to bump in interconnected tank resulting in a tank bump and filter breach.	1. Ventilation balance upset 2. Sudden barometric pressure change 3. Low intensity seismic event	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-ALL05	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to long term loss of ventilation system resulting in tank bump and blowout of filters.	1. Loss of power 2. Equipment casualty	Communications during sluicing Tank 241-C-106 waste to be chilled Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-TRANS01	Release of low energy radioactive aerosol through failed filters from Tank 241-AY-102 due to rapid waste level change, high waste temperature and resulting tank bump	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-AY-102 pump 3. Inadvertant or accidental actuation of Tank 241-AY-102 pump but not Tank 241-C-106 pump 4. ENRAF level indication fault 5. Pump controller fault	Communications during sluicing Tank 241-C-106 waste to be chilled Maintain levels in tanks during first two increments of solids removal	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-VENT02	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to inadequate ventilation from W030 resulting in increased waste temperature, steam bump and filter breach.	1. Error in calculations 2. Design error 3. Construction fault	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-VENT03	Release of low energy radioactive aerosol through failed filters in the 702A ventilation system of Tank 241-AY-102 due to severe ice storm, excessive tank vacuum and resulting tank bump	1. Natural phenomena	None	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-VENT05	Release of low energy radioactive aerosol through failed filters in the W030 ventilation system due to severe ice storm, excessive tank vacuum and resulting tank bump.	1. Natural phenomena	None	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-VENT06	Release of low energy radioactive aerosol from Tank 241-AY-102 through failed filters due to volcanic ashfall, excessive vacuum resulting in large steam bump and filter blowout.	1. Natural phenomena	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-VENT09	Release of low energy radioactive aerosol from largely intact Tank 241-AY-102 due to loss of primary or annulus ventilation which results in steam release.	1. Extended loss of power 2. Severe ventilation casualty	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-D-VENT19	Release of low energy radioactive aerosol through failed filters due to loss of primary or annulus ventilation for extended period of time resulting in rise in waste temperature and large bump in Tank 241-AY-102.	1. Extended loss of power 2. Severe ventilation casualty	Communications during sluicing	Cover blocks in place prior to sluicing Emer Resp Plan/Procedures	11X
W320-ABCD-TRANS01	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Positive mech stops limit nozzle travel	Cover blocks in place Emer Resp Plan/Procedures	12
W320-ABCD-ALL04	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakeage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Raw water metered	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-ABCD-ALL05	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Raw water metered	Cover blocks in place Emer Resp Plan/Procedures	12X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-ABCD-TRANS02	Release of liquid waste below grade and aerosol release to atmosphere due to loss of sluicer arm control in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Unavoidable operator action	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-ABCD-TRANS03	Release of liquid waste below grade and aerosol release to atmosphere due to siphoning of waste from Tank 241-AY-102 after the stoppage of pumping water exceeds maximum operating level in Tank C-106 resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Buildup of solids in openings 2. Equipment casualty	Active vent for heat removal Material balance performed every 24 hrs Syphon protection Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-ABCD-TRANS05	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer hose break in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, and breaching of tank bottom.	1. Primary failure of hose 2. Severe water hammer 3. Fatigue from vibration	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Stiff hose engineered to maintain integrity	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-ABCD-TRANS06	Release of liquid waste below grade and aerosol release to atmosphere due to sluicing arm breaking off and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner breach and steam bump.	1. Primary failure of sluicer 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Positive mech stops limit nozzle travel	Cover blocks in place Emer Resp Plan/Procedures	12X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-ABCD-TRANS07	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-ABCD-TRANS08	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-ABCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to excessive waste temperature change rate Tank 241-C-106 liner breaches, resulting in water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. High temperature in Tank 241-AY-102	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-BCD-ALL07	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, bulging of tank bottom, ripping of liner and steam bump.	1. Raw water leak 2. Surface water flood	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-ALL08	Release of liquid waste below grade and aerosol release to atmosphere due to excessive corrosion because of waste disturbance in Tank 241-C-106 resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Inadequate prediction of waste behavior	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-BCD-PUMP08	Release of liquid waste below grade and aerosol release to atmosphere due to submersible pump being raised too high, winch lifting strap breaking, pump falling and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner bulges/rips and steam bump occurs.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-BCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 water exceeds maximum operating level resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Loss of power 2. Equipment casualty	Active vent for heat removal Material balance performed every 24 hrs Syphon protection Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-D-ALL09	Release of liquid waste below grade and aerosol release to atmosphere due to seismic event Tank 241-C-106 liner is breached resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Natural Phenomena	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to movement of debris during sluicing which impacts and breaches the Tank 241-C-106 liner, resulting in water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Expected outcome of high pressure sluice. Many objects are in the waste.	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-F-TERM05	Release of liquid waste below grade and aerosol release to atmosphere due to high heat load after completion of sluicing process resulting in the need for water addition to Tank 241-C-106 with a deteriorated tank liner, water leakage into liner gap, steam formation, liner breach and steam bump.	1. Error in calculations	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures	12X
W320-B-ALL11	Release of liquid waste due to large water intrusion into Tank 241-C-106 resulting in high hydrostatic pressure and tank breach.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	Operator training Operator procedures	Emer Resp Plan/Procedures	13X
W320-B-TRANS22	Release of radioactive liquid from transfer line due to local flooding during transfer which results in line being uncovered and breached.	1. Raw water leak 2. Natural flow	None	Walkdown once/shift WRSS transfer lines equipped with active encasement leak detectors	14
W320-B-FLUSH06	Release of radioactive liquid from transfer line due to a pipe break in Tank 241-AY-102 pit with the high capacity drain cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	Service water freeze protection system Pit drains where open	Tank farms visually surveyed at least once a day	15A

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-TRANS10	Release of radioactive liquid release from sluice transfer line due to the blank flange being left off flushing connection in Tank 241-AY-102 pit and drain cover left on resulting in overflow of pit onto the ground during sluicing.	1. Maintenance error 2. Communications error between different groups using the pit	Pit drains where open	Tank farms visually surveyed at least once a day Material balance performed every 24 hrs Encasement leak detectors	15B
W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 onto the ground due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	Service water freeze protection system Pit drains where open	Tank farms visually surveyed at least once a day Material balance performed every 24 hrs	15X
W320-ABCD-ALL08*	Release of radioactive liquid from Tank 241-C-106 due to siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	1. Plugging of antisiphon holes 2. Loss of electrical power to the pumps 3. Shutdown from operations	None	Tank farms visually surveyed at least once a day Material balance performed every 24 hrs	15X
W320-B-ALL13	Release of radioactive liquid from Tank 241-AY-102 due to large water intrusion into tank	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage	Service water freeze protection system	Tank farms visually surveyed at least once a day Material balance performed every 24 hrs	15X
W320-B-FLUSH07	Release of radioactive liquid from transfer line due to pipe break in pit during flushing and drain plug cover on resulting in overflow of pit onto the ground.	1. Equipment failure 2. Maintenance or assembly error	Service water freeze protection system Pit drains where open	Tank farms visually surveyed at least once a day Material balance performed every 24 hrs	15X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-BCD-TRANS11	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	Repositioned jumpers service tested Cameras used to verify initial jumper integrity Isolation valves (manual) for flush system	Process pit and vault pit leak detectors Material balance every 24 hrs	16A
W320-BCD-TRANS12	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	Repositioned jumpers service tested Cameras used to verify initial jumper integrity Isolation valves (manual) for flush system	Process pit and vault pit leak detectors Material balance every 24 hrs	16B
W320-ABCD-TRANS11*	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	None	None	16X
W320-ABCD-TRANS12	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in distributor pit of Tank 241-AY-102 with cover block off during slurry transfer.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-B-TRANS23	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-AY-102 with cover block off during sluicing.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-TRANS24	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-B-TRANS25	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in sluice pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-B-TRANS26	Release of energetic radioactive aerosol from transfer line in Tank 241-C-106 pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-B-TRANS27	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	None	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-B-TRANS28	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 distributor pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-B-TRANS29	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-AY-102 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-B-TRANS30	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 pump pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-B-TRANS31	Release of radioactive aerosol from covered pit due to jumper or pipe breach in Tank 241-C-106 sluice pit resulting in spray release from pit.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-BCD-FLUSH01	Release of energetic radioactive aerosol from transfer line due to 3 way valve left in flush position after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	Repositioned jumpers service tested Cameras used to verify initial jumper integrity Isolation valves (manual) for flush system Backflow preventers	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-BCD-FLUSH02*	Release of energetic radioactive aerosol from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled and pressurized resulting in rupture of tank or transfer line.	1. Human error 2. Communications error between different groups	Isolation valves (manual) for flush system	Backflow preventers	16X
W320-BCD-TRANS13	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection and 3 way valve left in flush position after flushing. Cover plug remains in place on initiation of sluicing process. High capacity drain cover left on and pit overflows.	1. Maintenance error 2. Communications error between different groups using the pit	Repositioned jumpers service tested Cameras used to verify initial jumper integrity Isolation valves (manual) for flush system	Process pit and vault pit leak detectors Material balance every 24 hrs	16X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-PUMP01	Release of energetic radioactive aerosol from line break in Tank 241-AY-102 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-D-PUMP03	Release of energetic radioactive aerosol from line break in Tank 241-C-106 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-D-TRANS10	Release of energetic radioactive aerosol from jumper in pit due to seismic event. Cover block breached by ground motion resulting in spray release.	1. Natural Phenomena	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs	16X
W320-D-TRANS11	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	None	Access cntrl Material balance every 24 hrs	17
W320-B-TRANS32	Release of large high energy aerosolized radioactive waste from a spray leak from transfer line break due to aircraft strike on underground transfer line berm.	1. Light aircraft crash	None	Access cntrl Material balance every 24 hrs	17X

Table D-3. Defense-in-Depth Controls for Potential S3 and S2 Consequences. (35 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative	Rep Acc W320
W320-D-ALL06	Release of a small amount of low energy aerosolized waste through failed filters due to seismic event which induces a steam bump in Tank 241-AY-102, and failure of filters or ducting.	1. Natural Phenomena	None	Seismic shutdown switch	18A
W320-ALL-TRANS02	Release of small high energy aerosolized waste due to high winds or tornado resulting in failed ventilation ducting and unfiltered release.	1. Natural occurrence under proper conditions	HEPA filter Delta P alarm - where provided	HEPA filter Delta P - low Delta P interlock HEPA filter replacement	18F
W320-B-ALL14	Release of small low energy aerosolized waste to the atmosphere from intact pit due to high winds/dust devils during plug removal from pit cover.	1. High winds	None	None	18F

ALC = air lift circulator
GRE = gas release event
HASP = Tank Farms Health and Safety Plan
HEPA = high efficiency particulate air (filter)
IOSR = Interim operational safety requirements
JCS = Job Control system
WRSS = waste retrieval sluicing system

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Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
ANALYZED ACCIDENT: 5 - Caustic Spray Leak	This accident is analyzed and the results presented in the current BIO. An additional control has been included for Sodium Hydroxide cargo tanks to meet applicable DOT specifications.		Oper training TWRS Haz Material Prot Prog	Emerg resp plans and proc
W320-A-TRANS04	Release of large high energy aerosolized waste from Tank 241-C-106 due to high waste temperature during slurry transfer which results in a steam bump. Bump induces flammable gas release which is ignited resulting in a dome burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None
W320-A-TRANS05	Release of energetic radioactive aerosol to atmosphere due to temperature out of specification resulting in steam bump when Tank 241-C-106 level is lowered which induces a release of a flammable gas plume and then is ignited.	1. Operator mistake 2. Temperature measurement fault	Mon dome pressure in Tank 241-C-106 Meas background conc for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-A-TRANS06	Release of energetic radioactive aerosol from damaged tank due to waste temperature being out of specification during start of slurry transfer in Tank 241-C-106 and subsequent ignition of organics.	1. Operator mistake 2. Temperature measurement fault	Vehicle position spotters Tank farm fences	HEPA filter replacement
W320-ABCD-ALL01	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-C-106 dome	1. Raw water line rupture 2. Heavy rainfall	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures
W320-ABCD-ALL02	Release of energetic radioactive aerosol from damaged tank due to flooding on top of Tank 241-AY-102 dome	1. Raw water line rupture 2. Heavy rainfall	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-ABCD-ALL03	Release of energetic radioactive aerosol from tank dome collapse due to flooding on top of tank dome	1. Raw water line rupture 2. Heavy rainfall	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures
W320-ABCD-ALL04	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakeage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Raw water metered	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-ALL05	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Raw water metered	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-ALL07	Release of radioactive liquid from Tank 241-C-106 onto the ground due to large water intrusion into tank.	1. Raw water leak 2. Surface water flood 3. Vent system water inleakage 4. Excessive transfer from Tank 241-AY-102 5. Water intrusion in Tank 241-C-105 that cascades over to Tank 241-C-106	Service water freeze protection system Pit drains where open	Tank farms visually surveyed at least once a day Material balance performed every 24 hrs
W320-ABCD-ALL08*	Release of radioactive liquid from Tank 241-C-106 due to siphoning of waste from Tank 241-AY-102 into Tank 241-C-106	1. Plugging of antisiphon holes 2. Loss of electrical power to the pumps 3. Shutdown from operations	None	Tank farms visually surveyed at least once a day Material balance performed every 24 hrs
W320-ABCD-CHILL02	Release of energetic radioactive aerosol from covered pit or deadend pipe due to propylene glycol spray leak into ventilation system of Tank 241-C-106 with ignition propagating into tank dome.	1. Piping or tubing leak	Fire prot prog Rad prot prog Vehicle position spotters Tank farm fences Vegetation cntrl prog	Contam cntrl prog

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-ABCD-CHILL03	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to excessive cooling from process chiller which restricts inflow and loop seal fails to operate.	1. Chiller control fault 2. High humidity	None	None
W320-ABCD-TRANS01	Release of liquid waste due to sluicer nozzle jet being directed at and breaching Tank 241-C-106 wall resulting in water leaking into liner gap where steam vapor forms and breaches tank bottom.	1. Unavoidable operator action	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Positive mech stops limit nozzle travel	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-TRANS02	Release of liquid waste below grade and aerosol release to atmosphere due to loss of sluicer arm control in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Unavoidable operator action	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-TRANS03	Release of liquid waste below grade and aerosol release to atmosphere due to siphoning of waste from Tank 241-AY-102 after the stoppage of pumping water exceeds maximum operating level in Tank 241-C-106 resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Buildup of solids in openings 2. Equipment casualty	Active vent for heat removal Material balance performed every 24 hrs Syphon protection Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-TRANS05	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer hose break in Tank 241-C-106 resulting in jet striking tank. liner with liner being breached, water leakage into liner gap, steam formation, and breaching of tank bottom.	1. Primary failure of Hose 2. Severe Water hammer 3. Fatigue from vibration	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Stiff hose engineered to maintain integrity	Cover blocks in place Emer Resp Plan/Procedures

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-ABCD-TRANS06	Release of liquid waste below grade and aerosol release to atmosphere due to sluicing arm breaking off and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner breach and steam bump.	1. Primary failure of sluicer 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers Positive mech stops limit nozzle travel	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-TRANS07	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow being excessive in Tank 241-C-106 resulting in jet striking tank liner with liner being breached, water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-TRANS08	Release of liquid waste below grade and aerosol release to atmosphere due to sluicer flow excessive into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Sluice flow control fault 2. Operator error	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to excessive waste temperature change rate Tank 241-C-106 liner breaches, resulting in water leakage under tank bottom, steam formation, breaching of tank bottom and large steam bump.	1. High temperature in Tank 241-AY-102	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-ABCD-TRANS11	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	Fire prot prog Rad prot prog	Contam cntrl prog

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-ABCD-TRANS11*	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	None	None
W320-ABCD-TRANS12	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in distributor pit of Tank 241-AY-102 with cover block off during slurry transfer.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-ABCDF-ALL01*	Release of energetic radioactive aerosol to atmosphere due to buildup of flammable gas in Tank 241-AY-102 pit drain pipe which is then ignited.	1. Flammable gas generation from tank waste	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None
W320-ALL-VENT01	Release of energetic radioactive aerosol from breached ventilation duct for Tank 241-AY-102 due to a buildup of ammonium nitrate in ventilation ducting and ignition via hot work, range fire etc.	1. Natural occurrence under proper conditions	None	HEPA filter replacement
W320-B-ALL01	Release of a large amount of high energy aerosolized waste from Tank 241-C-106 dome collapse due to volcanic ashfall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures
W320-B-ALL02	Release of a large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to volcanic ashfall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures
W320-B-ALL03	Release of high energy aerosolized waste to the atmosphere from Tank 241-C-106 dome collapse due to extreme snow fall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-B-ALL04	Release of large amount of high energy aerosolized waste from Tank 241-AY-102 dome collapse due to extreme snow fall.	1. Natural phenomena	HASP procedure JCS procedure Oper training Oper procedures	Rad Prot Prog Emer Resp Plan/Procedures
W320-B-ALL05	Release of energetic radioactive aerosol from Tank 241-C-106 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	Shutdown oper during high wind HASP procedure JCS procedure Oper training Oper procedures	Load absorber around riser Rad Prot Prog Emer Resp Plan/Procedures
W320-B-ALL06	Release of energetic radioactive aerosol from Tank 241-AY-102 dome collapse due to dome being overloaded.	1. Maintenance error 2. Procedure violation	HASP procedure JCS procedure Oper training Oper procedures	Load absorber around riser Rad Prot Prog Emer Resp Plan/Procedures
W320-B-ALL08	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 due to a large water intrusion which induces a flammable gas release event. It is then ignited resulting in a dome space fire.	1. Raw water leak 2. Surface water flood	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks Mon level growth	None
W320-B-ALL09	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-AY-102 during slurry distribution and subsequent ignition of organics.	1. Sluicing causes organic separation	Vehicle position spotters Tank farm fences	HEPA filter replacement
W320-B-ALL10	Release of energetic radioactive aerosol from damaged tank due to formation of organic layer in Tank 241-C-106 during sluicing and subsequent ignition of organics.	1. Sluicing causes organic separation	Vehicle position spotters Tank farm fences	HEPA filter replacement
W320-B-FLUSH01	Release of energetic radioactive aerosol from damaged Tank 241-C-106 single shell tank due to ignition of flammable gas plume and resulting filter breach induced by large water intrusion into tank.	1. Maintenance error 2. Communications error between different groups using the pit	HEPA filter Delta P alarm - where provided HEPA filter testing	HEPA Filter Delta P - low Delta P interlock HEPA Filter replacement Sampler recorder

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-B-FLUSH04	Release of low energy radioactive aerosol from breached Tank 241-C-106 due to flushing water spray through sluice nozzle resulting in excessive tank vacuum.	1. Planned	None	None
W320-B-TRANS14	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to low slurry flow to distributor which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. 3-way ball valve in flushing system not fully open 2. Pump controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-B-TRANS15	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to air injected into the waste from the startup of slurry flow from the distributor. Gas is scrubbed from the waste and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Normal procedure	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-B-TRANS16	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to distributor nozzle breaking off which results in solids piling up. Pile generates significant amount of flammable gas and LFL is reached in dome space. It is then ignited resulting in a dome space fire.	1. Primary failure of distributor 2. Severe water hammer 3. Severe thermal shock 4. Corrosion 5. Metal fatigue from vibration	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks Mon level growth	None
W320-B-TRANS17	Release of high energy aerosolized waste from damaged Tank 241-C-106 due to the sluicer hose breaking which then impinges into the solids releasing a region of retained flammable gas. The gas is then ignited and a plume fire results.	1. Primary failure of Hose 2. Severe Water hammer 3. Severe thermal shock 4. Corrosion 5. Fatigue from vibration	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-B-TRANS18	Release of large high energy aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-C-106 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with a plume burn.	1. Flowmeters fault or out of calibration 2. Operator error in positioning Tank 241-C-106 pump 3. Inadvertant or accidental actuation of Tank 241-C-106 pump but not Tank 241-AY-102 pump 4. ENRAF level indication fault 5. Pump controller fault 6. Tank 241-C-106 T/C fault	Mon dome pressure in Tank 241-C-106 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-B-TRANS23	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-AY-102 with cover block off during sluicing.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-B-TRANS24	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in pump pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-B-TRANS25	Release of energetic radioactive aerosol from line break due to pipe or jumper breach in sluice pit of Tank 241-C-106 with cover block off.	1. Pipe failure 2. Improper Assembly 3. Other operators change jumper hookup 4. Connector faults	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-B-TRANS26	Release of energetic radioactive aerosol from transfer line in Tank 241-C-106 pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-B-TRANS27	Release of energetic radioactive aerosol from transfer line in pit due to flammable gas collecting in pit and being ignited. Cover block lifted and falls onto piping in pit resulting in spray release.	1. Chimney through deep drop legs 2. 6 in. high capacity drain to dome space 3. Pit sealed to minimize inleakage	None	Process pit and vault pit leak detectors Material balance every 24 hrs

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-B-TRANS32	Release of large high energy aerosolized radioactive waste from a spray leak from transfer line break due to aircraft strike on underground transfer line berm.	1. Light aircraft crash	None	Access cntrl Material balance every 24 hrs
W320-B-VENT08	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-C-106 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	Vehicle position spotters Tank farm fences	HEPA filter replacement
W320-B-VENT09*	Release of energetic radioactive aerosol from damaged tank due to loss of Tank 241-AY-102 ventilation for many months, dry out of waste and subsequent ignition of organics.	1. Loss of power 2. Equipment casualty	Vehicle position spotters Tank farm fences	HEPA filter replacement
W320-BCD-ALL02	Release of energetic radioactive aerosol from collapsed Tank 241-AY-102 due to excessive vacuum resulting from W030 ventilation system inlet damper closing and failure of PCV fails to relieve vacuum.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None	None
W320-BCD-ALL03	Release of energetic radioactive aerosol from damaged Tank 241-C-106 due to excessive vacuum resulting from ventilation system fan overspeed and failure of tank loop seal failure.	1. Rotameter valve to controller fault 2. Operator error in adjusting rotameter or inadvertant adjustment	None	None
W320-BCD-ALL07	Release of liquid waste below grade and aerosol release to atmosphere due to water intrusion into Tank 241-C-105 which travels through cascade line into Tank 241-C-106 with water level exceeding maximum operating level resulting in leakage into liner gap, steam formation, bulging of tank bottom, ripping of liner and steam bump.	1. Raw water leak 2. Surface water flood	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-BCD-ALL08	Release of liquid waste below grade and aerosol release to atmosphere due to excessive corrosion because of waste disturbance in Tank 241-C-106 resulting in leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Inadequate prediction of waste behavior	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-BCD-FLUSH01	Release of energetic radioactive aerosol from transfer line due to 3-way valve left in flush position after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	Repositioned jumpers service tested Cameras used to verify initial jumper integrity Isolation valves (manual) for flush system Backflow preventers	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-BCD-FLUSH02*	Release of energetic radioactive aerosol from flush tank of transfer truck due to start of submersible pump in Tank 241-C-106 during the flush of slurry transfer line. Flush tank is filled and pressurized resulting in rupture of tank or transfer line.	1. Human error 2. Communications error between different groups	Isolation valves (manual) for flush system	Backflow preventers
W320-BCD-PUMP03	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks	None
W320-BCD-PUMP04	Release of energetic radioactive aerosol to atmosphere due to submersible pump being raised too high in Tank 241-AY-102, winch lifting strap breaking, pump falling into waste resulting in a flammable gas release which is ignited by broken electrical cables.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-BCD-PUMP05	Release of small high energy aerosol to atmosphere due to immersible pump being raised too high in Tank 241-C-106, motor breaks gear assembly, pump freespools into waste resulting in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None
W320-BCD-PUMP08	Release of liquid waste below grade and aerosol release to atmosphere due to submersible pump being raised too high, winch lifting strap breaking, pump falling and penetrating Tank 241-C-106 liner resulting in water leakage into liner gap, steam formation, liner bulges/rips and steam bump occurs.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-BCD-PUMP09	Release of large high energy aerosolized waste to atmosphere due to immersible pump being raised too high in Tank 241-C-106, winch lifting strap breaking, pump falling into waste results in a flammable gas release which is ignited by broken electrical cables, plume burn.	1. Operator error in positioning direction 2. Inadvertant or accidental actuation 3. Winch controller fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None
W320-BCD-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to loss of pumping from Tank 241-C-106 and continued pumping of Tank 241-AY-102 water exceeds maximum operating level - resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Loss of power 2. Equipment casualty	Active vent for heat removal Material balance performed every 24 hrs Syphon protection Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-BCD-TRANS11	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-C-106 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	Repositioned jumpers service tested Cameras used to verify initial jumper integrity Isolation valves (manual) for flush system	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-BCD-TRANS12	Release of energetic radioactive aerosol from transfer line due to blank flange left off flushing connection in Tank 241-AY-102 pit after flushing. Cover plug is lifted out of cover block on initiation of sluicing process.	1. Maintenance error 2. Communications error between different groups using the pit	Repositioned jumpers service tested Cameras used to verify initial jumper integrity Isolation valves (manual) for flush system	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-D-ALL06	Release of a small amount of low energy aerosolized waste through failed filters due to seismic event which induces a steam bump in Tank 241-AY-102, and failure of filters or ducting.	1. Natural Phenomena	None	Seismic shutdown switch
W320-D-ALL07	Release of energetic radioactive aerosol from damaged double shell Tank 241-AY-102 due to seismic event which releases flammable gas from the waste and after shocks cause mechanical sparks which ignites the flammable gas mixture.	1. Natural Phenomena	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None
W320-D-ALL08	Release of energetic radioactive aerosol to atmosphere due to start of air lift circulators in Tank 241-AY-102 resulting in a release of flammable gas plume which is then ignited.	1. Human error 2. Communications error with other workers using the tank 3. IOSRs require activation of ALCs in event temperature above limit	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks Mon level growth	None

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-D-ALL09	Release of liquid waste below grade and aerosol release to atmosphere due to seismic event Tank 241-C-106 liner is breached resulting in water leakage into liner gap, steam formation, breaching of tank bottom and large steam bump.	1. Natural Phenomena	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures
W320-D-CHILL01	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from pit chiller into Tank 241-C-106.	1. Piping or tubing leak	Vehicle position spotters Tank farm fences	HEPA filter replacement
W320-D-CHILL02	Release of energetic radioactive aerosol from damaged tank due to a leak and ignition of propylene glycol from ventilation chiller into Tank 241-C-106.	1. Piping or tubing leak	Vehicle position spotters Tank farm fences	HEPA filter replacement
W320-D-PUMP01	Release of energetic radioactive aerosol from line break in Tank 241-AY-102 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-D-PUMP03	Release of energetic radioactive aerosol from line break in Tank 241-C-106 transfer pit due to immersible pump being positioned too high resulting in air entrainment in transfer line. Booster pump torques in reaction to air in transfer line and jumper connectors break. Cover block is off.	1. Operator error in positioning 2. Inadvertant or accidental repositioning 3. Level indication fault 4. Waste level indicator on pump fault	None	Process pit and vault pit leak detectors Material balance every 24 hrs

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-D-PUMP04	Release of energetic radioactive aerosol from damaged Tank 241-AY-102 due to pumping of more solids than anticipated. Annulus cooling mod not completed resulting in overheating of waste and a tank bump. Bump induces large flammable gas release. It is then ignited resulting in a dome space fire.	1. Mass flowmeter fault or out of calibration 2. Operator error in positioning slurry pump 3. Inadvertant or accidental repositioning 4. Level indication fault 5. Waste level indicator on pump Tank 241-C-106 fault 6. Pump controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Mon vent flow rate in tanks	None
W320-D-TRANS05	Release of energetic radioactive aerosol to atmosphere due to head space gas concentration above LFL in Tank 241-AY-102 with the start of pumping which ignites the flammable gas.	1. Spontaneous GRE 2. Induced GRE	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-D-TRANS06	Release of large high energy aerosolized waste to the atmosphere due to slurry transfer rate being excessive resulting in a rapid reduction in the hydrostatic pressure in Tank 241-C-106. This results in a flammable gas release. Gas is ignited and a dome space fire results.	1. Sluice flow control fault	Mon dome pressure in Tank 241-C-106 Mon vent flow rate in tanks	None
W320-D-TRANS07	Release of high energetic aerosolized waste to the atmosphere due to sluice water transfer rate being excessive resulting in the Tank 241-AY-102 waste level being lowered quickly with the waste temperature too high. This results in a large steam bump and flammable gas release with ignition.	1. Operator mistake 2. Level indication fault 3. Pump controller fault	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-D-TRANS09	Release of liquid waste below grade and aerosol release to atmosphere due to movement of debris during sluicing which impacts and breaches the Tank 241-C-106 liner, resulting in water leakage into liner gap, steam formation, breaching of tank bottom and steam bump.	1. Expected outcome of high pressure sluice. Many objects are in the waste.	Active vent for heat removal Material balance performed every 24 hrs Level mon of Tank 241-C-106 Comm maintained between control trailers	Cover blocks in place Emer Resp Plan/Procedures

Table D-4. Defense-in-Depth Controls for Potentially Severe (E3 and E2) Environmental Consequences. (16 sheets)

ID	Hazardous Conditions	Candidate Causes	DID-Preventive	DID-Mitigative
W320-D-TRANS10	Release of energetic radioactive aerosol from jumper in pit due to seismic event. Cover block breached by ground motion resulting in spray release.	1. Natural Phenomena	Repositioned jumpers service tested Cameras used to verify initial jumper integrity	Process pit and vault pit leak detectors Material balance every 24 hrs
W320-D-TRANS11	Release of large high energy aerosolized radioactive waste to the atmosphere from a spray leak from transfer line due to seismic event.	1. Natural Phenomena	None	Access cntrl Material balance every 24 hrs
W320-D-VENT12	Release of energetic radioactive aerosol from collapsed Tank 241-C-106 due to incorrect alignment of current ventilation system through sluice nozzle resulting in excessive tank vacuum with loop seal failure.	1. Operator error 2. Communications error	None	None
W320-D-VENT13	Large high energy radioactive aerosolized waste release from Tank 241-AY-102 to the atmosphere due to influx of cold water spray into tank which results in an excessive vacuum. A large flammable gas release is induced. It is then ignited resulting in a dome space fire.	1. Possible result of slurry distribution	Mon dome pressure in Tank 241-C-106 and Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-D-VENT16	Large high energy aerosolized waste release from Tank 241-AY-102 to the atmosphere due to the loss of primary or annulus ventilation for an extended period which results in a gradual rise in waste temperature. Flammable gas builds up in the dome space to the LFL. It is then ignited resulting in a dome space fire.	1. Extended loss of power 2. Severe ventilation casualty	Mon dome pressure in Tank 241-AY-102 Video mon of waste in Tank 241-AY-102 Meas background concentrations for 3-4 weeks prior to sluicing Mon vent flow rate in tanks	None
W320-D-VENT17	Release of high energy aerosolized release to the atmosphere due to an ice storm which prevents air inflow into Tank 241-AY-102 resulting in an excessive tank vacuum. This results in a flammable gas release with ignition.	1. Natural phenomena	Mon dome pressure in Tank 241-AY-102 Mon vent flow rate in tanks	None

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HNF-SD-WM-SAR-067
Revision 1
Volume VI

Tank Waste Remediation System Final Safety Analysis Report

Volume VI:
Addenda 2, 3, and 4

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FLUOR DANIEL HANFORD, INC.
Richland, Washington

Hanford Management and Integration Contractor for the
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SAFETY ANALYSIS FOR THE REPLACEMENT CROSS-SITE TRANSFER SYSTEM

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EXECUTIVE SUMMARY

The purpose of this Addendum to the Tank Waste Remediation System Final Safety Analysis Report (FSAR) HNF-SD-WM-SAR-067, is to incorporate the safety analysis for Project W-058 (Replacement of the Cross-Site Transfer System) into the FSAR. The replacement cross-site transfer system was an ongoing project when the FSAR was being developed and thus was not included as part of its original scope. It is important to note that this Addendum was previously attached to the Basis for Interim Operation (BIO) and has been modified where necessary to assure compatibility with the FSAR. It is important to note that the hazards information presented in Appendices B, C, and D have been updated, as necessary, and incorporated into the FSAR hazards analysis database. Appendices B, C, and D are retained in this Addendum for information only and should not be used in the Unreviewed Safety Question process.

Scope and Structure

The scope of this Addendum is the safety analysis for the replacement cross-site transfer system. The overall approach applied to the analysis for the replacement cross-site transfer system is the same as that described in the FSAR. Therefore, many of the detailed discussions in the FSAR are equally applicable to the analysis for the replacement cross-site transfer system and will not be repeated. Where there are differences, because of unique features of the replacement cross-site transfer system, these differences will be cited and discussed in detail. When the topics of discussion are the same (such as detailed descriptions of analysis methodologies), the Addendum will briefly discuss the topic and reference the FSAR. It is important to note, however, that sufficient detail on the replacement cross-site transfer system will be provided in this Addendum for evaluating the acceptability of future proposed activities and the associated Unreviewed Safety Question determinations.

This Addendum is organized according to the format of DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, with the exception of the Executive Summary, which follows the format established in the BIO. Because this Addendum was originally attached to the BIO, this format was selected to facilitate comparisons of the summary conclusions drawn in the Addendum and the main BIO. This BIO format (for the Executive Summary only) is retained in accordance with the direction, to attach the BIO Addendums to the FSAR in the current form while making necessary reference changes and editorials to ensure readability, that was provided in Department of Energy Richland Operations Office Letter 99-TSD-034, *Guidance for Preparations for Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) Approval*. In those chapters where information is provided about Site-wide programmatic controls, the chapters are abbreviated to discuss only those programs or controls affected by the replacement cross-site transfer system. Descriptions of general Site wide programs are provided by reference only.

Safety Management

The discussion of the Safety Management System in the Executive Summary of the FSAR is also applicable to the replacement cross-site transfer system.

Hazard Analysis

The discussion of hazard analysis in the Executive Summary of the FSAR is also applicable to the replacement cross-site transfer system. Of the 29 representative accidents selected for quantitative analysis in the FSAR, six were determined by hazard analysis to require further analysis to account for the replacement cross-site transfer system.

Hazard Classification

According to the FSAR, the hazard classification of all double-shell and single-shell waste tanks, and the associated waste transfer systems, is Hazard Category 2. The replacement cross-site transfer system is also used to transfer tank waste and is therefore classified as Hazard Category 2.

Accident Analysis

The analysis results for existing transfer systems in the FSAR are unaffected by the introduction of the replacement cross-site transfer system. Expansion of the Tank Waste Remediation System Authorization Basis to address the replacement cross-site transfer system, however, has required re-examination of six FSAR accidents for specific applicability to the replacement cross-site transfer system. Summaries of these six accidents are presented below, along with a discussion of how the results compare with those originally determined in the FSAR.

Accidents Below Risk Guidelines with Selected Controls

Analysis determined that five of the six accidents reanalyzed for the replacement cross-site transfer system do not pose significant risks with the application of controls (i.e., the risks are below the evaluation guidelines). For these accidents, application of controls ensures operations can be conducted safely. Additional Defense-in-Depth controls, that serve to further reduce the risks from these accidents, are also identified. The accidents are as follows:

- Nuclear Criticality
- Subsurface leak remaining subsurface
- Surface leak resulting in pool
- Subsurface leak resulting in pool
- Spray leak in structures or from overground waste transfer lines.

The designation of the 5 accidents listed above, as accidents that are below risk guidelines with selected controls, is consistent with the conclusion drawn in the FSAR (where the replacement cross-site transfer system was not considered).

Accidents Prevented with Selected Controls

The spray leak from underground waste transfer lines accident (as evaluated for the replacement cross-site transfer line) is prevented by the implemented controls on excavation activities. This conclusion is consistent with that drawn in the FSAR.

Summary Conclusions

In summary, this Addendum to the FSAR reaches the following conclusions:

- The selected safety structures, systems, and components and the accompanying controls (Technical Safety Requirements, Health and Safety Plans, and implementing procedures) provide prevention and mitigation measures to address these vulnerabilities.

- The analyses show that these measures provide reasonable assurance that operation of the replacement cross-site transfer system can be conducted safely.

It is important to note that operation of the replacement cross-site transfer system will be integrated into the Tank Waste Remediation System facility operations. The new controls for the replacement cross-site transfer system, stipulated in this Addendum, have been added to HNF-SD-WM-TSR-006, Tank Waste Remediation System Technical Safety Requirements.

Collectively, these conclusions find that the replacement cross-site transfer system can be operated safely following the requirements of this Addendum and the FSAR.

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LIST OF TERMS

AC	Administrative Control
ALARA	As Low As Reasonably Achievable
ANSI/ASME	American National Standards Institute/American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BIO	Basis for Interim Operation
CSER	Criticality Safety Evaluation Report
D&D	decontamination and decommissioning
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
FDH	Fluor Daniel Hanford
FSAR	Final Safety Analysis Report
HazOp	hazards and operability study
HEPA	high-efficiency particulate air (filter)
LCO	Limiting Condition for Operation
N/A	not applicable
OCS	operator control station
PCU	process control unit
PE	potentially present elsewhere in/adjacent to facility
PF	potentially present in the facility
RCSTS	replacement cross-site transfer system
RL	U. S. Department of Energy, Richland Operations Office
SSC	structure, system, and component
SST	single-shell tank
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
USQ	Unreviewed Safety Question

1.0 SITE CHARACTERISTICS

The replacement cross-site transfer system (RCSTS) is located within the Tank Waste Remediation System (TWRS) facility, and therefore has the same site characteristics as the balance of the TWRS facility. A description of site characteristics necessary for understanding the TWRS and Hanford Site environment is included in Chapter 1.0, "Site Characteristics," of the TWRS Final Safety Analysis Report (FSAR).

1.1 INTRODUCTION

The objective of this chapter is to describe the site characteristics of the Hanford Site, as applicable to the safety analysis for the RCSTS.

1.2 REQUIREMENTS

Chapter 1.0 of the FSAR lists the applicable requirements. No changes to these requirements result from the installation or operation of the RCSTS.

1.3 SITE CHARACTERISTICS

The site characteristics for the TWRS facility, which includes the RCSTS, are described in Chapter 1.0 of the FSAR.

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2.0 FACILITY DESCRIPTION

A description of the Tank Waste Remediation System (TWRS) facility is provided in Chapter 2,"Facility Description," of the Final Safety Analysis Report (FSAR).

2.1 INTRODUCTION

In this chapter, the replacement cross-site transfer system (RCSTS) facilities and operations are described to support assumptions used in Chapter 3.0, "Safety Analysis."

2.2 REQUIREMENTS

The design codes, standards, regulations, and U.S. Department of Energy orders required for establishing the Authorization Basis of the TWRS facilities are listed in Section 2.2, "Requirements," of the FSAR. Because the RCSTS is a part of the TWRS facility, the listed documents also apply to the RCSTS. In addition to these documents, the RCSTS also was designed to comply with the following requirements:

- DOE 6430.1A, *General Design Criteria*, Change 0 (1989)
- SDC-4.1, *Standard Architectural-Civil Design Criteria: Design Loads for Facilities* (1993)
- WHC-SD-W058-FDC-001, *Functional Design Criteria for Project W-058, Replacement of the Cross-Site Transfer System* (1996)
- ACI 349-90, *Code Requirements for Nuclear Safety Related Concrete Structures* (1990)
- 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" (1995)
- 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" (1995)
- WAC 173-303, "Dangerous Waste Regulations" (1995)
- DOE 5480.11, *Radiation Protection for Occupational Workers, Change 3* (1992)
- ANSI/ASME B31.3, *Chemical Plant and Petroleum Refinery Piping* (1993)
- ASME AG-1, *Code on Nuclear Air and Gas Treatment* (1991).

2.3 FACILITY OVERVIEW

An overview of the tank farm facilities configuration, including a brief history of TWRS operations, is provided in Section 2.3, "Facility Overview," of the FSAR.

The RCSTS provides a means of transferring single-shell tank (SST) waste, double-shell tank (DST) waste, and other liquid slurry wastes resulting from normal 200 West Area operations to the treatment, storage, and disposal facilities in the 200 East Area. East to west transfers can also be made. The transfer route is shown in Figure 2-1.

2.4 FACILITY STRUCTURES

Detailed descriptions of the TWRS facilities are provided in Section 2.4, "Facility Structures," of the FSAR. Many of these descriptions are relevant to the RCSTS, since it interfaces with these existing tank farm systems. Presented below is a description of the RCSTS transfer piping and associated systems and structures.

2.4.1 Transfer Pipe System Description

The RCSTS is a buried pipe-in-pipe system approximately 10.5 km (6.5 mi) long. The primary piping is 7.6-cm (3-in.), 304 L stainless steel, Schedule 40. The encasement piping is 15.2-cm (6-in.), ASTM A53 Grade B carbon steel, standard weight and 30.5-cm (12-in.) ASTM A53 Grade B carbon steel, standard weight at the expansion loops, with epoxy coating to minimize external corrosion. The primary piping is designed in accordance with the requirements of ANSI/ASME B31.3, while the overall pipe-in-pipe design complies with the secondary containment requirements stipulated in the standards listed in Section 2.2 of this addendum. A material of construction position paper (Parsons 1994, *Project W-058/W-028, Material of Construction Position Paper*) provides the justification for selecting the piping based on the reliability of the selected materials. The RCSTS pipe design is depicted in Figure 2-2.

The 241-SY-A and 241-SY-B valve pits in the 200 West Area are connected with the 244-A lift station in the 200 East Area by the RCSTS. Liquid waste can be transferred in either direction between the 200 East and 200 West Areas through one of the two RCSTS lines, using existing transfer pumps. The other RCSTS line is designed to transfer wastes with as much as 30 vol% solids from the 200 West Area to the 200 East Area, using existing tank farm transfer pumps and the RCSTS booster pumps. (It should be noted that this 30 vol% solids is based on a displacement measurement in a sight glass and that normal loading for slurry transfers is expected to be 10 vol% solids or less.)

The RCSTS provides one line each to the 241-SY-A and 241-SY-B valve pits in the 200 West Area. These buried lines follow a single construction trench to a new diversion box, also located in the 200 West Area (diversion box 6241-A). Two booster pumps are connected to one of the lines in this diversion box.

From diversion box 6241-A, the lines travel to another new structure at the high point in the route, vent station 6241-V, located in the 600 Area, between the 200 East and 200 West Areas. Each transfer line has a vent at the high point that allows air to be introduced into the line so that the line can drain after waste transfers are completed.

The transfer lines continue on to the 244-A lift station in the 200 East Area. The lines are connected to new nozzles that are installed in the lift station wall.

The primary and encasement pipe are all-welded construction. No remotely installed jumpers are used except at the interfaces with existing diversion boxes. In addition, the piping is buried below the frost line on the 200 Area plateau.

The system is designed to minimize the possibility of plugging in the pipes, pipe fittings, and other piping components. To promote gravity drainage, the system is designed so that the vent station is the high point and the end points in East and West Area are the low points with the pipe having a continuous slope of at least 0.25%. Valves will fail in the "as-is" position, allowing waste to drain to the source and destination tanks. The encasement piping is insulated with polyurethane foam and a fiberglass reinforced-plastic jacket to minimize the temperature drop of an uninterrupted waste transfer to a maximum of 20 °F.

The encasement piping is terminated inside each of the various structures encountered along the RCSTS route. Each segment of the encasement is provided with a drain valve at each end and with a rupture disk at the diversion box and vent station. The rupture disk limits any potential pressure buildup within the encasement. Regular leak testing of the encasement segments can be performed from inside the diversion box and vent station, and from the encasement connections located in the 244-A lift station and the 241-SY-A and 241-SY-B valve pits.

The buried piping is marked by a 15.2-cm- (6-in.-) wide continuous plastic sheet marker placed in the soil directly above each pipe, one foot below the ground surface for identification of hazardous waste lines. Additionally, magenta and yellow route markers that extend 1.5 m (5 ft) aboveground are located at road and rail crossings, are spaced at maximum intervals of 45.7 m (150 ft), are located at changes in direction, and are staggered every 22.9 m (75 ft) with electrical conduit markers.

In order to meet the RCSTS design requirements (WHC-SD-W058-FDC-001, *Functional Design Criteria for Project W-058, Replacement of the Cross-Site Transfer System*), the boosted system will have a maximum operating pressure of 8,446.1 kPa (1,225 lbs/in^2). The maximum pressure produced by a combination of the transfer and booster pumps during a no-flow condition is 9,859.5 kPa (1,430 lbs/in^2), which is within the limits of the piping code. Even though the maximum pressure produced in the line that does not use the booster pump is 1,585.8 kPa (230 lbs/in^2), both lines are designed to the higher pressures noted above. Because most wastes will not have the combination of all

possible worst-case design parameters, listed in Table 2-1, operating pressure will normally be significantly less than the design pressure. Pressure interfaces for the RCSTS are shown in Figure 2-3.

As indicated in Figure 2-3, the RCSTS is designed for a higher pressure than the piping beyond the lift station to which it is connected. This existing piping is protected from overpressurization by two redundant relief valves in the boosted line, which are installed in the 244-A lift station. A rupture disk is located immediately upstream of and in line with each relief valve to keep the valve from becoming contaminated under normal conditions and thereby facilitates valve calibration and maintenance. At a pressure of 230 psig (1586 kPa), the rupture disk will rupture, an alarm will activate at the operator control station (OCS), and the relief valve will discharge into the 244-A catch tank. It should be noted that the 230 psig (1586 kPa) relief valve setting is based on the lowest maximum operating pressure of the East Tank Farm piping that can receive flow from the RCSTS.

Each of the two rupture disk/relief valve systems is connected to the 244-A catch tank by a 3-inch line. The 244-A catch tank is a carbon steel tank located in a steel-lined vault within the 244-A lift station. The tank has a capacity of 61,627 L (16,280 gal). (The maximum amount of flow to the tank through the RCSTS pressure relief valve is 15,900 L [4,200 gal] based on an operator response of 30 minutes.)

2.4.1.1 Flush Water System. Flush water is provided at the 241-SY Tank Farm for boosted transfers. The flush system will be available before a transfer is started. The flush system is an aboveground installation designed to flush the boosted line at 1.8 m/s (6 ft/s). The water for this system comes from a 178,000-L (47,000-gal) tank that is filled by a raw water supply line from the 241-SY raw water service pit. The raw water used in making up flush solutions is low in chlorides and fluorides (historically less than 1 ppm of either). The insulated tank will store heated flush water and is vented to the atmosphere. The raw water supply line to the water flush tank allows chemical addition and mixing in order to adjust the pH. Flush water in the tank will be conditioned to a pH that is approximately 11.0.

The flush system is isolated from the waste transfer system by a check valve followed by two valves with a pressure transmitter (with an associated alarm) between them, in the 241-SY-A valve pit. During waste transfer operations the valves are closed to isolate the flush system from the transfer system. If waste leaks by the first valve, the pressure transmitter will actuate an alarm and shut down the transfer pumps. (The pressure transmitter is hardwired from its location in the 241-SY-A valve pit to the 241-SY-271 instrument building. On a high pressure indication it provides a signal into the existing 200 West master shutdown circuit.) The valves prevent the backflow of waste into the flush lines and water flush tank.

2.4.1.2 Leak Detection. Any leak detected in the RCSTS structures will automatically stop the transfer in progress by stopping all operating pumps and preventing additional waste from being transferred until the alarm is cleared. Leak detection systems are located at a low-point sump in the diversion box and vent station to provide an indication of a leak. These leak detection systems include dual probe electrodes, induction-type relays, fail-safe relays, transmitters, and reset switches.

In the RCSTS transfer line, a continuous coaxial cable is run in the annular region between the primary and secondary pipe (Figure 2-2). Before initial startup, this annular region is filled with an inert gas to minimize corrosion and spurious leak detection alarms. After the annular region is filled, valves on each end of each encasement section are then closed to isolate the purge gas. This system alarms in the OCS and provides the location of the detected leak.

2.4.1.3 Diversion Box 6241-A. Diversion Box 6241-A is located in the 200 West Area and contains two booster pumps connected in parallel to one of the transfer lines. An interlock prevents the two pumps from being operated simultaneously.

The two booster pumps are multistage, horizontal, split-case, centrifugal pumps with an all-stainless steel volute and impeller. Each booster pump has a variable speed drive that varies the speed of the pump to maintain waste velocity at the rate required to prevent line plugging (up to 1.8 m/s [6 ft/s]) over a wide range of waste characteristics. The pumps were fabricated and assembled in accordance with NFPA 70, *National Electrical Code*.

The diversion box pit is entered only for certain maintenance tasks and only after the transfer line has been flushed and appropriate entrance requirements are met. The pits are accessed for maintenance through an airtight entry door shielded by a labyrinth wall on the inside of the pit. Penetrations for an air sample line, an air exhauster hookup, a liner washdown system, and an emergency pumpout line are also provided. Air passes to and from the diversion box (due to temperature and pressure changes) through a HEPA filter connected to a 15 cm (6-in) pipe that penetrates the wall at grade level near the roof. A portable exhauster can be connected to the air exhauster hookup line to provide ventilation, when required.

2.4.1.4 Vent Station 6241-V. Vent station 6241-V is located approximately midway between the 200 West and 200 East Areas at the high point in the system. After a waste transfer and flush, a negative pressure will develop at the system high point as fluid attempts to drain by gravity to the sending and receiving tanks. Each transfer line has a vent at the high point that will allow air to be introduced into the transfer lines to break this vacuum.

Each vent line has two pneumatic valves in series that are normally closed to isolate the line from the waste transfer piping. A pressure transmitter is located between the two valves and is interlocked to shut down the transfer and booster pump upon detection of pressure when the two valves are closed. In addition, the two valves are interlocked such that they cannot be opened unless a pressure sensor in the vent station transfer piping registers a negative pressure, which will develop only when the line is

draining. When a break of the suction in the line is desired, the two pneumatic valves will be opened (along with a third isolation valve near the filter) and air will be drawn into the transfer line through a HEPA filter. The HEPA filter provides protection against the remote possibility of contaminated air exiting the transfer pipe into the vent station.

The vent station pit is entered only for certain maintenance tasks and only after the transfer line has been flushed and appropriate entrance requirements are met. The pits are accessed for maintenance through an airtight entry door shielded by a labyrinth wall on the inside of the pit. Penetrations for an air sample line, an air exhauster hookup, liner washdown system, and an emergency pumpout line are also provided. Air passes to and from the vent station (due to temperature and pressure changes) through a HEPA filter connected to a 15-cm (6-in) pipe that penetrates the wall at grade level near the roof. A portable exhauster can be connected to the air exhauster hookup line to provide ventilation, when required.

2.4.1.5 Instrumentation and Control System. Instrumentation and control of the RCSTS is centered around a computer-based monitor and control system that controls the entire process from the existing 242-S Evaporator building in the 200 West Area. The OCS consists of a personal computer running graphical, object-oriented, database software with a graphical cathode-ray tube/operator interface. The OCS is interconnected to a series of local process control units (PCUs) installed at each pit. Each PCU is used to collect process input, control process outputs, communicate with the OCS, and execute programmable control schemes. Local control may be accomplished from the PCU. The entire control system may be operated from any of the PCUs with the use of a portable terminal.

2.5 PROCESS DESCRIPTION

2.5.1 Waste Composition

The RCSTS will transfer wastes between the tanks in the 200 East and 200 West Area tank farms. The chemical composition of the waste for any given transfer through the RCSTS will depend on the originating tank.

2.5.2 Process Description

The most common type of transfer will be from the 200 West Area to the 200 East Area via Tank 241-SY-102. A transfer pump in the sending tank will retrieve the waste and send it to the 241-SY-A or 241-SY-B valve pit. Depending on the type of waste, the capabilities of the transfer pump and the destination of the waste, it will go either into the boosted or unboosted line. If the waste goes through 241-SY-B, it will enter the slurry line where booster pumps are available at RCSTS diversion box 6241-A (or they may be bypassed) to ensure that the required minimum velocity is maintained to prevent the settling of solids. The booster pumps have a variable speed drive that uses a flow-indicating controller to maintain the desired flow rate. A master pump shutdown circuit automatically shuts down a transfer in the

event that a leak occurs during a transfer. A single signal from a pit leak detector is sufficient to initiate the shutdown. (Depending on the nature and duration of the shutdown, the transfer will either be restarted or the line will be flushed.)

Once the route is established and a transfer is started, several parameters will be monitored at the interfacing facilities to ensure the transfer proceeds properly. The booster pump in use is monitored for start/stop, motor speed, pump bearing vibration, motor-winding temperature, pump-bearing temperature, and pump-seal failure. The pumped line is also monitored for pressure, temperature, flow rate, valve status, misrouting detection, and leak detection. The temperature is monitored at both the sending and the receiving tanks. A pressure transmitter on the boosted line provides high-pressure indication with a software interlock to shut down the pump on high pressure. Other indications that the transfer is not proceeding properly may result in an automatic or manual shutdown of the transfer.

Valves located within the RCSTS may be positioned by the operator at the OCS or can be operated locally. Position indication is provided locally and at the OCS by providing valves with limit switches for the fully open and the fully closed positions. A display graph shows the status of valves. Once a route has been selected, the valves are interlocked to prevent a misrouting.

Once a transfer is complete, the transfer piping is flushed with water as required. This flush reduces the radioactivity, removes any residual solids in the transfer lines, and also helps to minimize corrosion.

Transfer lines may be preheated, if required, by using flushing water heated in the water flush tank. This feature will be used if the waste is prone to plugging because of a decrease in temperature.

2.6 CONFINEMENT SYSTEMS

The confinement systems of the RCSTS include the transfer equipment (i.e., piping) and the associated structures (diversion box 6241-A and vent station 6241-V). The inner piping provides the primary confinement of the transferred waste while the encasement piping provides a secondary confinement. The RCSTS structures (diversion box 6241-A and vent station 6241-V) will provide confinement of any leaks that develop in equipment located within the structures (such as valves, or the booster pumps). Each of these structures is constructed of cast-in-place reinforced concrete, designed to comply with the structural requirements listed in Section 2.2 of this addendum. In addition, both structures have a HEPA filter (connected to a 15 cm (6-in) pipe that penetrates the wall at grade level near the roof), which serves as an additional confinement feature. These HEPA filters meet the requirements of ASME AG-1, *Code on Nuclear Air and Gas Treatment*. During transfer operations, the entry door is closed and the pipe penetrations are capped or flanged so that air forced from the structure (due to pressure or temperature changes) passes through the filter. (Prior to initial operation, a leak test of the diversion box and vent station was performed.)

2.7 SAFETY SUPPORT SYSTEMS

2.7.1 Fire Protection

It was concluded in WHC-SD-W058-FHA-001, *Fire Hazards Analysis for the Replacement Cross-Site Transfer System, Project W-058* that a fire protection system for the RCSTS is not required. Normal fire safety practices will be followed. Combustible material and fire loadings will be held to a minimum. The support buildings, diversion box 6241-A, and vent station 6241-V are constructed of concrete and the risk of fire loss within them is very small.

2.7.2 Radiation Protection Systems

There are no permanent radiation monitoring systems installed within the RCSTS structures. Portable radiation monitoring systems are used during inspection and maintenance activities.

2.8 UTILITY DISTRIBUTION SYSTEMS

2.8.1 Raw Water System

The RCSTS uses existing raw water systems for the normal flushing operation. The flush tank is connected to the 241-SY Tank Farm raw water system, and will be filled, as necessary, prior to commencing waste transfers.

2.8.2 Instrument Air System

At diversion box 6241-A and at vent station 6241-V, a small packaged air compressor and dryer are used to provide dry, oil-free, instrument-quality air for operation of the pneumatic valves and seal air for the booster pump shaft seals.

2.8.3 Electrical Power Distribution System

At diversion box 6241-A, new 13.8-kV lines extend from nearby existing 13.8-kV lines, C8-L3 and C8-L4. Each line supplies a pad-mounted 13.8 kV-480Y/277 V ac, 3-phase, 4-wire, 60 Hz transformer rated at 500 kVA. Each transformer is sized to meet all electrical requirements at this diversion box. The transformers supply a 480 V panel that distributes power to each component.

The electrical power for vent station 6241-V is provided from an existing 13.8 kV-480Y/277 V ac, 3-phase, 4-wire, 60 Hz transformer rated at 225 kVA, supplied by the existing overhead 13.8-kV line C8-L7. The transformer supplies a 480 V panel that distributes power to each component.

The electrical power for the flush system is provided from an existing 480V switchgear located in the 252-S substation building. Two new 480 V ac, 800 A, 3-phase, 60 Hz circuit breakers have been added to spare compartments of the switchgear. Each circuit breaker will provide power for one 498 KW flush water heater and smaller loads including the flush water pump.

2.9 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

The TWRS auxiliary system and support facilities include administrative areas, control facilities, communications systems, lighting, and sewage treatment. These facilities will also be used to support RCSTS operation and are described in Section 2.9, "Auxiliary Systems and Support Facilities," of the FSAR.

2.9.1 Control Facility

The 242-S Evaporator control room monitors the 200 West Area tank farm system parameters (e.g., ventilation and tank level) or valve positioning, pump operation, and tank-level data during waste transfers. In addition, the 242-S Evaporator control room will be used to monitor and control the transfers between the 200 Areas through the RCSTS.

Figure 2-1. Replacement Cross-Site Transfer System Route.

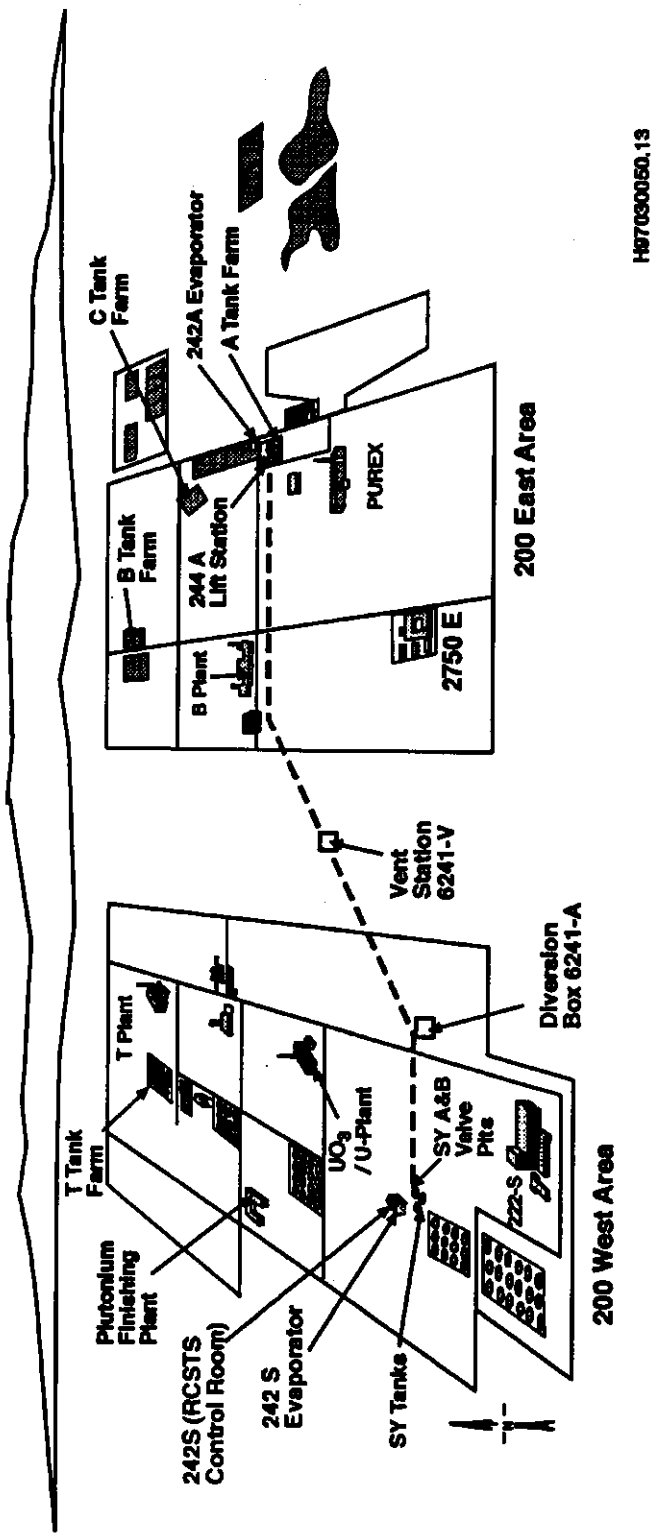

Figure 2-2. Replacement Cross-Site Transfer System Piping.

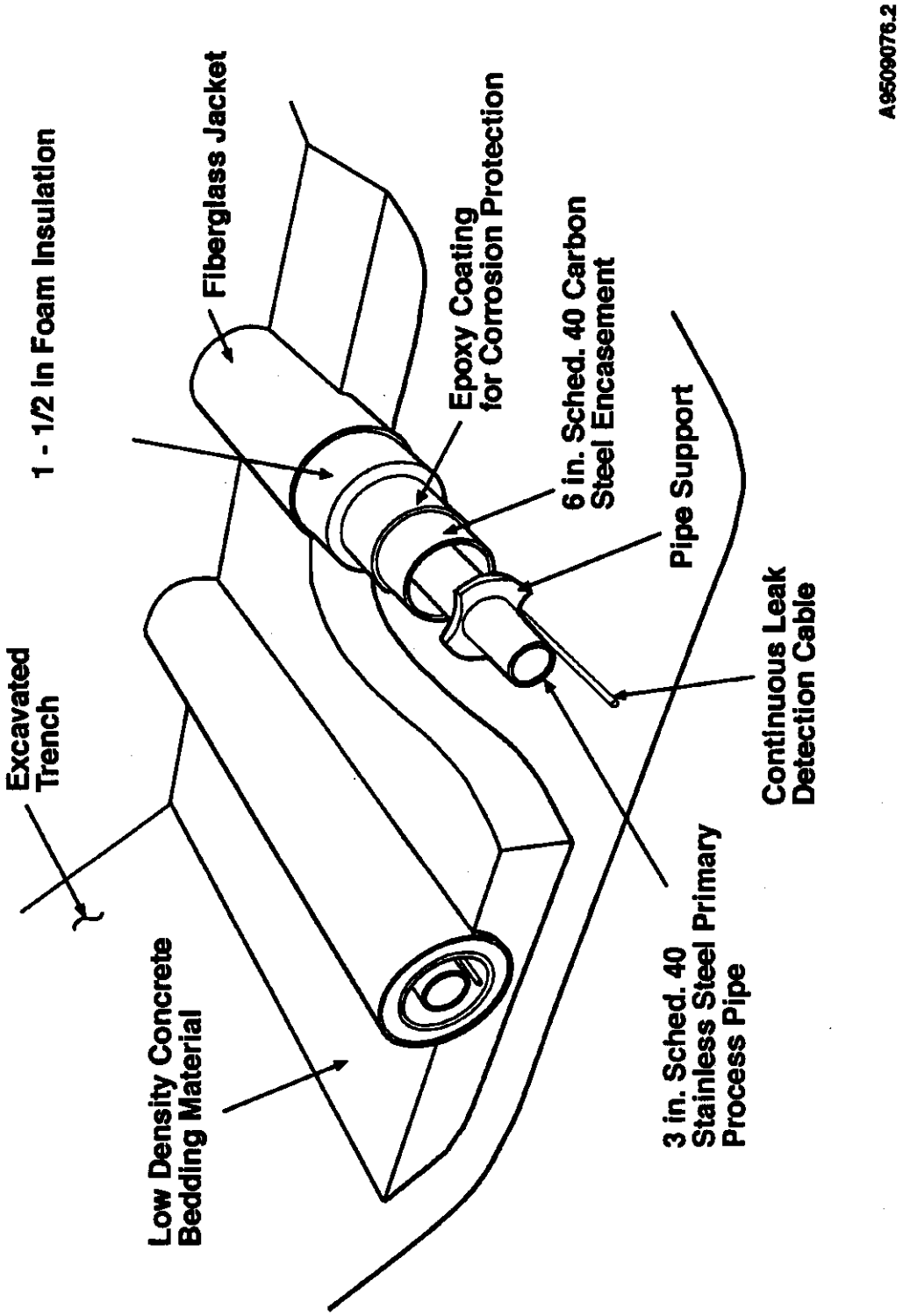

Figure 2-3. Replacement Cross-Site Transfer System Pressure Interface.

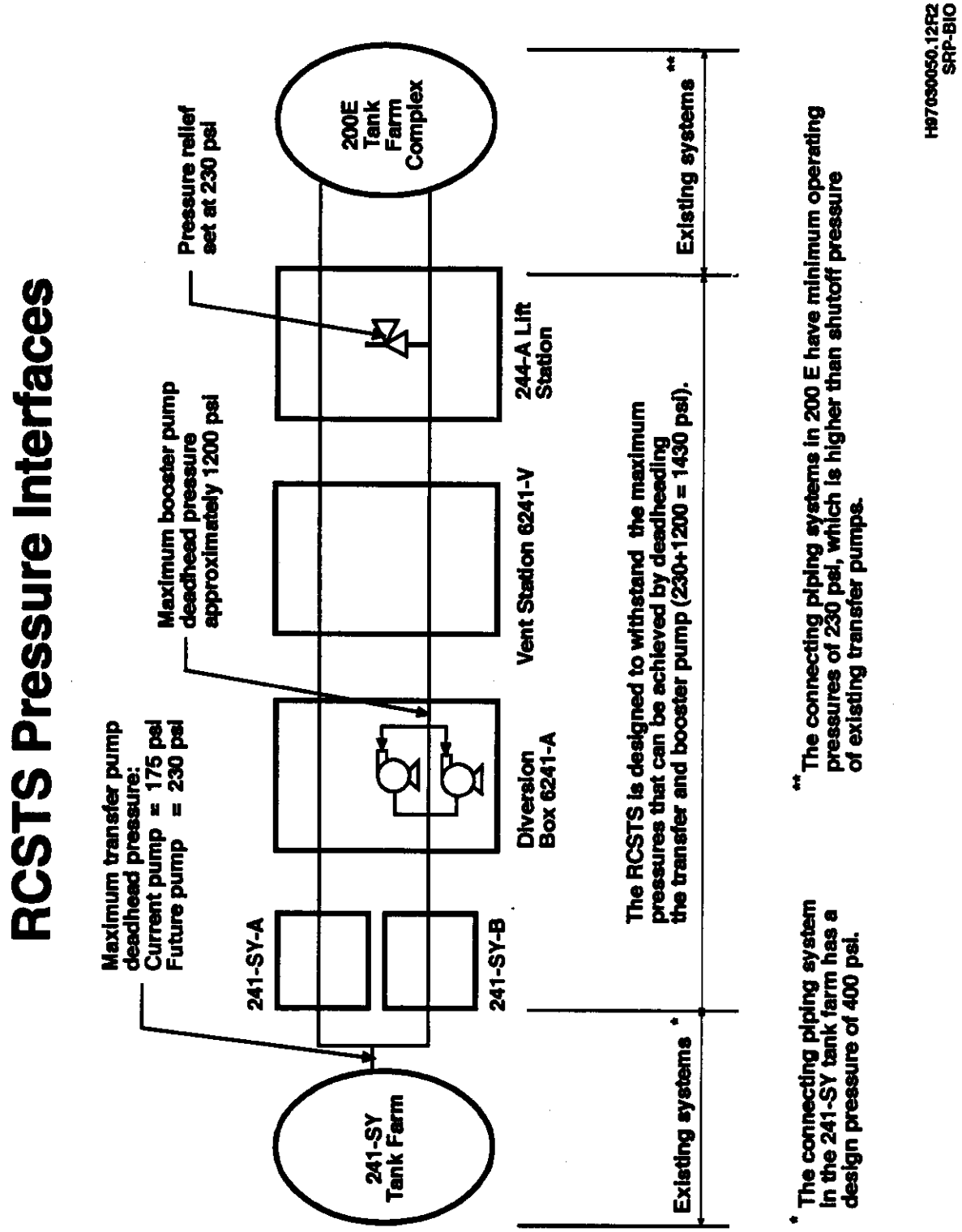

Figure 2-4. Diversion Box 6241-A Overview.

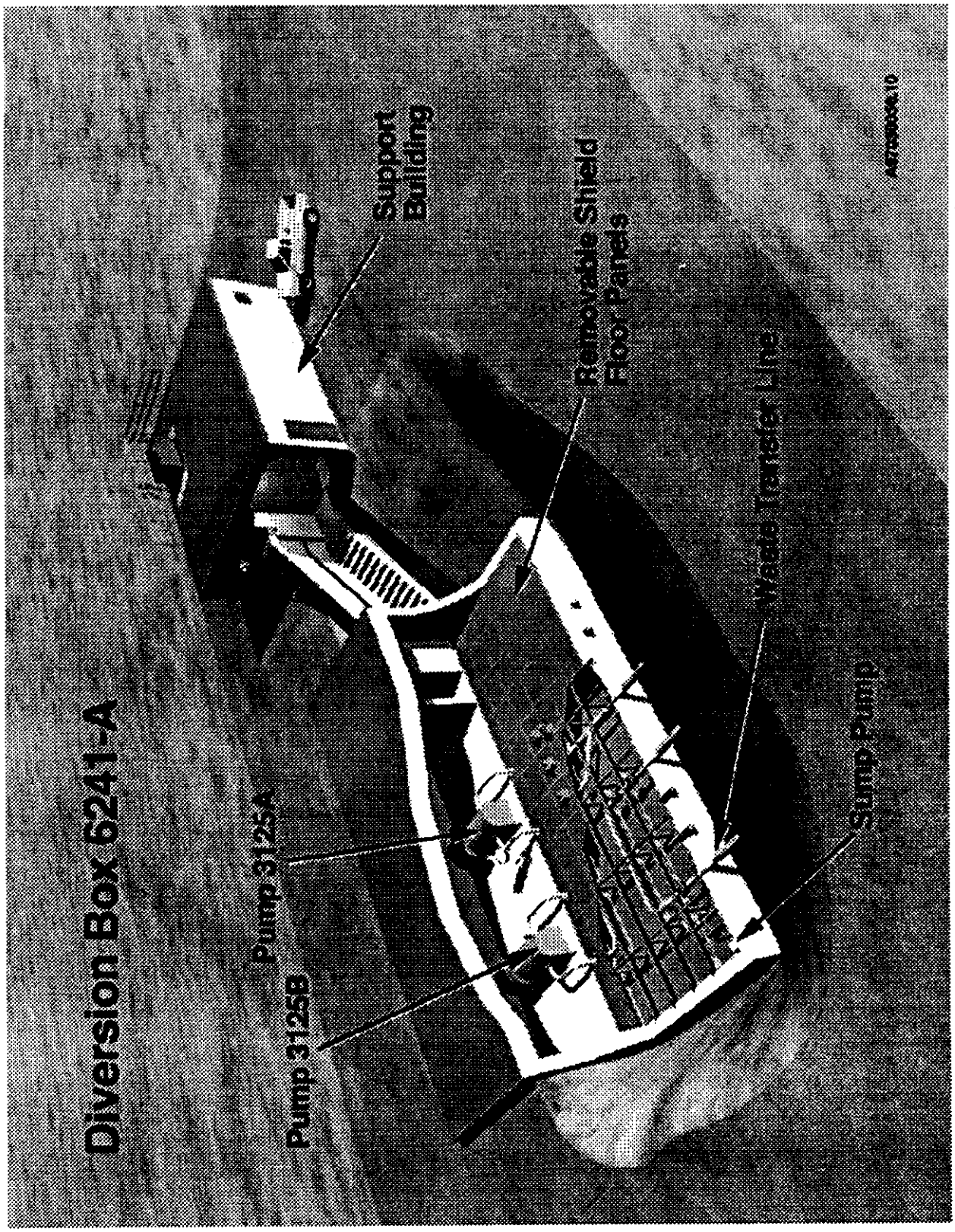

Figure 2-5. Diversion Box 6241-A.

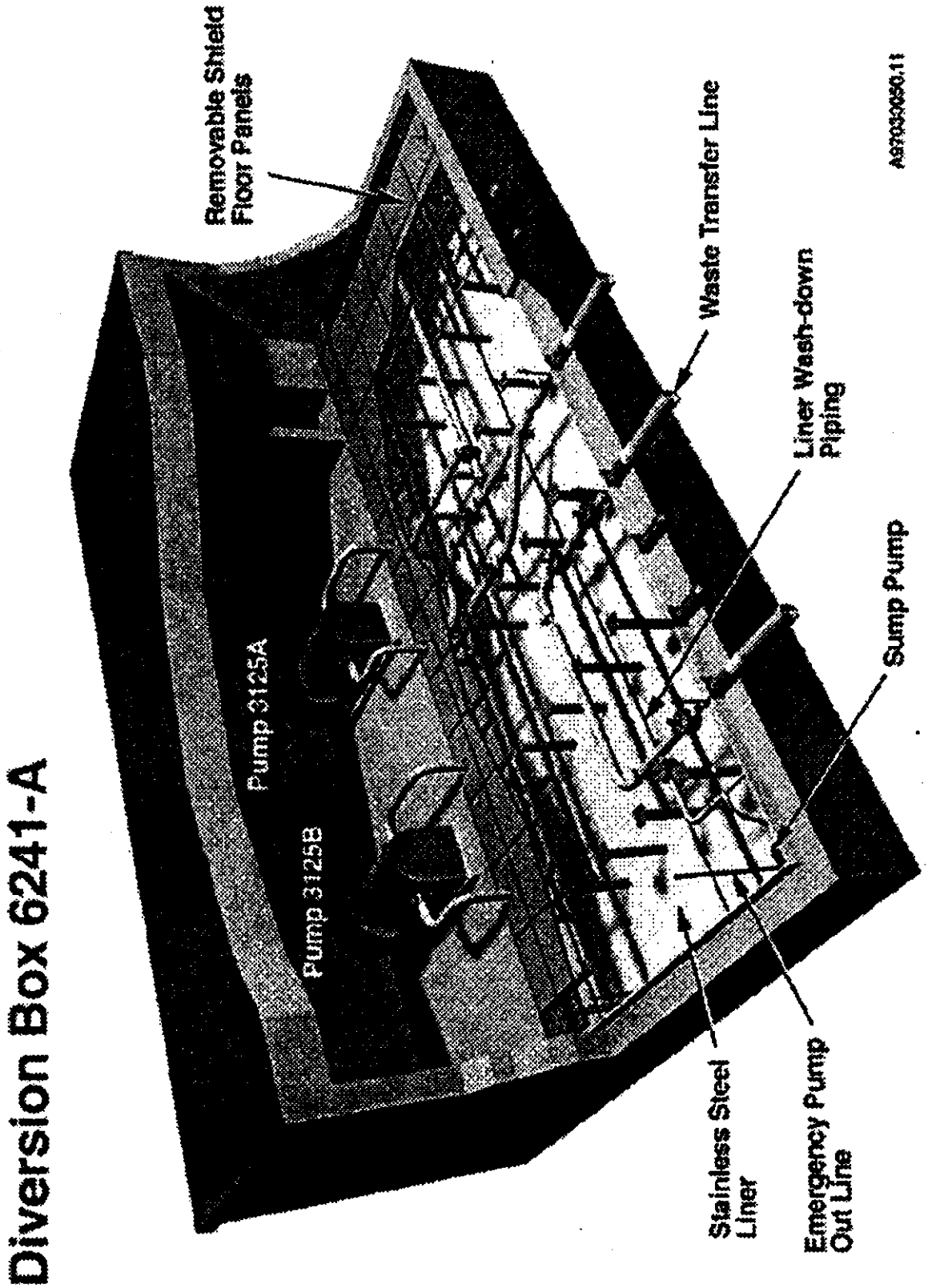

Figure 2-6. Vent Station 6241-V Overview.

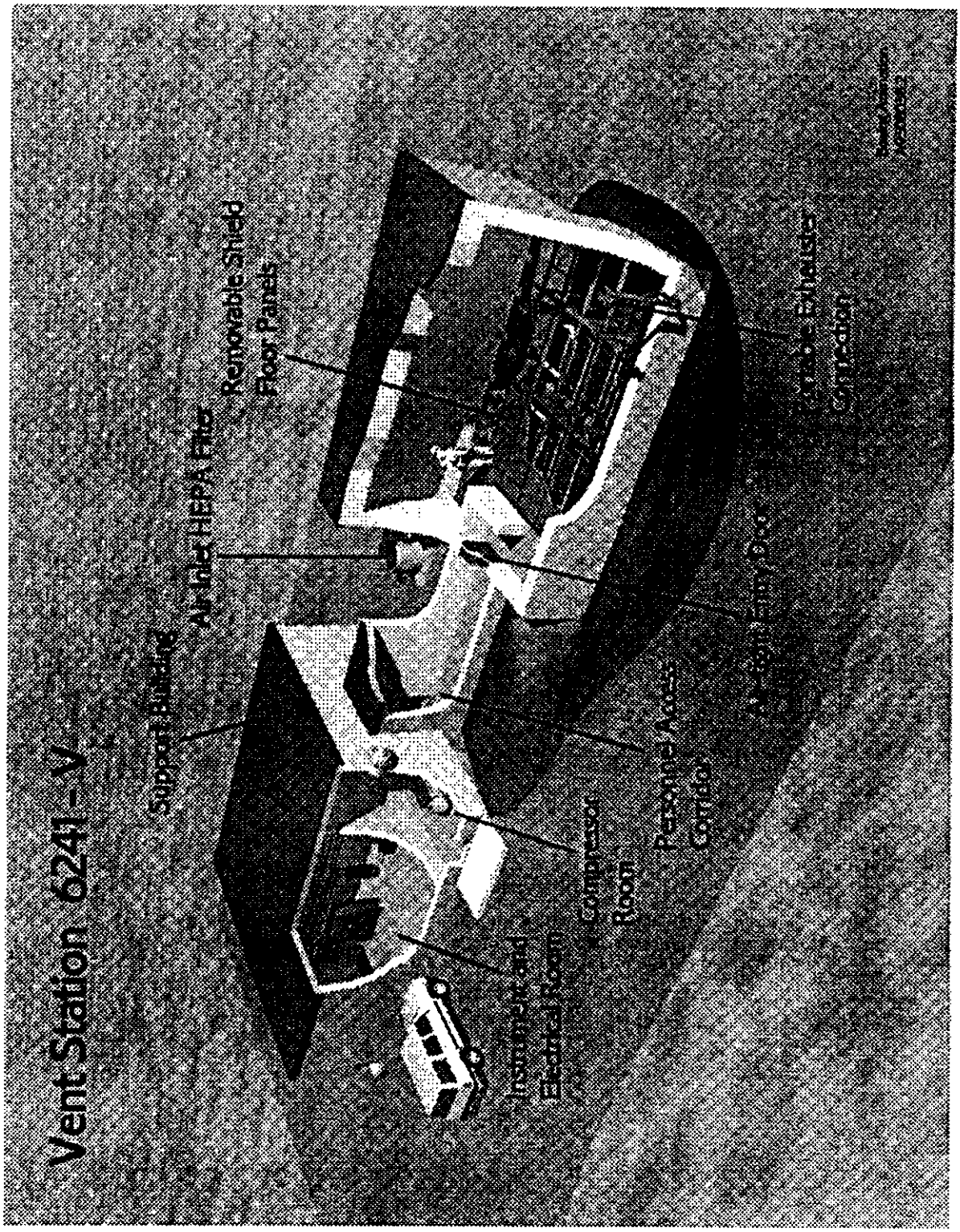

Figure 2-7. Vent Station 6241-V.

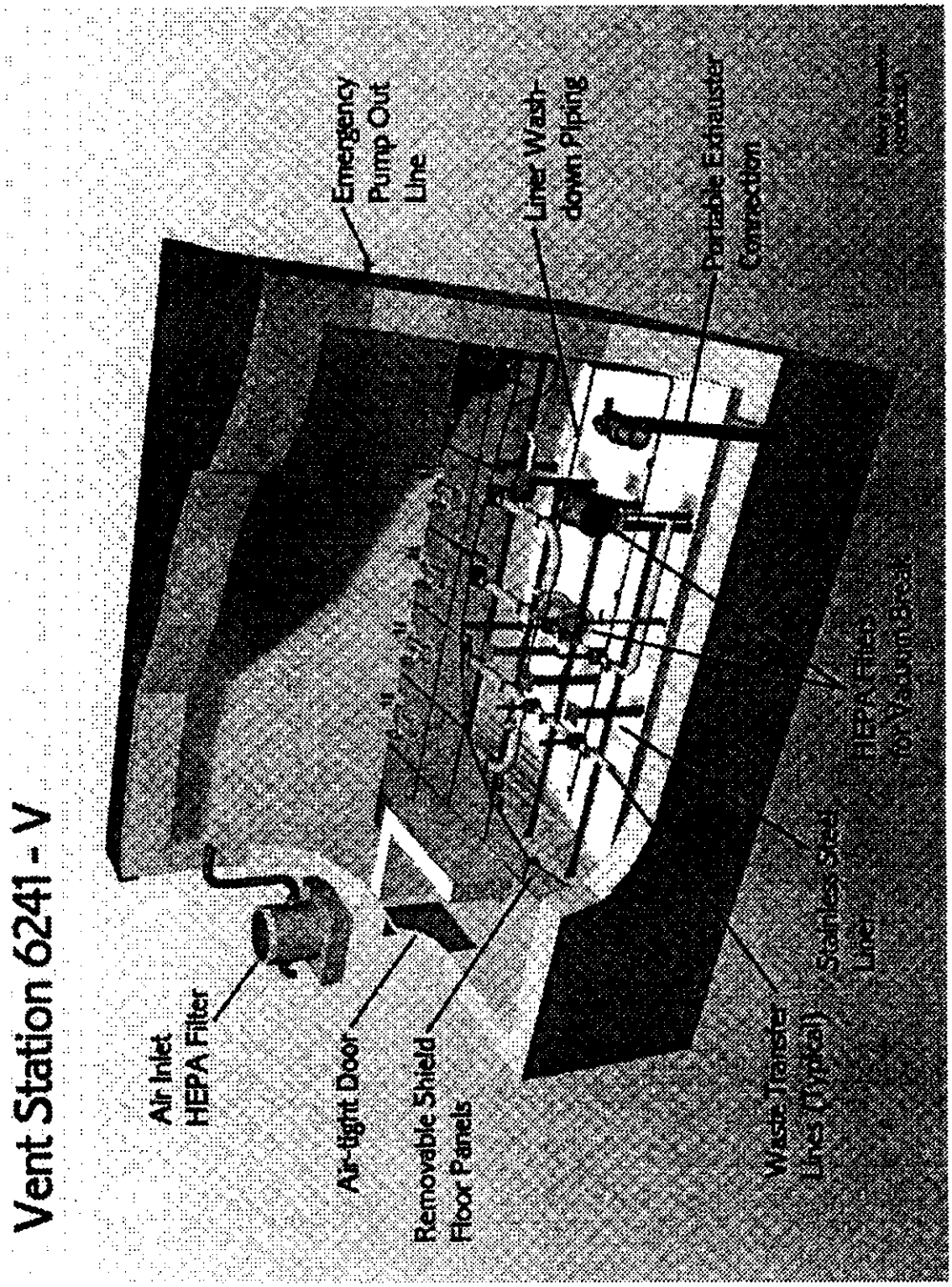

Table 2-1. RCSTS Design Parameters.[a]

Achievable design velocity	4.5 ft/s	6.0 ft/s
Specific gravity	1.5	1.25
Viscosity	30.0 cP	10 cP
Solid content	30.0 displacement vol%	20.0 displacement vol%
Miller number	<100	<100
Minimum pH		
Transfers/flushes	11.0	11.0
Temperature		
Transfers/flushes	2 to 93 °C (35 to 200 °F)	2 to 93 °C (35 to 200 °F)
Insulation	Required	Required
Particle size[(See Note)]	0.5 to 4,000 μm	0.5 to 4,000 μm
Friction factor	0.0404	Newtonian flow

NOTE:
0 - to 50-μm particles will comprise approximately 95% of total.
50 - to 500-μm particles will comprise <5% of total.
500 - to 4000-μm particles will comprise <1% of total.

[a] It is important to note that this table is presented for information only. These design parameters were specified as part of the Functional Design Criteria for the RCSTS and do not factor into the safety analysis.

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3.0 SAFETY ANALYSIS

3.1 INTRODUCTION

The safety analysis of the replacement cross-site transfer system (RCSTS) facilities and operations are described in this chapter. The discussions in Section 3.1, "Introduction," of the Final Safety Analysis Report (FSAR), are also applicable to the safety analysis for the RCSTS.

3.2 REQUIREMENTS

DOE orders and standards that provide requirements and guidance for hazard and accident analyses for nonreactor nuclear facilities are as follows:

- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)
- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (1992)
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (1994).

Additional requirements for hazard and accident analyses are identified in Section 3.2, "Requirements," of the FSAR. The DOE requirements on the definition of the Hanford Site boundary and on risk guidelines, that were followed in the FSAR, are also applied to the analyses presented in this Addendum.

3.3 HAZARD ANALYSIS

Presented in this section are the methodology and results of the hazard analysis conducted for the RCSTS facilities and operations. The types of events considered in the RCSTS hazard analysis are internal events, external events, and natural phenomena that can cause the uncontrolled release of radioactive or hazardous materials and affect the public, workers, or the environment. Sabotage and terrorism are not considered.

3.3.1 Methodology

The methodology used to perform the RCSTS hazard analysis is the same as that described in Section 3.3.1, "Methodology," of the FSAR. Details of the hazard analysis, as related to the RCSTS, are presented below.

3.3.1.1 Hazard Identification. The hazards analysis includes identification of the hazards associated with the RCSTS design, processes, and operations. The same methodology described in Section 3.3.1.1, "Hazard Identification," of the FSAR was used for the RCSTS. The hazard identification form and related checklist used for the RCSTS evaluation are the same as those shown in

Tables 3.3.1.1-1, "Sample Hazards Identification Form," and 3.3.1.1-2, "Hazard Identification Checklist and Energy Designators," of the FSAR.

It should be noted that the RCSTS material at risk assumptions are based on the following:

- **Chemical Inventory** — The source for the RCSTS maximum hazardous chemical inventory is WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*. This document contains the bounding limits for chemical concentrations for the waste to be transported through the RCSTS.

- **Radiological Inventory** — The RCSTS worst-dose radiological inventory is based on WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, and WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations*. These documents contain bounding unit-liter doses for the tanks within the TWRS facility. Aging waste is the bounding unit-liter dose used in the RCSTS analysis.

3.3.1.2 Hazard Topography. The TWRS hazard topography is described in Section 3.3.1.2, "Hazard Topography," of the FSAR. The hazardous conditions identified for the components and activities of the RCSTS were mapped into this topography.

3.3.1.3 Hazard Evaluation. Detailed discussions of hazard evaluation techniques are presented in Section 3.3.1.3, "Hazard Evaluation," of the FSAR. The methodology described in these sections was applied to the hazard evaluation of the RCSTS. A hazards and operability (HazOp) study was performed by a team of cognizant TWRS Operations and Engineering personnel, safety analysts familiar with the RCSTS, and technical experts in specialty areas for the RCSTS. This study is documented in WHC-SD-W058-PHA-001, *Hazards and Operability Study for the Replacement Cross-Site Transfer System*. A revision to this document has been made to account for changes to the original RCSTS design.

After the list of hazards were identified through the HazOp process, these hazards were compared with those associated with the existing cross-site transfer line in the BIO hazards database. Each existing cross-site transfer line hazard was found to be accounted for in the RCSTS hazards list. The FSAR hazard identifier was incorporated into the related RCSTS hazard identifier to facilitate future reference.

3.3.1.4 Candidate Accident Selection. The methodology for candidate accident selection is described in Section 3.3.1.4, "Candidate Accident Selection," of the FSAR. This methodology was applied to accident selection for the RCSTS. The initial list of bins was based on the list of candidate accidents developed for the FSAR. Evaluation of the individual RCSTS hazards identified no unique hazards that would result in the establishment of another accident bin, beyond those used in the FSAR.

3.3.1.5 Controls Identification. The methodology for controls identification is described in Section 3.3.1.5, "Controls Identification," of the FSAR. This FSAR methodology was also applied to controls identification for the RCSTS.

3.3.2 Hazards Analysis Results

3.3.2.1 Hazard Identification. Results of the hazard identification activities for the RCSTS are presented in the following sections. Details of the hazard analysis are presented in the following appendices of this Addendum:

- Appendix A, "Hazard Basis"
- Appendix B, "Analyzed Accidents and Represented Hazardous Conditions"
- Appendix C, "Hazard Evaluation Result"
- Appendix D, "Control Allocation Tables."

3.3.2.1.1 Material at Risk. The material at risk for each component of the RCSTS is identified in Table A-2 and was developed from information obtained during hazard analysis activities. The RCSTS will transfer tank wastes which contain radioactive material and chemical compounds (e.g., sodium hydroxide and sodium nitrate) typically found in waste tanks. Radiological and chemical composition of the transferred waste will depend on the constituents of the originating tank. The RCSTS may also contain flush solutions, consisting of water with enough sodium hydroxide added to bring the pH to approximately 11. Other chemicals may be added (e.g., sodium nitrate) to the flush solution.

The radiological material at risk is assumed to be from the worst-case tank in the Aging Waste Facility. The composition of this waste is documented in WHC-SD-WM-SARR-037. The toxicological composition of the waste is defined in WHC-SD-WM-SARR-011.

Hazardous Materials External to RCSTS. The RCSTS does not store or provide chemicals for process activities other than small quantities of sodium hydroxide used in the flush water system.

3.3.2.1.2 Energy Sources. The next step in the hazard identification process entails the identification of the energy sources that could contribute to the uncontrolled release of the material at risk. The energy sources for the RCSTS were identified using an energy source checklist.

The checklist that was applied to the RCSTS was developed from the management oversight and risk tree list (DOE-76-45/4 SSDC-4, *MORT User's Manual*) with other energy sources, specific to TWRS facilities, included.

The energy sources identified for the RCSTS are recorded in Table 3-1 (and the definitions are shown in Table 3-2). These results reflect the energy sources present during routine operational activities.

3.3.2.2 Hazard Classification. DOE 5480.23 requires the hazard classification of nuclear facilities and operations. Section 3.3.2.2, "Hazard Classification," of the FSAR documents the hazard classification of TWRS facilities performed in accordance with DOE-STD-1027-92. Single-shell tanks, double-shell tanks, aging waste facility tanks, and associated waste transfer systems are designated as Hazard Category 2 facilities. The RCSTS is part of the waste transfer system within the TWRS facility. It is interconnected to existing TWRS facility equipment and is not an independent segment. In addition, the RCSTS brings no new material at risk to the TWRS facility. Therefore, the RCSTS is also classified as Hazard Category 2.

3.3.2.3 Hazard Evaluation. The hazard evaluation activity for the RCSTS identified hazardous conditions with the potential for significant health, environmental, occupational, and radiation exposure consequences. All consequence and frequency assessments developed during hazard analysis activities are based on an assumed RCSTS configuration with no controls.

3.3.2.3.1 Accident Selection. As noted in Section 3.3.1.4 of this addendum, the initial list of bins was based on the list of candidate accidents developed for the FSAR. Evaluation of the individual RCSTS hazards identified no unique hazards that would result in the establishment of any additional accident bins. This initial set of candidate accidents represents all the S3 (offsite) and S2 (onsite) hazardous conditions that were selected for the TWRS facility in the FSAR. These accidents are shown in Table 3-3.

Out of a total of 29 candidate accidents identified in the FSAR, 13 accidents and one natural phenomena bin were used in the binning process for the RCSTS hazardous conditions. A list of the hazardous conditions represented for each of the 13 accidents is shown in Table B-1, while the list of binned RCSTS hazardous conditions is provided in Table B-2, which also includes the natural phenomena bin. Of the 13 accidents, six accidents were reanalyzed to account for the differences in the event scenario unique to the RCSTS. This final set of accidents, representing all S3 (offsite) and S2 (onsite) hazardous conditions that needed to be reanalyzed for the RCSTS, is shown in Table 3-4. A description of the reanalyzed accident scenarios and how the scenario differs from the original FSAR scenario is provided in Section 3.4.

3.3.2.3.2 Defense-in-Depth. The hazardous conditions identified for the RCSTS are shown in Appendix C of this addendum and are arranged according to consequence category (i.e., S3, S2, S1, etc.). Where applicable, Defense-in-Depth controls have been allocated to hazardous conditions with potential S3, S2, E3, and E2 consequences. In addition, Defense-in-Depth controls have been allocated to the hazardous conditions with significant facility worker consequences (F3/S1). The control allocation tables are shown in Appendix D of this addendum.

Protection Against Offsite Consequences. The controls identified for the reanalyzed accidents with potential offsite consequences are described in Section 3.4 of this addendum. These descriptions also include a discussion of accident consequences and frequency.

Protection Against Onsite Consequences. The controls identified for the reanalyzed accidents with potential onsite consequences are described in Section 3.4. These descriptions also include a discussion of accident consequences and frequency.

3.3.2.3.3 Facility Worker Protection. In the course of the RCSTS hazard analysis process, a number of potential hazardous conditions only affecting the facility worker were identified. These hazardous conditions were divided into three categories: uncontrolled releases of radioactive or hazardous material, operational radiation and hazardous material protection concerns, and occupational safety concerns.

Protection Against Uncontrolled Releases. From the hazard analysis database a list of anticipated hazardous conditions resulting in only facility worker effects from releases was developed (i.e., F3, S1 hazardous conditions with no controls). The hazardous conditions were reviewed to determine if they represented the potential for serious injury or death to the facility worker. For those hazardous conditions, Safety-Significant SSCs and TSRs were developed. Appendix D lists the anticipated hazardous conditions affecting the facility worker along with the applicable SSCs and TSRs.

Operational Radiation and Hazardous Material Protection. The hazard evaluation for the RCSTS identified a number of potential facility worker radiation exposure concerns. Although identification of potential facility worker radiation exposure and hazardous material concerns was not the specific focus of the hazards evaluation, the exposure concerns are recorded in Appendix C, Table C-5 of this addendum.

Occupational Safety. The hazard evaluation for the RCSTS identified a number of potential facility worker occupational safety concerns. Potential facility worker occupational safety hazardous conditions are recorded in Appendix C, Table C-6 of this addendum. These occupational hazards associated with the RCSTS are typical of those associated with other waste transfer systems in the TWRS facility. Industrial safety is implemented through HNF-SD-WM-HSP-002, *Tank Farms Health and Safety Plan*, which establishes procedures and provides general guidelines to minimize health and safety risks to facility workers.

3.3.2.3.4 Environmental Protection. The hazard analysis identified hazardous conditions with significant environmental (E3 or E2) consequences. These hazardous conditions are recorded in Appendix C, Table C-4 of this addendum. For most of these hazardous conditions, the controls to protect the public, onsite worker, and facility worker also provide for protection of the environment. A listing of the hazardous conditions with significant environmental consequences (E3 and E2) and applicable SSCs and TSRs is provided in Appendix D of this addendum.

Table 3-1. RCSTS Hazards Identification.[a]

Energy Classification[b]	RCSTS	
	PF	PE
Corrosive	2	N/A
Explosive/pyrophoric	6,7,8,10	N/A
Nuclear criticality	N/A	N/A
Flammable materials	11,13,14	3,7
Thermal radiation	N/A	N/A
Chemical reactions	1	N/A
Friction	N/A	N/A
Electrical	3,4,5,9,10	N/A
Kinetic-rotational	2,3	N/A
Kinetic-linear	N/A	1,4,5
Mass, gravity, height	2,3,11,13,14,16	5
Pressure-volume	7,9,11	N/A
Thermal (except radiant)	N/A	N/A

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

[b]See Table 3-2 for the specific energy classifications represented by the numeric designators.

N/A = not applicable.
PE = potentially present elsewhere in/adjacent to facility.
PF = potentially present in the facility.

Table 3-2. Hazard Identification Checklist and Energy Designators.

A Corrosive 1 Acids 2 Caustic 3 Natural chemicals 4 Decon solution 5 High temperature waste 6 Other	**D Flammable Materials** 1 Packing materials 2 Rags 3 Gasoline 4 Lube oil 5 Coolant oil 6 Paint solvent 7 Diesel fuel 8 Buildings and contents 9 Trailers and contents 10 Grease 11 Hydrogen 12 Nitric acid 13 Organics 14 Gases-other 15 Liquids-other 16 Sodium 17 Other	**H Electrical** 1 Battery banks 2 Diesel units 3 Transformers 4 Wiring 5 Switchgear 6 Underground wiring 7 Cable runs 8 Service outlets/ fittings 9 Pumps 10 Motors 11 Heaters 12 Power tools 13 Small equipment 14 Electrical equipment 15 Hot plates 16 High voltage 17 Locomotive, electrical 18 Transmission lines 19 Other	**K Mass, Gravity, Height** 1 Human effort 2 Stairs 3 Lifts and cranes 4 Bucket and ladder 5 Trucks 6 Slings 7 Hoists 8 Elevators 9 Jacks 10 Scaffold and ladders 11 Pits 12 Elevated doors 13 Vessels 14 Vaults 15 Excavations 16 Raw water lines 17 Other
B Explosive/Pyrophoric 1 Caps 2 Primer cord 3 Dynamite 4 Scrub chemicals 5 Dusts 6 Hydrogen 7 Gases, other 8 Nitrates 9 Peroxides-superoxides 10 Pu and U metal 11 Other	**E Thermal Radiation** 1 Furnaces and boilers 2 Steam liners 3 Lab equipment 4 Solar 5 Other	**I Kinetic-Rotational** 1 Centrifuges 2 Motors 3 Pumps 4 Fans 5 Laundry equipment 6 Shop equipment 7 Other	**L Pressure-Volume** 1 Boilers 2 Surge tanks 3 Autoclave 4 Test Loops 5 Gas bottles 6 Pressure vessels 7 Stressed members 8 Gas receivers 9 Negative pressure collapse 10 Steam headers and lines 11 Positive pressure release 12 Other
C Nuclear Criticality 1 Vaults 2 Temporary storage areas 3 Shipping and receiving areas 4 Filters 5 Casks 6 Burial ground 7 Storage racks 8 Canals and basins 9 Decon solution 10 Trucks, forklifts, dollies 11 Hand carry 12 Cranes/lifts 13 Hot cells, assembly, inspection 14 Laboratories 15 Tanks 16 Other	**F Chemical Reactions** 1 Uncontrolled chemical reactions 2 Other **G Friction** 1 Belts 2 Bearings 3 Fans 4 Gears 5 Motors 6 Power tools 7 Other 8 All	**J Kinetic-Linear** 1 Cars, trucks, buses 2 Forklifts, dollies, carts 3 Railroad 4 Obstructions 5 Crane loads 6 Pressure vessel blowdown 7 Other	**M Thermal (except radiant)** 1 Convective 2 Exposed components 3 Heaters 5 Fire boxes 6 Electric wiring, equip 7 Furnaces 8 Steam lines 9 Welding torch 10 Other

Table 3-3. Accidents Analyzed and Comparison of RCSTS to TWRS FSAR Accident Analysis. (2 sheets)

Number	FSAR Accidents	Addendum Section	FSAR Section	RCSTS Comparison
1	Nuclear Criticality	3.4.2.1	3.3.2.4.1	Reanalyzed for RCSTS
2	HEPA Filter Failure - Exposure to High Temperature or Pressure	3.4.2.2	3.3.2.4.2	Covered by FSAR
3	Fire in Contaminated Area	3.4.2.3	3.3.2.4.3	Covered by FSAR
4	Evaporator Dump	3.4.2.4	3.3.2.4.4	Not applicable
5	Steam Intrusion from Interfacing Systems	3.4.2.5	3.3.2.4.5	Not applicable
6	Leak from Railcar/Tank Trailer	3.4.2.6	3.3.2.4.6	Not applicable
7	Subsurface Leak Remaining Subsurface	3.4.2.7	3.3.2.4.7	Reanalyzed for RCSTS
8	Unplanned Excavation/Drilling in Pond/Ditch/Crib	3.4.2.8	3.3.2.4.8	Not applicable
9	Caustic Spray Leak	3.4.2.9	3.3.2.4.9	Covered by FSAR
10	Sodium Fire	3.4.2.10	3.3.2.4.10	Not applicable
11	Mixing of Incompatible Material - Toxic Vapor Generation	3.4.2.11	3.3.2.4.11	Covered by FSAR
12	Mixing of Incompatible Material - Tank Pressurization	3.4.2.12	3.3.2.4.12	Covered by FSAR
13	Tank Failures Due to Excessive Loads	3.4.2.13	3.4.2.1	Not applicable
14	Flammable Gas Deflagrations	3.4.2.14	3.4.2.2	Covered by FSAR
15	Organic Solvent Fire	3.4.2.15	3.4.2.4	Covered by FSAR
16	In-Tank Fuel Fire/Deflagration	3.4.2.16	3.4.2.5	Covered by FSAR
17	Organic Salt-Nitrate Reaction	3.4.2.17	3.4.2.6	Not applicable
18	Surface Leak Resulting in Pool	3.4.2.18	3.4.2.7	Reanalyzed for RCSTS
19	Subsurface Leak Resulting in Pool	3.4.2.19	3.4.2.8	Reanalyzed for RCSTS

Table 3-3. Accidents Analyzed and Comparison of RCSTS to TWRS FSAR Accident Analysis. (2 sheets)

Number	FSAR Accidents	Addendum Section	FSAR Section	RCSTS Comparison
20	Spray Leak in Structure or from Overground Waste Transfer Lines	3.4.2.20	3.4.2.9	Reanalyzed for RCSTS
21	Spray Leak from Underground Waste Transfer Lines	3.4.2.21	3.4.2.7 3.4.2.8 3.4.2.9	Reanalyzed for RCSTS
22	Tank Bump	3.4.2.22	3.4.2.11	Not applicable
23	Natural Phenomena-High Wind	3.4.2.23	3.4.2.12.1	Covered by FSAR
23	Natural Phenomena - Lightning	3.4.2.23	3.4.2.12.2	Covered by FSAR
23	Natural Phenomena - Seismic	3.4.2.23	3.4.2.12.3	Covered by FSAR

Table 3-4. FSAR Accidents Reanalyzed for RCSTS.

FSAR Section	Reanalyzed Accident	Addendum Section
3.3.2.4.1	Nuclear Criticality	3.4.2.1
3.3.2.4.7	Subsurface Leak Remaining Subsurface	3.4.2.7
3.4.2.7	Surface Leak Resulting in Pool	3.4.2.18
3.4.2.8	Subsurface Leak Resulting in Pool	3.4.2.19
3.4.2.9	Spray Leak in Structure or from Overground Waste Transfer Lines	3.4.2.20
3.4.2.7 3.4.2.8 3.4.2.9	Spray Leak From Underground Waste Transfer Lines	3.4.2.21

3.4 ACCIDENT ANALYSIS

3.4.1 Methodology

It is important to note that this Addendum was originally attached to the BIO. Therefore, the level of detail in the descriptions of the accident analyses and the section headings correspond to that found in the BIO.

Six accidents previously analyzed in the FSAR (nuclear criticality, subsurface leak remaining subsurface, surface leak resulting in pool, subsurface leak resulting in pool, spray leak in structure or from overground waste transfer lines, and spray leak from underground waste transfer lines) were reanalyzed for the RCSTS to determine whether the FSAR analysis is bounding. These accidents were reanalyzed because parameters such as temperatures, pressures, flows, and component dimensions are different for the RCSTS and may therefore affect the FSAR analysis results. The accident analysis methodology for reevaluation of these accidents is the same as that described in Section 3.4.1, "Methodology," of the FSAR. It should be noted that, because of the differences in design, some assumptions used in the analysis of the RCSTS are different from those used in the analysis of transfer systems in the FSAR. However, these assumptions did not involve the overall analysis methodology (i.e., radiological and toxicological consequence calculation methodology and the basis for estimating frequency), which remained consistent with the FSAR methodology. Analysis results are reported in the following sections and the supporting calculations are documented in HNF-2542, *Revised Spray Leak Calculations for Project W-058*.

3.4.2 Accident Analysis Scenarios

This section provides the analysis for the six accidents (nuclear criticality, subsurface leak remaining subsurface, surface leak resulting in pool, subsurface leak resulting in pool, spray leak in structure or from overground waste transfer lines, and spray leak from underground waste transfer lines) that need to be revisited for the RCSTS. To provide a complete picture of how the RCSTS relates to the other accident scenarios, all other FSAR accident scenarios are discussed with a focus on any interfaces with the RCSTS.

As noted previously, the six reanalyzed accidents are presented in the same format that was previously used in the BIO. However, only the new controls (as updated to account for the FSAR) are shown in this Addendum. The existing controls that remain applicable are provided by reference to the FSAR.

It is important to note that plugging of the transfer lines (deemed to be highly improbable based on the system design) is an availability and operational concern, but not a safety concern (i.e., it will not cause a waste release nor would it worsen the consequences of the leak and spray accidents already evaluated).

3.4.2.1 Nuclear Criticality. Nuclear criticality is reevaluated for the RCSTS, not because of any criticality concern within the transfer line itself, but because of the potential transfer of solids (containing plutonium) between waste tanks. The background of the nuclear criticality analysis is described below.

The FSAR evaluated the potential for nuclear criticality and concluded that no credible scenario has been identified that leads to a criticality in a double-contained receiver tank (DCRT), DST, or SST, according to the existing inventory of plutonium that is in the tank farms. For information purposes, an analysis was done in the FSAR to quantify the consequences of a criticality event initiated by the hypothetical transfer of a large volume of new waste containing a high plutonium concentration. The described scenario assumes 500 L (130 gal) of solution with a concentration of 10 g Pu/L is transferred to the tank farm. The waste is assumed to form a compact sphere in the tank which expands until a criticality occurs. The criticality is modeled as a single burst and produces a pressure increase in the headspace leading to a release of material.

The RCSTS does not affect this scenario since the criticality is assumed to occur in the tank. In addition, a criticality in a 76-mm (3-in.) line is a practical impossibility since concentrations approaching that of pure Pu metal are needed to produce a criticality in an infinite 3-in. cylinder. This is a safe geometry, i.e., a criticality cannot occur in the solutions that are pumped.

However, a waste leak to the soil from the RCSTS is a potential criticality concern, since the leak could result in an accumulation of fissile material in a non-criticality safe geometry. Evaluations of the criticality safety implications of supernate leaking into the ground are documented in WHC-SD-SQA-CSA-20356, *CSER 92-009: An Analytical Model for Evaluating Subcritical Limits for Waste In Hanford Site Storage Tanks*, WHC-SD-SQA-CSA-20363, *CSER 94-001: Criticality Safety of Single-Shell Waste Storage Tanks*, and WHC-SD-SQA-CSA-20368, *CSER 94-004: Criticality Safety of Double-Shell Waste Storage Tanks*. A leak to the soil could result in the filtering and trapping of plutonium in the soil. A model of plutonium in the soil was created (the soil was modelled as SiO_2). The analysis concluded a criticality would not occur because the solids contain a sufficient ratio of neutron absorbers to prevent criticality. Even if the absorbers were removed, a criticality would not occur because of the large quantity of plutonium required.

The final item to be evaluated for the RCSTS is the interface between the sending and receiving tanks. The RCSTS has the capability to transfer solutions with up to a 30 vol% solids content (while the FSAR only considered supernate transfers for criticality). It is possible that the plutonium concentration in the solids transferred through the RCSTS may exceed the discharge limits in the receiver DST if the solids content is actually 30 vol%. Therefore, an additional control is necessary to ensure that transfers involving waste solids are evaluated, prior to commencing the transfer.

3.4.2.1.1 Controls. An additional control is added to the Administrative Control on nuclear criticality safety. Prior to any slurry transfers with waste tank solids through the RCSTS, a Criticality Safety Evaluation Report will be issued which addresses the suspension of solids in the sending tank and particle segregation after settling in the sending and receiving tanks.

The other criticality controls listed in the FSAR are still applicable.

3.4.2.2 HEPA Filter Failure - Exposure to High Temperature or Pressure. Potential releases from HEPA filter failure are evaluated in the FSAR. Fire is determined to be the bounding initiator. The heat from a fire in close proximity to a ventilation system degrades the HEPA filter and causes a release of a portion of the waste that has accumulated on the filter. In addition, the failed filter is assumed to provide an unfiltered release pathway that continues to operate for up to one year. Waste tanks with active ventilation systems produce the bounding consequences. The RCSTS diversion box 6241-A and vent station 6241-V are passively ventilated structures (whose atmospheres should be essentially uncontaminated except under spray or pool leak accident conditions) and thus are bounded by the FSAR results.

A pressure differential of 2.5 kPa (0.4 psig) can fail HEPA filters. The only events identified in the FSAR, that are capable of generating pressures in excess of 2.5 kPa (0.4 psig), occur in waste tanks and thus are bounding for the RCSTS.

The controls identified in the FSAR for HEPA filters (i.e., periodic radiation monitoring of HEPA filter loading and HEPA filter change-out criteria) are applicable to the RCSTS. (However, for the RCSTS, these controls are based on the surface leak resulting in pool accident analyzed in Section 3.4.2.18 and the spray leak accident analyzed in Section 3.4.2.20.) No additional controls are required.

3.4.2.3 Fire In Contaminated Area. There are numerous contaminated areas associated with waste transfer systems that are routinely accessed, such as valve pits, pump pits, and diversion boxes. In the scenario analyzed in the FSAR, fuel from a crane gas tank is spilled into a contaminated (and open) valve pit, where it catches fire. The analysis without controls showed that controls are required to protect the onsite worker. To protect the onsite worker, an ignition control program has been established in the Technical Safety Requirements (TSRs). These ignition controls are applicable to the RCSTS.

3.4.2.4 Evaporator Dump. This accident involves a loss of electrical power to the evaporator, which results in a discharge of the contents of the evaporator to a double-shell tank. This scenario is not applicable to the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.5 Steam Intrusion from Interfacing Systems. This accident involves steam jets that are used to transfer waste into the tank farms. As a result

of operator error, steam is routed to the headspace of a waste tank, which results in a pressure increase and HEPA filter failure. This scenario does not involve the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.6 Leak from Railcar/Tank Trailer. This scenario evaluates the effects of a railcar breach, as the railcar is about to enter the 204-AR Waste Unloading Facility. This scenario is not applicable to the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.7 Subsurface Leak Remaining Subsurface for the RCSTS.

Purpose of Analysis: The purpose of this analysis is to evaluate the risks associated with a potential leak of waste to the soil that remains subsurface.

Analysis Strategy: Subsurface leaks that remain subsurface are analyzed in the FSAR for the TWRS waste transfer systems, but this analysis did not include the RCSTS, which was an ongoing project outside the original FSAR scope. The FSAR analysis considered both single-wall and encased line leaks. A leak from a single-walled direct-buried pipe was selected as the bounding accident. This scenario was considered bounding because the leak flows directly to the soil (i.e., there is no encasement) and the direct-buried pipe provides minimal soil shielding. Both these factors serve to maximize the radiological dose consequence. Also, leaks from pipe encasements will tend to flow to process pits where the pit leak detectors will provide indication of a leak. The RCSTS is a pipe encased within a pipe system, which is continuously sloped (with vent station 6241-V representing the high point) to facilitate drainage of any primary pipe leak to a process pit. Therefore, the FSAR analysis of subsurface leak that remains subsurface is bounding for the RCSTS.

3.4.2.7.1 Accident Scenario Assuming No Controls.

Sequence of Events. The bounding scenario for the subsurface leak remaining subsurface is described in Section 3.3.2.4.7, "Subsurface Leak Remaining Subsurface," of the FSAR.

Results Summary. FSAR Table 3.3.2.4.7-1, "Summary of Consequences and Frequencies of a Subsurface Leak Remaining Subsurface Without Controls," presents the bounding onsite radiological consequences for the subsurface leak remaining subsurface accident assuming no controls. There are no offsite radiological nor any toxicological consequences for this accident, based on the distance to the site boundary and the fact the release remains below the soil surface.

Implication of Results. For the bounding accident, the onsite radiological consequences are below the risk guidelines. Therefore, no structures, systems, and components have been designated as Safety-Class or Safety-Significant for protection of the onsite and offsite receptor. However, controls have been established for protection of the facility worker.

3.4.2.7.2 Accident Scenario Assuming Controls. No accident scenarios assuming controls are postulated, because the radiological and toxicological consequences for the scenario without controls are below the risk guidelines.

3.4.2.7.3 Key Assumptions. Key assumptions are presented below.

Important to Accident Frequency. The accident assuming controls was not analyzed because the consequences with no controls were below the risk guidelines.

Important to Accident Consequences. The assumptions that are important to the calculation of accident consequences are described in Section 3.3.2.4.7, of the FSAR.

3.4.2.7.4 Controls. The existing controls listed in the FSAR are applicable to pipe-in-pipe encased lines and waste transfer-associated structures and thus are also applicable to the RCSTS.

Safety Structures, Systems, and Components. There are no additional Safety-Class or Safety-Significant structures, systems, and components selected for the RCSTS. Table 3.3.2.4.7-2, "Summary of Safety Structures, Systems, and Components for Subsurface Leak Remaining Subsurface," in the FSAR lists the Safety-Significant structures, systems, and components selected to prevent or mitigate the risk of subsurface leaks that remain subsurface. The Safety-Significant designation of the waste transfer pipe-in-pipe encasement, transfer leak detection systems, and tank level detection systems, identified in the FSAR, are provided to protect the facility worker and are applicable to the RCSTS.

Technical Safety Requirements. There are no additional TSRs selected for the RCSTS. Table 3.3.2.4.7-3, "Summary of Technical Safety Requirement Controls for Subsurface Leak Remaining Subsurface," in the FSAR lists the TSRs selected to prevent or mitigate the risk of subsurface leaks that remain subsurface. These TSRs (regarding transfer controls, transfer leak detection systems, and transfer pump administrative lock controls) identified in the FSAR are applicable to the RCSTS.

Defense-in-Depth. There are no additional Defense-in-Depth controls identified for the RCSTS. The existing Defense-in-Depth controls identified in FSAR Table 3.3.2.4.7-4, "Summary of Defense-in-Depth Controls for Subsurface Leak Remaining Subsurface," are applicable to the RCSTS.

3.4.2.8 Unplanned Excavation/Drilling in "Cribs, Ditches, and Ponds." This accident considers inadvertent excavation in a crib, ditch, or pond that contains a large quantity of contaminated soil. This accident does not involve the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

Excavations that result in breaches of waste transfer lines (including the RCSTS) are addressed in Section 3.4.2.21.

3.4.2.9 Caustic Spray Leak. This accident involves a spray release of sodium hydroxide from a 1-inch Schedule 10 commercial steel pipe while the solution

is being transferred to a waste tank. The RCSTS itself will not be used as a means for caustic addition to tanks. However, sodium hydroxide may be added to the flush tank that is interconnected to the RCSTS. Since the bounding accident (i.e., worst-case concentration and lightest piping used for transferring sodium hydroxide) has already been considered in the FSAR, no additional analysis is required for the RCSTS and no additional controls, beyond those listed in the FSAR, are required.

3.4.2.10 Sodium Fire. The 2727-W Sodium Storage Facility contains five tanks that are filled with solid sodium. The evaluated accident is initiated by high winds, that damage the building, and are followed by heavy rain that causes a sodium-water reaction followed by a fire. This accident is specific to the 2727-W Building and does not involve the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.11 Mixing of Incompatible Material - Toxic Vapor Generation. The bounding scenario assumes a rapid uncontrolled addition of caustic to a double-contained receiver tank which increases the pH level and ultimately results in the release of ammonia. The analysis applies to DCRTs, DSTs, and SSTs. The FSAR analysis does not include waste transfer systems, because caustic additions are typically done locally and not through waste transfer systems. Therefore, the existing FSAR analysis is adequate for the RCSTS and no additional controls, beyond those listed in the FSAR, are required.

3.4.2.12 Mixing of Incompatible Material - Tank Pressurization. This scenario assumes that an uncontrolled mixture of incompatible materials in a waste tank results in a tank pressurization and an airborne release. The bounding accident is a mistransfer of 416 L (110 gal) of 57% nitric acid from B-Plant to DCRT. The presence of the RCSTS has no impact on this bounding source term or accident scenario. Thus, the existing FSAR analysis is adequate for the RCSTS. Transfer controls to ensure waste compatibility are established in the FSAR. These controls are applicable to the RCSTS and no additional controls are required.

3.4.2.13 Tank Failure Due to Excessive Loads. This scenario involves tank failure caused by a load drop event. This accident is specific to waste tanks and is not applicable to the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.14 Flammable Gas Deflagrations. The flammable gas hazard poses an Unreviewed Safety Question (USQ) originally identified in 1990. This USQ was expanded to include steady state accumulation as well as gas release event phenomena (Wagoner 1996, Contract Number DE-AC06-96RL13200; *The U.S. Department of Energy [DOE], Richland Operations Office [RL], Definition and Declaration of Flammable Gas Unreviewed Safety Question [USQ]*). The scope of the flammable gas USQ was also expanded to include miscellaneous transfer system components (e.g., transfer lines, valve pits, diversion boxes, process pits, and transfer line cleanout boxes). The flammable gas USQ was closed for TWRS SSTs and DSTs (Wagoner 1998). The history and status of flammable gas related USQs is described in FSAR Section 3.4.2.2.1, "Background." Although the USQ was closed for SSTs and DSTs, the flammable gas USQ remains open for the miscellaneous transfer system components (TF-96-0433, *Consolidation of Flammable Gas/Slurry Growth Unreviewed Safety Question Issues*). This USQ is

also applicable to the RCSTS. (It should also be noted that the FSAR evaluates flammable gas deflagrations in waste tanks and these results are bounding for waste transfer systems such as the RCSTS.)

Controls for flammable gas hazards are derived in Appendix K, "Flammable Gas Hazards and Controls in Hanford Waste Storage Tanks and Waste Transfer Facilities," of the FSAR. Detailed quantitative analysis of the frequencies and consequences of flammable gas events in the RCSTS has not been performed. This is consistent with the open USQ (TF-96-0433) and the overall TWRS approach to the flammable gas issue. As noted in Section K5.4 of Appendix K of the FSAR, the flammable gas control strategy for waste transfer systems is based on a qualitative evaluation that concludes that historical evidence exists that the risk posed by this hazard is low. Risk is reduced by flushing transfer lines after use. In addition, gas concentrations are monitored during entry to all vapor spaces, such as process pits, that might be connected to transfer lines. Gas monitoring verifies the risk is low. Flushing practices are required to be continued to maintain a low risk of flammable gas generation and accumulation. Lastly, RCSTS equipment is evaluated for compliance with Ignition Source Controls specific to the use and location of the equipment. It is judged that additional controls are not warranted at this time.

3.4.2.15 Organic Solvent Fire. Some waste tanks contain separable organic solvent phases. If ignited, the burning organic can liberate sufficient energy to release hazardous material from the tank. The oxygen in the tank is the limiting parameter for this scenario. It is important to note that there are no ignition sources in the pipes or structures unique to the RCSTS that are capable of igniting the solvent. In addition, there is not enough oxygen in the transfer pipes to support sustained combustion. The FSAR analysis is therefore bounding.

3.4.2.15.1 Controls. A control is established in the FSAR that requires all waste transfers to be evaluated to ensure the waste transfer does not create an organic solvent hazard in the receiving or delivering tank which is outside the FSAR safety envelope, i.e., the control prevents the creation of a new tank with an organic solvent hazard unless the required organic controls are extended to that tank. This control is applicable to the operation of the RCSTS.

3.4.2.16 In-Tank Fuel Fire/Deflagration. This scenario postulates that an errant motor vehicle shears off one or more tank risers and ruptures the vehicle fuel tank. This accident is specific to waste tanks and is not applicable to the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.17 Organic Salt-Nitrate Reaction. Organic complexants were used during past Hanford operations and were discharged to the tank where they were mixed with sodium hydroxide, sodium nitrate, and other inorganic diluent already present in the tank. Organic complexants will react with these types of oxidizing materials. The reaction can be accelerated to a rapid combustion by heating to high temperatures by an initiator of sufficient energy.
A combustion front would be generated by such a condition and would spread through the combustible waste releasing significant energy and gases.

This accident scenario is specific to waste tanks. Even with the highest solids content (30 vol%), the RCSTS poses no hazard of propagating combustion reactions (since the moisture content is much greater than the 20 wt% water needed to preclude combustion). The only potential concern would be if solids were allowed to accumulate and dry in the transfer lines. Solids accumulation is precluded by flushing the RCSTS after transfers are completed.

The scenario is also relevant to waste transfer systems insofar as they may be used for tank moisture removal or addition. (Moisture is a moderator for this type of reaction.) The FSAR analysis states that the accident analysis and the specified controls are applicable to waste transfer lines. Therefore, the FSAR control strategy is applicable to the RCSTS, and no additional controls, beyond those listed in the FSAR, are required.

3.4.2.18 Surface Leak Resulting In Pool for the RCSTS.

Purpose of Analysis: A surface leak that occurs during a transfer through the RCSTS could form a pool. These waste pools are a safety concern because they can cause significant onsite and offsite inhalation doses and produce significant shine and skyshine doses to the onsite receptor.

Analysis Strategy: Surface leaks that result in pools have been analyzed in the FSAR for existing transfer routes, but not the RCSTS which was an ongoing project outside the FSAR scope. A misrouting of waste to a valve pit was analyzed as the bounding case in the FSAR. The RCSTS adds two new structures, diversion box 6241-A and vent station 6241-V, that were not considered in the FSAR analysis and are larger than existing waste transfer structures. (Note that the end points of the RCSTS, valve pits 241-SY-A and 241-SY-B in the 200 West Area and the 244-A lift station in the 200 East Area, are existing facilities for which the FSAR analysis is bounding.) Thus, leaks were evaluated in the two RCSTS structures, with diversion box 6241-A providing the bounding case.

The scenario where an RCSTS subsurface leak washes away the soil and results in a surface pool is analyzed in Section 3.4.2.19 of this addendum.

3.4.2.18.1 Accident Scenario Assuming No Controls.

Sequence of Events. The RCSTS scenario postulates that the spill occurs in diversion box 6241-A. The spill is postulated to occur with the diversion box entry door and pipe penetrations open, so that no credit is taken for the HEPA filter. The event duration (12 hours) and receptor exposure times are the same as in the FSAR (12 hours for the onsite receptor and 12 hours aerosol exposure for the offsite receptor). The event frequency is also the same (i.e., "anticipated").

The RCSTS scenario differs from the FSAR scenario as follows. The leak rate is assumed to be the maximum RCSTS flow rate of 530 Lpm (140 gpm) versus the 1,130 Lpm (300 gpm) used in the FSAR. Thus, maximum pool size is 381,600 L (100,800 gal) or 380 m^3, compared to 817,600 L (216,000 gal) in the FSAR. Because the volume of the diversion box is 622 m^3 (21,960 ft^3), there will be no overflow. Splashing, however, is assumed to continue for the entire 12 hour period, unlike the valve pit scenario analyzed in the FSAR,

where splashing is assumed to stop after the pit is half full. Also, because only the supernate line, WT-SNL-3150 is authorized for operation, the spill is assumed to be aging waste supernate (5 vol% solids and 95 vol% liquids).

Results Summary. The onsite and offsite radiological and toxicological consequences for the RCSTS pool leak accident assuming no controls and the comparison to risk guidelines are shown in Table 3.4.2.18-1. Supporting calculations are documented in HNF-2542.

Implication of Results. For the RCSTS pool leak accident, the onsite and offsite radiological and the onsite toxicological consequences exceed the risk guidelines. Therefore, controls are required.

3.4.2.18.2 Accident Scenario Assuming Controls. A suite of controls was selected for this accident in the FSAR. Several additional controls were selected for the accident scenario as analyzed for the RCSTS. To maintain the validity of the analysis in the FSAR for the piping downstream of the RCSTS, the pressure relief valve and rupture disk in lift station 244-A were elevated to Safety-Class status. (Note that the RCSTS is designed to withstand higher pressures than the existing piping to which it is connected.) This will preclude overpressurizing the downstream piping. A TSR control was selected to ensure that the doors and pipe penetrations (air sample line, exhauster hookup, liner washdown system, and emergency pumpout line) in diversion box 6241-A and vent station 6241-V are sealed during waste transfers to limit the release of unfiltered aerosols. A TSR control was also selected for the HEPA filter in diversion box 6241-A and vent station 6241-V to limit doses to the onsite receptor and facility worker.

Sequence of Events. The sequence of events for a pool leak in the RCSTS with controls is similar to that described in the FSAR, except that the leak is assumed to occur in diversion box 6241-A, instead of a valve pit. As in the FSAR, the maximum leak rate is assumed to be 1.3 L/s (20 gpm) and the leak detector in the diversion box is assumed to alarm after 51 mm (2 in.) of waste have accumulated. Flow is also assumed to occur for 30 minutes after the leak detector alarms to allow for operator response. The FSAR assumptions on aerosols being generated from splatter and splashing while the pump is running and convection currents keeping some aerosols in suspension after the transfer pump is shut off are also retained in the RCSTS analysis. The entry door and pipe penetrations are assumed to be sealed and therefore the majority (90%) of the airborne release passes through a HEPA filter, which is credited with reducing the source term. The presence of the HEPA filter represents the major difference from the FSAR (where the analyzed valve pit has no HEPA filter). Another FSAR assumption that remains the same for the RCSTS is that the frequency of the event with controls is also assumed to be "anticipated."

The changes to the FSAR sequence of events made for the RCSTS are as follows:

- The material spilled is aging waste supernate (5 vol% solids, 95 vol% liquids).

- The equipment leak occurs inside diversion box 6241-A with the entry door and pipe penetrations (air sample line, exhauster hookup, liner washdown system, and emergency pumpout line) assumed to be sealed.

- The amount of waste that is assumed to drain back through the leakage path after the pump is shut down is larger for the RCSTS. This maximum drain volume is 27.4 m^3 (968 ft^3) based on 5,730 m (18,800 ft) of 76-mm (3-in.) pipe.

- The majority (90%) of the airborne release is assumed to pass through a HEPA filter with a removal efficiency of 0.99. The remaining 10% of the airborne release is assumed to be unfiltered.

Results Summary. The radiological and toxicological consequences of the RCSTS accident assuming controls are presented in Table 3.4.2.18-2 and the associated calculations are documented in HNF-2542.

Implication of Results. The offsite and onsite radiological and toxicological consequences for the RCSTS surface leak resulting in pool accident, assuming controls, are below the risk guidelines.

3.4.2.18.3 Key Assumptions. Key assumptions are presented below.

Important to Accident Frequency. There are no key assumptions associated with the frequency of the RCSTS surface leak resulting in a pool accident.

Important to Accident Consequences. The FSAR assumption that the operator shuts down the transfer pump 30 minutes after alarm actuation is also used in the RCSTS analysis. The important assumptions with an impact on consequences for the RCSTS, which differ from those used in the FSAR, are as follows:

- The material spilled is aging waste supernate (5 vol% solids, 95 vol% liquids).

- The leak is assumed to occur in diversion box 6241-A, because this provides the bounding results for the two new waste transfer pits added by the RCSTS.

- The entry door is shut and the pipe penetrations (air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line) are sealed.

- The majority (90%) of the airborne release passes through a HEPA filter with an assumed efficiency of 0.99. In addition, the HEPA filter is assumed to be radiologically clean, since it should only be exposed to radionuclides during accident conditions. The remaining 10% of the release is assumed to be unfiltered.

- The amount of waste that is assumed to drain back through the leakage path after the pump is shut down is larger for the RCSTS. This maximum drain volume is 27.4 m^3 (968 ft^3) based on 5,730 m (18,800 ft) of 76-mm (3-in) pipe.

- The pressure relief valve installed in the 244-A lift station precludes the RCSTS from overpressurizing the downstream piping. The pressure relief valve will lift at a preset pressure 1590 kPa (230 psig) that is equal to the maximum operating pressure of the existing downstream piping. This protects the analysis in the FSAR, for surface leaks resulting in pool accidents, in equipment downstream of the RCSTS. It should also be noted that a rupture disk is located upstream of the relief valve (for As Low as Reasonably Achievable [ALARA] purposes, to allow testing and maintenance of the valve) and will rupture at a preset pressure to allow the relief valve to perform its safety function.

3.4.2.18.4 Controls. The following new controls are applicable to the RCSTS. It is important to note that these controls are an addition to the controls already listed in the FSAR. These RCSTS controls have been added to the consolidated list of controls presented in Table 3.3.2.3.2-1, "Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents," of the FSAR.

Safety Structures, Systems, and Components. Table 3.4.2.18-3 lists the new Safety-Class and Safety-Significant structures, systems, and components selected to prevent or mitigate the risk of RCSTS surface leaks resulting in a pool. These controls are unique to the RCSTS. The RCSTS pressure relief valve and rupture disk are only applicable to transfers through line WT-SLL-3160. Other Safety-Class and Safety-Significant structures, systems, and components are identified in FSAR Table 3.4.2.7-4, "Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool." The Safety-Class or Safety-Significant designations of the transfer leak detection systems, the abovegrade portions of process pits, diversion boxes, and valve pits, the tank level detection systems, and the pressure switch interlock or alarm systems (to prevent waste backflow to the flush system) are applicable to the RCSTS. Per agreement with DOE-Office of River Protection (ORP), the Safety-Class designation for the abovegrade portions of process pits, diversion boxes, and valve pits is not effective until March 30, 2000.

Technical Safety Requirements. Table 3.4.2.18-4 lists the new TSRs selected to prevent or mitigate the risk of RCSTS surface leaks resulting in a pool. These controls are unique to the RCSTS. The controls for the RCSTS pressure relief valve and rupture disk will be added to the TSR document after RL approval for transfers through WT-SLL-3160 is granted. Other TSRs are identified in FSAR Table 3.4.2.7-5, "Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool." The TSRs regarding the transfer pump administrative lock controls, the transfer leak detection systems, the transfer controls, the pressure switch interlock or alarm systems (to prevent waste backflow to the flush system), and the HEPA filter control program are applicable to the RCSTS.

Defense-in-Depth. There are no new Defense-in-Depth controls identified for the RCSTS. The existing Defense-in-Depth controls identified in FSAR Table 3.4.2.7-6, "Summary of Defense-in-Depth Controls for Surface Leak Resulting in Pool," are applicable to the RCSTS.

Table 3.4.2.18-1. Consequences of RCSTS Surface Leak Resulting in Pool without Controls.

Receptor/Hazard	Calculated Dose	Evaluation guidelines "anticipated" frequency
Onsite radiological	2,400 mSv (240 rem)	5 mSv (0.5 rem)
Offsite radiological	3.1 mSv (0.31 rem)	1 mSv (0.1 rem)
Onsite Toxicological sum-of-fractions	3.7	1 (≤ERPG-1)
Offsite Toxicological sum-of-fractions	0.00061	1 (≤PEL-TWA)

Table 3.4.2.18-2. Consequences of RCSTS Surface Leak Resulting in Pool with Controls.

Receptor/Hazard	Calculated Dose	Evaluation guidelines "anticipated" frequency
Onsite radiological	1.9 mSv (0.19 rem)	5 mSv (0.5 rem)
Offsite radiological	3.6E-03 mSv (3.6E-04 rem)	1 mSv (0.1 rem)
Onsite Toxicological sum-of-fractions	7.3E-03	1 (≤ERPG-1)
Offsite Toxicological sum-of-fractions	1.2E-05	1 (≤PEL-TWA)

Table 3.4.2.18-3. New Safety Structures, Systems, and Components for RCSTS Surface Leaks Resulting in Pool.

Structure, Systems, or Components	SC	SS	Safety Function	Comments
Entry doors and penetrations for diversion box 6241-A and vent station 6241-V		X	Limit release of aerosols generated by splatter inside the structure	
HEPA filter in diversion box 6241-A and vent station 6241-V		X	Limit release of respirable aerosols by filtering	
RCSTS pressure relief valve and rupture disk	X		Precludes overpressurizing existing piping downstream of RCSTS	Protects FSAR assumptions and analysis for existing piping

Note that these are the new safety SSCs that are unique to the RCSTS. All SSCs identified in FSAR Table 3.4.2.7-4, "Summary of Safety Structures, Systems, and Components for Surface Leak Resulting in Pool," are still applicable.

Table 3.4.2.18-4. New Technical Safety Requirements Controls for RCSTS Surface Leaks Resulting in Pool.

Control	Safety Function	Comments
Door and penetrations in diversion box 6241-A and vent station 6241-V	Ensure entry door is shut and air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line are sealed during waste transfers	
RCSTS pressure relief valve and rupture disk	Ensure pressure relief valve and rupture disk are operable during transfers	Protects FSAR assumptions and analysis for existing piping downstream of the RCSTS
HEPA Filter Control Program with the following key elements: • Periodic radiation survey to monitor HEPA filter loading • HEPA filter replacement per change-out criteria, i.e., ≤2 mSv/h (≤200 mrem/h) • Aerosol test upon installation • Periodic aerosol test	HEPA filter monitoring and replacement reduce consequences from a possible HEPA filter failure by limiting the inventory available for release Aerosol testing ensures filtering efficiency of HEPA filter	Applies to the inlet air HEPA filter system in diversion box 6241-A and vent station 6241-V

Note that these are the new TSRs that are unique to the RCSTS. All Technical Safety Requirement Controls listed in FSAR Table 3.4.2.7-5, "Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool," are still applicable. Also note that the HEPA filters listed in the preceding table are covered under the existing Administrative Control that requires periodic radiation surveillance and filter changeout with accumulations ≤200mrem/h and verification of the nominal particulate removal efficiency (≥99.95%).

3.4.2.19 Subsurface Leak Resulting In Pool for the RCSTS.

Purpose of Analysis: Transfer line leaks at high flow rates that are in excess of the natural infiltration rate of the soil can result in surface pools of waste. These waste pools are a safety concern because they can cause significant onsite and offsite inhalation doses and produce significant shine and skyshine doses to the onsite receptor.

Analysis Strategy: Subsurface leaks that result in pools are analyzed in the FSAR for the TWRS waste transfer systems, but this analysis did not include the RCSTS, which was an ongoing project outside the FSAR scope. The three basic types of transfer lines considered in the FSAR were unencased direct buried or bermed lines, buried concrete encased lines, and buried pipe-in-pipe lines. A subsurface leak from an unencased, bermed line was selected as the bounding accident in the FSAR. The rationale for this is fourfold. First, unencased lines are older, in direct contact with the soil, and more prone to failure than the encased lines. Second, leaks into pipe encasements will tend to flow to process pits where the pit leak detectors will provide indication of a leak. Third, leaks from pipe encasements will be under low pressure and downward oriented, so that surface pools will be far less likely to form than in bermed unencased piping. Finally, the surface pools that can develop from washing out a berm are larger than pools than can develop as a result of leaks from buried lines. The RCSTS is a modern pipe encased within a pipe system, which is continuously sloped (with vent station 6241-V representing the high point) to facilitate drainage of any primary pipe leak to a process pit. (In addition, although it is not credited in the safety analysis, the RCSTS primary piping was designed to meet the criteria for a Safety-Class designation.) Therefore, the FSAR analysis of subsurface leak resulting in a pool is bounding for the RCSTS.

The bounding scenario addresses transfer line leaks that are caused by internal initiators. Potential RCSTS leaks caused by excavation activities are addressed in Section 3.4.2.21, and potential RCSTS leaks caused by seismic events are addressed in Section 3.4.2.23.

3.4.2.19.1 Accident Scenario Assuming No Controls.

Sequence of Events. The bounding scenario for the subsurface leak resulting in a pool accident (without controls) is described in Section 3.4.2.8.1, "Scenario Development," of the FSAR.

Results Summary. FSAR Table 3.4.2.8-2, "Summary of Consequences and Frequencies of a Subsurface Leak Resulting in Pool Without Controls," presents the bounding onsite and offsite radiological and toxicological consequences for the subsurface leak resulting in a pool accident assuming no controls.

Implication of Results. For the bounding accident, the onsite and offsite radiological consequences and the onsite toxicological consequences exceed the risk guidelines. Therefore, controls are required.

3.4.2.19.2 Accident Scenario Assuming Controls.

Sequence of Events. The leak from an unencased bermed line provides the bounding accident scenario with controls. This is based on the same arguments presented in the accident scenario without controls. These arguments are further buttressed by the Safety-Class designation applied to waste transfer pipe encasements and the fact that the RCSTS primary pipe is designed (although it is not credited in the analysis) to a Safety-Class designation.

The bounding scenario for the subsurface leak resulting in a pool accident (with controls) is described in Section 3.4.2.8.1 of the FSAR.

Results Summary. The bounding onsite and offsite radiological and toxicological consequences for the subsurface leak resulting in a pool accident assuming controls are shown in FSAR Table 3.4.2.8-3, "Summary of Consequences and Frequencies of a Subsurface Leak Resulting in Pool With Controls."

Implication of Results. For the bounding accident, the onsite and offsite radiological and toxicological consequences satisfy the risk guidelines.

3.4.2.19.3 Key Assumptions. Key assumptions for the bounding accident are described in Section 3.4.2.8.3, "Consequence Analysis," of the FSAR. An additional assumption is made for the RCSTS, because of the potential pressure that may be achieved in the boosted line. The pressure relief valve installed in the 244-A lift station precludes the RCSTS from overpressurizing the downstream piping. The pressure relief valve will lift at a preset pressure (230 psig) that is equal to the maximum operating pressure of the existing downstream piping. This protects the analysis in the FSAR, for subsurface leaks resulting in pool accidents, in equipment downstream of the RCSTS. It should also be noted that a rupture disk is located upstream of the relief valve (for ALARA purposes, to allow testing and maintenance of the valve) and will rupture at a preset pressure (1,590 kPa [230 psig]) to allow the relief valve to perform its safety function.

3.4.2.19.4 Controls. The following new controls are applicable to the RCSTS. It is important to note that these controls are an addition to the controls already listed in the FSAR.

Safety Structures, Systems, and Components. Table 3.4.2.19-1 lists the new Safety-Class and Safety-Significant structures, systems, and components selected to prevent or mitigate the risk of RCSTS subsurface leaks resulting in pools. The listed SSCs are unique to the RCSTS. The RCSTS pressure relief valve and rupture disk are only applicable to transfers through line WT-SLL-3160. Other Safety-Class and Safety-Significant structures, systems, and components are identified in FSAR Table 3.4.2.8-4, "Summary of Safety Structures, Systems, and Components for Subsurface Leak Resulting in Pool." The Safety-Class designation of the waste transfer pipe-in-pipe encasement and the transfer system leak detection systems, and Safety-Significant designation of the tank level detection systems and the abovegrade

portions of process pits, diversion boxes, valve pits, and cleanout boxes are applicable to the RCSTS. Per agreement with DOE-ORP, the Safety-Significant designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

Technical Safety Requirements. Table 3.4.2.19-2 lists the new TSRs selected to prevent or mitigate the risk of RCSTS subsurface leaks that result in pools. These controls are unique to the RCSTS. The controls for the RCSTS pressure relief valve and rupture disk will be added to the TSR document after RL approval for transfers through WT-SLL-3160 is granted. The TSRs identified in FSAR Table 3.4.2.8-5, "Summary of Technical Safety Requirement Controls for Subsurface Leak Resulting in Pool," regarding the transfer pump administrative lock controls, transfer leak detection systems, transfer controls, and emergency response procedures are also applicable to the RCSTS.

Defense-in-Depth. There are no new Defense-in-Depth controls identified for the RCSTS. The Defense-in-Depth control identified in FSAR Table 3.4.2.8-6, "Summary of Defense-in-Depth Controls for Subsurface Leak Resulting in Pool," regarding encasement leak detectors is also applicable to the RCSTS.

Table 3.4.2.19-1. New Safety Structures, Systems, and Components for RCSTS Subsurface Leak Resulting in Pool.

Structure, Systems, or Components	SC	SS	Safety Function	Comments
RCSTS pressure relief valve and rupture disk	X		Precludes overpressurizing existing piping downstream of RCSTS	Protects FSAR assumptions/ analysis for existing piping
Transfer leak detector and interlock to transfer pump(s) or alarm	X		Detect the presence of leaks in diversion box 6241-A or vent station 6241-V and to either provide an alarm to alert operators to take mitigative action, or provide an interlock to shut down transfer pump operation to limit the volume of the waste spilled to 6241-A or 6241-V	

Note that this is the new safety SSC that is unique to the RCSTS. All SSCs identified in FSAR Table 3.4.2.8-4 are still applicable.

Table 3.4.2.19-2. New Technical Safety Requirements Controls for RCSTS Subsurface Leak Resulting in Pool.

Control	Safety Function	Comments
RCSTS pressure relief valve and rupture disk	Ensure pressure relief valve and rupture disk are operable during transfers	Protects FSAR assumptions and analysis for existing piping downstream of the RCSTS
Transfer leak detection systems and interlock to transfer pump(s) or alarm	Ensure leak detectors and their interlocks or alarms are operable during transfers	

Note that this is the new TSR that is unique to the RCSTS. All Technical Safety Requirement Controls listed in FSAR Table 3.4.2.8-5 are still applicable.

3.4.2.20 Spray Leak In the RCSTS.

Purpose of Analysis: A breach of containment during a transfer through the RCSTS could result in a pressurized spray release. These spray releases are a safety concern because, depending on the waste pressure and leak dimensions, they can be relatively efficient generators of respirable-sized aerosols.

Analysis Strategy: Spray leaks have been analyzed in the FSAR for existing transfer routes, but not for the RCSTS, which was an ongoing project outside the FSAR scope. A spray leak in a valve pit was analyzed as the bounding case in the FSAR. The RCSTS adds two new structures, diversion box 6241-A and vent station 6241-V, that were not considered in the FSAR analysis. (Note that the end points of the RCSTS, valve pits 241-SY-A and 241-SY-B in the 200 West Area and the 244-A lift station in the 200 East Area, are existing facilities for which the FSAR analysis is bounding.) Thus, for the RCSTS, spray leaks were evaluated in the two RCSTS structures, with diversion box 6241-A providing the bounding case.

The scenario where a subsurface leak in the RCSTS washes away the soil and results in a surface pool is analyzed in Section 3.4.2.19 of this addendum. RCSTS spray leaks caused by excavation activities are addressed in Section 3.4.2.21, and RCSTS spray leaks caused by a seismic event are addressed in Section 3.4.2.23.

3.4.2.20.1 Accident Scenario Assuming No Controls.

Sequence of Events. The RCSTS spray leak accident scenario assumes that the spray leak develops in diversion box 6241-A as a result of a leak in the piping or a valve. The spray leak is postulated to occur with the diversion box entry door and pipe penetrations open, so that no credit is taken for the HEPA filter or the diversion box structure. The event duration (24 hours) and offsite receptor exposure time is the same as in the FSAR (24 hours). For the onsite receptor the exposure time is 12 hours (the exposure time previously used in the BIO), which differs from the FSAR which uses 10 minute exposure time because of an assumed self-evacuation). The event frequency is also the same as in the FSAR (i.e., "anticipated"). Because only the supernate line, WT-SNL-3150, is authorized for operation, the spill is assumed to be aging waste supernate (5 vol% solids and 95 vol% liquids).

Results Summary. The onsite and offsite radiological and toxicological consequences for the RCSTS spray leak accident assuming no controls and the comparison to risk guidelines are shown in Table 3.4.2.20-I. Supporting calculations are documented in HNF-2542.

Implication of Results. For the RCSTS spray leak, the onsite and offsite radiological and the onsite toxicological consequences exceed the risk guidelines. Therefore, controls are required.

3.4.2.20.2 Accident Scenario Assuming Controls

Sequence of Events. The sequence of events for a spray leak in the RCSTS with controls was developed to be consistent with the BIO, and is significantly different (and more conservative) than the analysis in the FSAR. Unlike the FSAR analysis, no credit is taken for the leak detection system terminating the event. The leak is assumed to occur in diversion box 6241-A, instead of a valve pit. The entry doors and pipe penetrations (air sample line, exhauster hookup, liner washdown system, and emergency pumpout line) are credited with being sealed and therefore the majority (90%) of the airborne release passes through a HEPA filter, which is credited with reducing the source term. The presence of the HEPA filter represents a major difference from the FSAR (where the analyzed valve pit has no HEPA filter). Another major difference is that the material spilled is aging waste supernate (5 vol% solids, 95 vol% liquids). There are two FSAR assumptions that remain the same for the RCSTS. The concentration of respirable-sized particles is assumed to be 100 mg/m^3 and the frequency of the event with controls is also assumed to be "anticipated."

Results Summary. The radiological and toxicological consequences of a spray leak in the RCSTS are presented in Table 3.4.2.20-2 and the associated calculations are documented in HNF-2542.

Implication of Results. The offsite and onsite radiological and toxicological consequences of the spray leak in the RCSTS assuming controls are below the risk guidelines.

3.4.2.20.3 Key Assumptions. Key assumptions are presented below.

Important to Accident Frequency. There are no key assumptions associated with the frequency of the RCSTS spray leak.

Important to Accident Consequences. The important assumptions with an impact on consequences for the RCSTS, which differ from those used in the FSAR, are as follows:

- The material spilled is aging waste supernate (5 vol% solids, 95 vol% liquids).
- For the scenario without controls, the RCSTS spray leak is assumed to occur at the maximum RCSTS pressure of 8,960 kPa (1,300 psig).
- The entry door and pipe penetrations (air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line) in diversion box 6241-A are sealed.
- The majority (90%) of the airborne release passes through a HEPA filter with an assumed efficiency of 0.99. In addition, the HEPA filter is assumed to be radiologically clean, since it should only be exposed to radionuclides during accident conditions. The remaining 10% of the release is assumed to be unfiltered.

- The pressure relief valve installed in the 244-A lift station precludes the RCSTS from overpressurizing the downstream piping. The pressure relief valve will lift at a preset pressure (1590 kPa [230 psig]) that is equal to the maximum operating pressure of the existing downstream piping. This protects the analysis in the FSAR, for spray leaks, in equipment downstream of the RCSTS. It should also be noted that a rupture disk is located upstream of the relief valve (for ALARA purposes, to allow testing and maintenance of the valve) and will rupture at a preset pressure to allow the relief valve to perform its safety function.

3.4.2.20.4 Controls. The following new controls are applicable to the RCSTS. It is important to note that these controls are an addition to the controls already listed in the FSAR. These RCSTS controls have been added to the consolidated list of controls presented in Table 3.3.2.3.2-1 of the FSAR.

Safety Structures, Systems, and Components. Table 3.4.2.20-3 lists the Safety-Class and Safety-Significant structures, systems, and components selected to prevent or mitigate the risk of RCSTS spray leaks. These SSCs are unique to the RCSTS. The RCSTS pressure relief valve and rupture disk are only applicable to transfers through line WT-SLL-3160. Other Safety-Class and Safety-Significant structures, systems, and components are identified in FSAR Table 3.4.2.9-3, "Summary of Safety Structures, Systems, and Components for Spray Leaks in Structure or From Waste Transfer System." The Safety-Class designations for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes, and the pressure switch interlock or alarm systems (to prevent waste backflow to the flush system) is applicable to the RCSTS. Per agreement with DOE-ORP, the Safety-Class designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

Technical Safety Requirements. Table 3.4.2.20-4 lists the new TSRs selected to prevent or mitigate the risk of RCSTS spray leaks. These controls are unique to the RCSTS. The controls for the RCSTS pressure relief valve and rupture disk will be added to the TSR document after RL approval for transfers through WT-SLL-3160 is granted. Other TSRs are identified in FSAR Table 3.4.2.9-4, "Summary of Technical Safety Requirement Controls for Spray Leaks in Structure or From Waste Transfer Lines." The TSRs regarding the transfer pump administrative lock controls, transfer controls, service water pressure detection systems (to prevent waste backflow to the flush system), and the HEPA filter control program are applicable to the RCSTS.

Defense-in-Depth. There are no new Defense-in-Depth controls identified for the RCSTS. The existing Defense-in-Depth controls identified for spray leaks in FSAR Table 3.4.2.9-5, "Summary of Defense-in-Depth Controls for Spray Leaks in Structure or From Waste Transfer Lines," are applicable to the RCSTS.

Table 3.4.2.20-1. Consequences of RCSTS Spray Leak without Controls.

Receptor/Hazard	Calculated dose	Evaluation guidelines "anticipated" frequency
Onsite radiological (RCSTS)	1.93E+02 Sv (1.93E+04 rem)	5 mSv (0.5 rem)
Offsite radiological (RCSTS)	0.27 Sv (27 rem)	1 mSv (0.1 rem)
Onsite Toxicological (RCSTS) sum-of-fractions	291	1 (≤ERPG-1)
Offsite Toxicological (RCSTS) sum-of-fractions	0.49	1 (≤PEL-TWA)

Table 3.4.2.20-2. Consequences of RCSTS Spray Leak with Controls.

Receptor/Hazard	Calculated dose	Evaluation guidelines "anticipated" frequency
Onsite radiological (RCSTS)	2.1 mSv (0.21 rem)	5 mSv (0.5 rem)
Offsite radiological (RCSTS)	1.84E-03 mSv (1.84E-04 rem)	1 mSv (0.1 rem)
Onsite toxicological (RCSTS) sum-of-fractions	2.4E-02	1 (≤ERPG-1)
Offsite toxicological (RCSTS) sum-of-fractions	4E-05	1 (≤PEL-TWA)

Table 3.4.2.20-3. New Safety Structures, Systems, and Components for RCSTS Spray Leaks.

Structure, Systems, or Components	SC	SS	Safety Function	Comments
Entry doors and pipe penetrations for diversion box 6241-A and vent station 6241-V	X		Limit release of aerosols generated by spray inside the structure	
HEPA filter in diversion box 6241-A and vent station 6241-V		X	Limit release of respirable aerosols by filtering	
RCSTS pressure relief valve and rupture disk	X		Precludes overpressurizing existing piping downstream of RCSTS	Protects FSAR assumptions/ analysis for existing piping

Note that these are the new safety SSCs that are unique to the RCSTS. All SSCs identified in FSAR Table 3.4.2.9-3 are still applicable.

Table 3.4.2.20-4. New Technical Safety Requirements Controls for RCSTS Spray Leaks.

Control	Safety Function	Comments
Door and penetrations in diversion box 6241-A and vent station 6241-V	Ensure entry door is shut and air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line are sealed during waste transfers	
RCSTS pressure relief valve and rupture disk	Ensure pressure relief valve and rupture disk are operable during transfers	Protects FSAR assumptions and analysis for existing piping downstream of the RCSTS
HEPA Filter Control Program with the following key elements: • Periodic radiation survey to monitor HEPA filter loading • HEPA filter replacement per change-out criteria, i.e., ≤2 mSv/h (≤200 mrem/h) • Aerosol test upon installation • Periodic aerosol test	HEPA filter monitoring and replacement reduce consequences from a possible HEPA filter failure by limiting the inventory available for release Aerosol testing ensures filtering efficiency of HEPA filter	Applies to the inlet air HEPA filter system in diversion box 6241-A and vent station 6241-V

Note that these are the new TSRs that are unique to the RCSTS. All Technical Safety Requirement Controls listed in FSAR Table 3.4.2.9-4 are still applicable. Also note that the HEPA filters listed in the preceding table are covered under the existing Administrative Control that requires periodic radiation surveillance and filter changeout with accumulations ≤200mrem/h and verification of the nominal particulate removal efficiency (≥99.95%).

3.4.2.21 Spray Leak From Underground Waste Transfer Lines (RCSTS).

Purpose of Analysis: A construction excavation accident could conceivably breach the RCSTS piping and cause a spray leak or a surface leak that results in a pool. It should be noted that to be consistent with the BIO, this Addendum treated spray leaks from underground waste transfer lines as a separate accident. The FSAR treats this scenario within the context of FSAR Sections 3.4.2.7, 3.4.2.8, and 3.4.2.9.

Analysis Strategy: Although this accident has a different initiator (i.e., excavation activities), the result will be either a surface leak or spray leak, which have been previously analyzed. The FSAR analysis concludes that the calculations performed for surface leaks resulting in a pool and spray leaks (assuming no controls) provide the bounding results for the excavation accident. This conclusion is also true for the RCSTS (i.e., the results reported in Sections 3.4.2.18 and 3.4.2.20 are bounding).

3.4.2.21.1 Accident Scenario Assuming No Controls.

Sequence of Events. The FSAR addresses excavation accidents within the context of FSAR Sections 3.4.2.7, 3.4.2.8, and 3.4.2.9. The sequence of events for the RCSTS is the same as that reported for other waste transfer systems in the FSAR.

Results Summary. Because no credit was taken for the confinement of the spray within the RCSTS structure, the onsite and offsite radiological and toxicological consequences for the RCSTS excavation accident are bounded by the consequences calculated for the surface leak resulting in a pool and spray leak accidents in Sections 3.4.2.18.1 and 3.4.2.20.1.

Implication of Results. For the RCSTS surface leak resulting in a pool and spray leak, the onsite and offsite radiological and toxicological consequences exceed the risk guidelines. Therefore, controls are required.

3.4.2.21.2 Accident Scenario Assuming Controls.

Sequence of Events. Controls were selected to prevent the excavation accident by restricting and monitoring excavation activities in the vicinity of waste transfer lines. These controls, imposed in the FSAR, are also applicable to the RCSTS. No additional controls are required.

3.4.2.21.3 Key Assumptions. The key assumptions documented in the FSAR are applicable to the RCSTS. No additional assumptions are required.

3.4.2.21.4 Controls. The existing excavation controls listed in the FSAR are applicable to the RCSTS. One additional Defense-in-Depth control is identified for the RCSTS.

Safety Structures, Systems, and Components. There are no Safety-Class and Safety-Significant structures, systems, and components required for this accident scenario in the FSAR nor are any required for the RCSTS.

Technical Safety Requirements. Tables 3.4.2.7-5, "Summary of Technical Safety Requirement Controls for Surface Leak Resulting in Pool," and 3.4.2.9-4, "Summary of Technical Safety Requirement Controls for Spray Leak in Structure or From Waste Transfer Lines," in the FSAR lists the TSRs selected to prevent leaks initiated by excavation activities. These TSRs identified in the FSAR are applicable to the RCSTS.

Defense-in-Depth. The Defense-in-Depth controls identified in FSAR Tables 3.4.2.7-6, "Summary of Defense-in Depth Controls for Surface Leak Resulting in Pool," and 3.4.2.9-5, "Summary of Defense-in-Depth Controls for Spray Leak in Structure or From Waste Transfer Lines," are applicable to the RCSTS. In addition, the magnetic warning tape that lies above the transfer lines (to warn of the underground piping and conduit) is also a Defense-in-Depth control for the RCSTS.

3.4.2.22 Tank Bump. Tank bumps occur when steam trapped in the waste causes a waste rollover and a rapid pressurization of the tank headspace. This accident is specific to waste tanks and is not applicable to the RCSTS. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.23 Natural Phenomena. Natural phenomena analyzed in the FSAR include high winds, lightning, and earthquakes. The FSAR indicates that seismically induced spray leaks and surface pool leaks present the bounding natural phenomena accident for waste transfer systems. The FSAR further indicates that for waste transfer systems there are no Safety-Class or Safety-Significant structures, systems, and components associated with seismic protection. This statement also applies to the structures, systems, and components of the RCSTS (i.e., none are designated as Safety-Class or Safety-Significant for seismic protection). It should be noted, however, that diversion box 6241-A and vent station 6241-V were designed and constructed as Safety-Class (i.e., to withstand a 0.2 g earthquake), although this feature is not credited in the analysis. Emergency Preparedness controls mitigate the consequences of the seismic event by terminating waste transfers. These controls are listed in FSAR Table 3.4.2.12.3-3, "Summary of Technical Safety Requirement Controls for Natural Phenomena - Seismic," and are applicable to the RCSTS.

3.4.3 Beyond Design Basis Events

An analysis of Beyond Design Basis events is documented in the FSAR.

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4.0 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

The safety classifications for RCSTS structures, systems, and components (SSCs) are presented in the following sections. Safety classifications for TWRS facility SSCs are described in Chapter 4.0, "Safety Structures, Systems, and Components," of the FSAR.

4.1 INTRODUCTION

The controls selected for each accident are described in Chapter 3.0, "Safety Analysis." The selection process follows the SSC classification methodology described in WHC-CM-4-46*, *Nonreactor Facility Safety Analysis Manual*, and Dunford 1996, *Tank Waste Remediation System Final Safety Analysis Report Project Plan Comment Response; Risk-Based Approach.* In addition, the control decision criteria described in Chapter 3.3.1.5, "Controls Identification," of the FSAR are also followed.

The SSCs included in this report are divided into two categories, Safety-Class SSCs and Safety-Significant SSCs. Safety-Class SSCs prevent or mitigate releases to the public that would otherwise exceed the offsite radiological risk guidelines, or prevent a nuclear criticality. Those SSCs that support the safety function of a Safety-Class SSC are also Safety-Class SSCs.

Safety-Significant SSCs prevent or mitigate releases of radiological materials to onsite workers and toxic chemicals to the offsite public and onsite workers. Safety-Significant SSCs also include those safety SSCs that protect the facility worker from serious injury (or fatality) due to hazards not controlled by institutional safety programs. Those SSCs which support the safety function of a Safety-Significant SSC are also Safety-Significant SSCs.

It should be noted that some SSCs of the RCSTS are designated as Safety-Class for one accident and designated as Safety-Significant for a different accident. In conformance with the FSAR, SSCs that serve more than one safety function are classified for the higher function.

4.2 REQUIREMENTS

DOE orders and standards that provide requirements and guidance for safety classification of SSCs are as follows:

- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)

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*Refer to Appendix G, "Sitewide Controlled Manual Cross-Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XXX) superseded by Fluor Daniel Hanford, Inc., procedures (e.g., HNF-PRO-XXX).

- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (1994).

The design codes, standards, and regulations for the safety SSCs are defined in WHC-CM-4-46.

4.3 SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS

This section provides information about the Safety-Class SSCs identified in Chapter 3.0. Table 4-1 provides a summary list of those SSCs.

It is important to note that the 241-SY-A and 241-SY-B valve pits and the 244-A lift station, which are connected to the RCSTS, were evaluated within the scope of the FSAR and therefore Safety-Class and Safety-Significant SSCs that are applicable only to these structures (and not diversion box 6241-A and vent station 6241-V) will not be discussed here, since they are already documented in the FSAR.

4.3.1 Safety-Class SSCs

The following is a summary of SSCs that perform a Safety-Class function for the RCSTS. Safety-Class items that are unique to the RCSTS are described, as well as Safety-Class items that were previously identified in the FSAR but are also applicable to the RCSTS.

The new Safety-Class SSCs identified for the RCSTS are the pressure relief valve and rupture disk, and the diversion box 6241-A and vent station 6241-V entry doors and pipe penetrations (air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line). Safety-Class SSCs, previously identified in the FSAR, that are also applicable to the RCSTS include waste transfer pipe encasements, pressure switch interlocks or alarms (to prevent waste backflow into the flush line), abovegrade portions of process pits, diversion boxes, valves pits, and cleanout boxes, and transfer leak detection systems.

4.3.1.1 Safety Function(s). The reanalyzed accidents in Sections 3.4.2.18, 3.4.2.19, and 3.4.2.20 identified new Safety-Class SSCs. The safety function of the SSCs are listed in Table 4-1.

4.3.1.2 System Descriptions. System descriptions of the Safety-Class SSCs are provided below. Additional descriptions are provided in Section 2.4.1.

4.3.1.2.1 Entry Door and Penetrations on Diversion Box 6241-A and Vent Station 6241-V. Entry doors, shielded by a labyrinth wall on the inside of the pit, allow pit access. In addition, pipes (that penetrate the walls) are provided for an air sample line, an air exhauster hookup, liner washdown system, and an emergency pumpout line on both RCSTS structures. The door is verified to be closed and the pipe penetrations sealed prior to commencing waste transfers. The safety function of the entry door and pipe penetrations (air sampling line, exhauster hookup, liner washdown system, and emergency

pumpout line), credited in the spray leak in the RCSTS structures, is to provide a physical barrier in case of a spray release during a transfer.

4.3.1.2.2 RCSTS Pressure Relief Valve. Two pressure relief valves are located on the boosted line in the 244-A Lift Station. This provides protection from a single failure of a valve failing to lift. The valves are set to relieve at 1,590 kPa (230 psig). The safety function of the RCSTS pressure relief valve, credited in spray leak in structures or from overground lines, surface leak resulting in pool, and subsurface leak resulting in pool accident analyses, is to lift at a preset pressure that is equal to the maximum operating pressure of the existing downstream piping. This precludes overpressurizing the downstream piping connected to the RCSTS and thereby protects the existing accident analysis in the FSAR. The rupture disk is located upstream of the relief valve and must rupture at a preset pressure to allow the relief valve to perform its safety function.

4.3.1.2.3 Rupture Disk. A rupture disk is installed upstream from (and in line with) each of the pressure relief valves noted above. Because the rupture disk isolates the pressure relief valve (for maintenance and testing purposes) it is also a Safety-Class item. The rupture disks must fail at the designated pressure of 1,590 kPa (230 psig) to preserve the Safety-Class function of the pressure relief valve.

4.3.1.2.4 Other RCSTS Safety-Class SSCs Identified in FSAR. The following Safety-Class SSCs have been identified in the FSAR (for other waste transfer systems) and are also applicable to the RCSTS.

- **Pressure Switch Interlocks or Alarms.** (Section 4.3.6, "Pressure Switch Interlocks or Alarms" of the FSAR.) The pressure switch, between the two valves in the 241-SY-A valve pit that serve to isolate the RCSTS from the interconnected flush system, is covered by this Safety-Class designation. During waste transfer operations the valves are closed to isolate the flush system from the transfer system. If waste leaks by the first valve during transfer operations, then the rise in pressure will be detected and an alarm will be actuated and the interlock will shut down the transfer pump. When the transfer system is being flushed, the pressure of the flush water is above the pressure switch setpoint thus ensuring that the transfer pump is in the shut down condition. The safety function of the pressure switch interlocks to waste transfer pumps, credited in the spray leak in structures and surface leak resulting in pool accident analyses, is to prevent backflow of waste into interconnecting systems.

- **Transfer Leak Detection Systems.** (Section 4.3.17, "Transfer Leak Detection Systems," of the FSAR.) Leak detection conductivity probes are located at a low-point sump in the diversion box and vent station to provide an indication of a leak. The safety function of the transfer leak detection system, credited in the FSAR for the surface leak resulting in pool accident and the RCSTS subsurface leak resulting in pool accident, is to detect waste accumulation in the pits (when 51 mm [2 in.] have accumulated) and provide a transfer pump auto stop or alarm function.

The RCSTS transfer leak detectors are described in Section 2.4.1.2 of this addendum.

- **Waste Transfer Pipe Encasements.** (Section 4.3.5, "Pipe Encasements," of the FSAR.) The safety function of the pipe encasements, credited in the subsurface leak resulting in pool accident, is to ensure that a leak in the primary waste transfer system piping is directed to a waste transfer-associated structure. This Safety-Class designation also applies to the RCSTS.

  The waste transfer pipe encasements are described in Section 2.4.1 of this addendum.

- **Abovegrade Portions of Process Pits, Diversion Boxes, Valve Pits, and Cleanout Boxes.** (Section 4.3.23, "Abovegrade Portions of Process Pits, Diversion Boxes, Valve Pits, and Cleanout Boxes," of the FSAR.) The safety functions of the aboveground portions of process pits, diversion boxes, valve pits, and cleanout boxes, credited in the surface leak resulting in pool accident, are to provide an intact boundary for the leaked waste, and when leak detector alarms and appropriate operator response times to stop the transfer are credited, to prevent premature structure overflow and the formation of a surface pool. For the spray leak in structures accident the credited safety functions are to provide an impaction surface that prevent a waste leak from jetting directly into the atmosphere and to limit the release of aerosols to the atmosphere by means of tortuous air passages between adjacent surfaces that promote impingement and condensation. This Safety-Class designation also applies to Diversion Box 6241-A and Vent Station 6241-V. Per agreement with DOE-ORP, the Safety-Class designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

  The RCSTS waste transfer structures (Diversion Box 6241-A and Vent Station 6241-V) are described in Sections 2.4.1.3, 2.4.1.4, and 2.6 of this addendum.

4.3.1.3 Functional Requirements. The functional requirements are listed in Table 4-1.

4.3.1.4 System Evaluation. The system evaluation for performance criteria for TSRs are listed in Table 4-1.

4.3.1.5 Controls (TSRs). The controls required to support the new Safety-Class SSCs for the RCSTS (i.e., entry doors and pipe penetrations on diversion box 6241-A and vent station 6241-V, pressure relief valves/rupture disks in the 244-A lift station, and transfer leak detection systems) are described in HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*. Controls for the Safety-Class SSCs that are applicable to the RCSTS (but have already been identified for other waste transfer systems) are described in Chapter 4.0 of the FSAR. These SSCs include pressure switch interlocks or alarms, transfer leak detection systems, pipe encasements, and

aboveground portions of process pits, diversion boxes, valve pits, and cleanout boxes. Per agreement with DOE-ORP, the Safety-Class designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

4.4 SAFETY-SIGNIFICANT STRUCTURES, SYSTEMS, AND COMPONENTS

This section provides information about the Safety-Significant SSCs identified for the RCSTS in Chapter 3.0. Table 4-2 provide a summary list of those SSCs.

4.4.1 Safety-Significant SSCs

The following is a summary of SSCs that perform a Safety-Significant function for the RCSTS. Safety-Significant items that are unique to the RCSTS are described, as well as Safety-Significant items that were previously identified in the FSAR but are also applicable to the RCSTS.

The new Safety-Significant SSCs identified for the RCSTS are the diversion box 6241-A and vent station 6241-V entry doors and pipe penetrations (air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line) and the inlet HEPA filter unit on the diversion box and vent station. Safety-Significant SSCs, previously identified in the FSAR, that are also applicable to the RCSTS include tank level detection systems, waste transfer pipe encasements, transfer leak detection systems, and abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes. Per agreement with DOE-ORP, the Safety-Significant designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

4.4.1.1 Safety Function(s). The reanalyzed accidents in Sections 3.4.2.18, 3.4.2.19, and 3.4.2.20 identified new Safety-Significant SSCs. The safety functions of the SSCs are listed in Table 4-2.

4.4.1.2 System descriptions. System descriptions of the Safety-Significant SSCs are provided below. Additional descriptions are provided in Section 2.4.1.

4.4.1.2.1 Entry Door and Penetrations on Diversion Box 6241-A and Vent Station 6241-V. Entry doors, shielded by a labyrinth wall on the inside of the pit, allow pit access. In addition, pipes (that penetrate the walls) are provided for an air sample line, an air exhauster hookup, liner washdown system, and an emergency pumpout line on both RCSTS structures. The door is verified to be closed and the pipe penetrations sealed prior to commencing waste transfers. The safety function of the entry door and pipe penetrations (air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line), credited in the surface leak resulting in pool accident analysis for the RCSTS, is to limit release of aerosols generated by splatter inside the structure.

4.4.1.2.2 High-Efficiency Air Filters on Diversion Box 6241-A and Vent Station 6241-V. The HEPA filter in the diversion box and vent station are credited with providing an efficiency of 0.99 in the analysis of pool leaks and spray leaks. The actual HEPA filter efficiency is 0.999, but because moisture can degrade filter performance, an efficiency of 0.99 is conservatively used in the analysis. The safety function of the HEPA filters, credited in spray leak in structures and surface leak resulting in pool accident analyses for the RCSTS, is to remove respirable airborne particulates from the airborne release and thereby reduce the inhalation dose to the onsite receptor and facility worker.

4.4.1.2.3 Other RCSTS Safety-Significant SSCs Identified in FSAR. The following Safety-Significant SSCs have been identified in the FSAR and are also applicable to the RCSTS.

- **Tank Level Detection Systems.** (Section 4.4.9, "Tank Level Detection Systems," of the FSAR.) The safety function of the level monitors credited in the RCSTS subsurface leak remaining subsurface, subsurface leak resulting in pool, and surface leak resulting in pool accidents, is to indicate the waste level in the tank to support mass balance calculations during waste transfers.

  The tank level detection systems are described in Section 4.4.9.2, "System Description," of the FSAR.

- **Waste Transfer Pipe Encasements.** (Section 4.4.6, "Pipe Encasements," of the FSAR.) The safety function of the pipe encasements credited in the subsurface leak remaining subsurface accident is to ensure that a leak in the primary waste transfer system piping is directed to a waste transfer-associated structure.

  The waste transfer pipe encasements are described in Section 2.4.1. of this addendum.

- **Transfer Leak Detection Systems.** (Section 4.4.11, "Transfer Leak Detection Systems," of the FSAR.) Leak detection conductivity probes are located at a low-point sump in the diversion box and vent station to provide an indication of a leak. The safety function of the transfer leak detection system, credited in the FSAR for the subsurface leak remaining subsurface accident, is to detect waste accumulation in the pits (when 51 mm [2 in.] have accumulated) and provide a transfer pump auto stop or alarm function.

  The RCSTS transfer leak detectors are described in Section 2.4.1.2 of this addendum.

- **Abovegrade Portions of Process Pits, Diversion Boxes, Valve Pits, and Cleanout Boxes.** (Section 4.4.14, "Abovegrade Portions of Process Pits, Diversion Boxes, Valve Pits, and Cleanout Boxes," of the FSAR.) The safety functions of the aboveground portions of process pits, diversion boxes, valve pits, and cleanout boxes, credited in the surface leak resulting in pool accident, are to limit the aerosol release generated by waste leak splattering and

splashing in waste transfer structures and to limit the shine dose form the waste leak. For the subsurface leak resulting pool accident the credited safety functions are to provide an intact boundary for the leaked waste, and when leak detector alarms and appropriate operator response times to stop the transfer are credited, to prevent premature structure overflow and the formation of a surface pool. This Safety-Significant designation also applies to Diversion Box 6241-A and Vent Station 6241-V. Per agreement with DOE-ORP, the Safety-Significant designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

4.4.1.3 Functional Requirements. The functional requirements are listed in Table 4-2.

4.4.1.4 System Evaluation. The system evaluation for performance criteria for TSRs are listed in Table 4-2.

4.4.1.5 Controls (TSRs). The controls required to support the new Safety-Significant SSCs for the RCSTS (i.e., entry doors and penetrations on diversion box 6241-A and vent station 6241-V, and HEPA filters on the diversion box and vent station) are described in HNF-SD-WM-TSR-006. Controls for the Safety-Significant SSCs that are applicable to the RCSTS (but have already been identified for other waste transfer systems) are described in Chapter 4.0 of the FSAR. These SSCs include tank level detection systems, pipe encasements, transfer leak detection systems, and aboveground portions of process pits, diversion boxes, valve pits, and cleanout boxes. Per agreement with DOE-ORP, the Safety-Significant designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

Table 4-1. New RCSTS Safety-Class Structures, Systems, and Components Summary. (2 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria for TSRs
Diversion Box 6241-A and Vent Station 6241-V Entry Doors and Penetrations (4.3.1.2.1)	Spray Leak in Structure or from Overground Waste Transfer Lines (3.4.2.20)	The safety function of the diversion box and vent station entry doors and pipe penetrations is to provide a physical barrier in case of a spray leak during a transfer and thereby limit the release of aerosols and the subsequent dose to the offsite receptor.	The entry door and pipe penetrations must confine direct spray leaks to the inside of the structure. The entry door assemblies shall seal fit the structure, so that there are no paths for a direct spray leak or aerosol release to the atmosphere. The pipe penetrations must also be capable of being sealed during waste transfers.	The door assembly shall be visually inspected prior to a waste transfer to ensure that the door is closed and operable. The pipe penetrations for the air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line are also verified to be flanged or capped prior to commencing waste transfers.
Pressure Relief Valve (4.3.1.2.2)	Surface Leak Resulting in Pool (3.4.2.18) Subsurface Leak Resulting in Pool (3.4.2.19) Spray Leak in Structure or from Overground Waste Transfer Lines (3.4.2.20)	The safety function of the pressure relief valve is to prevent overpressurization of the piping downstream from the RCSTS. This protects the assumptions used in the FSAR accident analyses, which did not account for interfaces with the RCSTS.	The pressure relief valve shall relieve at a pressure of 1590 kPa (230 psig).	Prior to waste transfers (utilizing the booster pump), it shall be verified that the pressure relief valve has not relieved and is operable. It should be noted that this control is not required until transfers utilizing the booster pumps are initiated.

Table 4-1. New RCSTS Safety-Class Structures, Systems, and Components Summary. (2 sheets)

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria for TSRs
Rupture Disk (4.3.1.2.3)	Surface Leak Resulting in Pool (3.4.2.18) Subsurface Leak Resulting in Pool (3.4.2.19) Spray Leak in Structure or from Overground Waste Transfer Lines (3.4.2.20)	The safety function of the rupture disk is to fail and thereby allow the pressure relief valve to perform its Safety-Class function of preventing overpressurization of the piping downstream from the RCSTS.	The rupture disk shall fail at a pressure of 1590 kPa (230 psig).	Prior to waste transfers (utilizing the booster pump), it shall be verified that the rupture disk has not failed and is operable. It should be noted that this control is not required until transfers utilizing the booster pumps are initiated.

Note: The other Safety-Class SSCs that are applicable to the RCSTS (i.e., pressure switch interlocks or alarms, transfer leak detection systems, waste transfer line encasements, and abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes) have been previously identified in the FSAR. Per agreement with DOE-ORP, the Safety-Class designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

Table 4-2. New Safety-Significant Structures, Systems, and Components Summary.

SSC	Accident(s)	Safety functions	Functional requirements	Performance criteria for TSRs
Diversion Box 6241-A and Vent Station 6241-V Entry Doors and Penetrations (4.4.1.2.1)	Surface Leak Resulting in a Pool (3.4.2.18)	The safety function of the diversion box and vent station entry doors and pipe penetrations is to provide a barrier to limit the release of aerosols generated by splatter during a pool leak accident and thereby limit the subsequent dose to the onsite receptor.	The entry door and pipe penetrations must confine aerosols to the inside of the structure. The entry door assemblies shall seal fit the structure, so that there are no paths for a direct aerosol leak to the atmosphere. The pipe penetrations must also be capable of being sealed during waste transfers.	The door assembly shall be visually inspected prior to a waste transfer to ensure that the door is closed and operable. The pipe penetrations for the air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line are also verified to be flanged or capped prior to commencing waste transfers.
Inlet Air HEPA Unit (4.4.1.2.2)	Spray Leak in Structure or from Overground Waste Transfer Lines (3.4.2.20) Surface Leak Resulting in Pool (3.4.2.18)	The safety function of the diversion box and vent station ventilation system HEPA filter unit is to provide filtration of aerosols generated by splatter or by direct spray releases within the pits.	The HEPA filter radiation level is less than or equal to 200 mrem/hr on contact. The HEPA filter nominal particulate removal efficiency is at least 99.95%.	Operability of the HEPA filter units is verified at the time of installation and annually thereafter using a challenge aerosol.

Note: The other Safety-Significant SSCs that are applicable to the RCSTS (i.e., tank level monitors, waste transfer line encasements, transfer leak detection systems, abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes) have been previously identified in the FSAR. Per agreement with DOE-ORP, the Safety-Significant designation for the abovegrade portions of process pits, diversion boxes, valve pits, and cleanout boxes is not effective until March 30, 2000.

5.0 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 INTRODUCTION

The existing operating envelope for the Tank Waste Remediation System (TWRS) is defined by the Technical Safety Requirements (TSRs) listed in Chapter 5.0 of the Final Safety Analysis Report (FSAR). These controls are implemented through HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, which was prepared using the guidance of DOE 5480.22, *Technical Safety Requirements*. The purpose of this chapter is to identify the additional TSRs that bring the RCSTS within the TWRS safety envelope. The new TSRs have been added to HNF-SD-WM-TSR-006.

5.2 REQUIREMENTS

The DOE Orders required for establishing the safety basis of the RCSTS are listed below.

- DOE 5480.22, *Technical Safety Requirements*, Change 2, (1996)
- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994).

The documents used to implement the DOE Order requirements include:

- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (1994)
- WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (1989)
- HNF-SD-WM-HSP-002, *Tank Farms Health and Safety Plan* (1998).

5.3 TECHNICAL SAFETY REQUIREMENT COVERAGE, AND DERIVATIONS

The accident analysis in Chapter 3.0, along with the designation of safety SSCs and the associated TSRs in Chapter 4.0, indicated that operation of the RCSTS adds several new TSRs to the TWRS facility.

The new or modified controls are discussed below. Other Safety-Class and Safety-Significant SSCs identified for the RCSTS are not unique and are covered by TSRs previously identified in the FSAR.

5.3.1 AC 5.7 Nuclear Criticality Safety

The RCSTS has the capability to transfer wastes with up to a 30 vol% solids content. The intentional redistribution of solids in waste tanks (which would result from the transfer of a slurry with a high solids content) is not considered a routine activity and must be evaluated on a case by case basis. Therefore, a new control is added to AC 5.7 to require that a

Criticality Safety Evaluation Report be completed prior to initiating transfers of waste slurries with high solids content through the RCSTS.

5.3.2 AC 5.18 HEPA Filter Controls

Each of the two RCSTS structures (diversion box 6241-A and vent station 6241-V) is passively ventilated with a HEPA filter. The accident analysis for the Surface Leak Resulting in Pool and Spray Leak in Structure accidents assumes that 90% of the airborne release passes through a HEPA filter with an assumed efficiency of 0.99. Because this filtering reduces the onsite consequences to below the risk evaluation guidelines, the HEPA filters are designated as Safety-Significant. Therefore, to protect the assumptions in the accident analysis, the applicability of AC 5.18 is extended to include the HEPA filters in diversion box 6241-A and vent station 6241-V. AC 5.18 requires that the filters be monitored periodically to verify that the radiation level is less than or equal to 200 mrem/h on contact and be tested annually to verify an efficiency of greater than or equal to 99.95%.

5.3.3 LCO 3.1.1 Transfer System Covers and Entry Doors

The two new RCSTS structures (diversion box 6241-A and vent station 6241-V) are designed differently than the existing waste transfer structures and will use an entry door for routine access instead of concrete covers. Therefore, LCO 3.1.1 is modified to include the entry doors for diversion box 6241-A and vent station 6241-V. The entry door will be verified to be closed prior to commencing waste transfers. In addition, both structures have several pipes (i.e. air sampling line, exhauster hookup, liner washdown system, and emergency pumpout line) that penetrate the concrete walls. These are also added to LCO 3.1.1 to ensure that the lines are either flanged or capped prior to commencing waste transfers. The purpose of these controls is to provide a barrier for aerosols that could potentially be generated from spray leaks or from splatter during pool leak events.

5.3.4 LCO 3.1.3 RCSTS Transfer Leak Detection System

The accident analysis for the RCSTS Subsurface Leak Resulting in Pool accident assumes that the subsurface leaks will drain through the encasement to a waste transfer structure where the RCSTS transfer leak detection system will detect the leak and either provide an alarm to alert operators to take mitigative action, or provide an interlock to shut down transfer pump operation, thus limiting the volume of the waste leaked. Because the accident without controls results in unacceptable offsite consequences, the RCSTS transfer leak detection system is designated as Safety-Class. LCO 3.1.3, which applies to all process pits and diversion boxes, will ensure operability of the RCSTS transfer leak detection system.

5.3.5 LCO 3.1.5 Replacement Cross-Site Transfer System PRV and Rupture Disk

The RCSTS piping is designed for a higher pressure than the piping to which it is interconnected at the 244-A lift station. Therefore, pressure relief valves are installed in the 244-A lift station and are designed to lift at 1590 kPa (230 psig). This is equivalent to the maximum operating pressure of the existing downstream piping. The Safety-Class designation and accompanying Limiting Condition for Operation (LCO) are required to preclude introducing new potential accident initiators (from overpressurization) for the piping systems previously analyzed in the FSAR. A rupture disk is located immediately upstream of and in line with each relief valve to keep the valves from becoming contaminated under normal conditions and thereby facilitates valve calibration and maintenance. At a pressure of 1590 kPa (230 psig), the rupture disks will rupture, an alarm will activate at the operator control station, and the relief valves will discharge into the 244-A catch tank. LCO 3.1.5 will verify operability of these relief devices.

Note: Transfers through replacement cross-site transfer line WT-SLL-3160 are not authorized (Wagoner 1997, Contract Number DE-AC06-96RL13200; *Approval of Authorization Basis [AB] Amendment Package for Project W-058, Replacement Cross-Site Transfer System*). LCO 3.1.5 will be added to HNF-SD-WM-TSR-006 after DOE-RL approval for transfers through line WT-SLL-3160 is granted.

5.4 DERIVATION OF FACILITY MODES

The operational modes for the TWRS facility are defined in the Technical Safety Requirements document. Operation of the RCSTS does not change any of these definitions of facility operating modes.

5.5 INTERFACE WITH TSRs FROM OTHER FACILITIES

The TSRs for the RCSTS are contained within the TSRs for TWRS.

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6.0 PREVENTION OF INADVERTENT CRITICALITY

This chapter contains information on prevention of inadvertent criticality as a result of the installation and/or operation of the replacement cross-site transfer system (RCSTS). Further information on the criticality safety and protection program for the Tank Waste Remediation System (TWRS) facility is provided in Chapter 6.0 "Prevention of Inadvertent Criticality," of the FSAR. The program ensures that sufficient controls are in place to prevent inadvertent nuclear criticality excursions in the TWRS facilities.

6.1 REQUIREMENTS

See Section 6.2 "Requirements," of the FSAR for requirements.

6.2 FACILITY IMPLEMENTATION

Prior to any slurry transfers through the RCSTS with waste tank solids, a Criticality Safety Evaluation Report will be issued which addresses the suspension of solids in the sending tank and the particle segregation after settling in the sending and receiving tanks. See Chapter 6.0 of the TWRS FSAR for facility implementation.

6.3 PROJECT IMPLEMENTATION

Project implementation is achieved by requiring the Criticality Safety Evaluation Reports discussed in Section 6.2 above. See Chapter 3.0, Section 3.4.2.1 for further discussion on criticality.

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7.0 RADIATION PROTECTION

This chapter identifies the requirements for radiation protection as a result of the installation and operation of the replacement cross-site transfer system (RCSTS).

7.1 REQUIREMENTS

See Section 7.2, "Requirements," of the FSAR for the requirements.

7.2 FACILITY IMPLEMENTATION

See Chapter 7.0, "Radiation Protection" of the TWRS FSAR for facility implementation.

7.3 PROJECT IMPLEMENTATION

Because of the anticipated dose rates, the diversion box and vent station pits will be considered high radiation zones during all waste transfers and the entry doors will be locked. Procedural controls on physical access to high radiation zones require the person-in-charge to account for all personnel who have entered the high radiation area and to verify that all personnel have exited prior to placing the locks.

Entry will not normally be allowed to diversion box 6241-A or vent station 6241-V when waste is in the transfer line (i.e., during waste transfers or before the line has been flushed, after a transfer is complete). Entry, when waste is in the line, will only be allowed after management review and concurrence or in case of emergency. No other project-specific requirements related to radiation protection were identified for the RCSTS.

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8.0 HAZARDOUS MATERIAL PROTECTION

This chapter identifies the requirements for hazardous material protection other than radiological hazards for the replacement cross-site transfer system (RCSTS).

8.1 REQUIREMENTS

See Section 8.2, "Requirements," of the FSAR for the requirements.

8.2 FACILITY IMPLEMENTATION

See Chapter 8.0 "Hazardous Material Protection," of the FSAR for facility implementation.

8.3 PROJECT IMPLEMENTATION

No project-specific requirements related to hazardous material protection were identified for the RCSTS.

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9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

This chapter lists the requirement documents for the radiological and hazardous waste management for the replacement cross-site transfer system (RCSTS).

9.1 REQUIREMENTS

See Section 9.2, "Requirements," of the FSAR for the requirements.

9.2 FACILITY IMPLEMENTATION

See Chapter 9.0, "Radioactive and Hazardous Waste Management," of the FSAR for facility implementation.

9.3 PROJECT IMPLEMENTATION

Slightly contaminated flush water is the only additional waste that is expected to be generated through operation of the RCSTS. No additional requirements relating to radioactive and hazardous waste management were identified for the RCSTS.

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10.0 INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

This chapter identifies the requirements for testing, surveillance, and maintenance for the replacement cross-site transfer system (RCSTS) and the implementing program documents.

10.1 REQUIREMENTS

See Section 10.2, "Requirements," of the FSAR for the requirements.

10.2 FACILITY IMPLEMENTATION

See Chapter 10.0, "Initial Testing, In-Service Surveillance, and Maintenance," of the FSAR for facility implementation.

10.3 PROJECT IMPLEMENTATION

10.3.1 Initial Testing

The RCSTS is a new system and must be tested prior to becoming fully operational. A detailed test plan, HNF-SD-W058-SUP-002, *Project W058 Startup Test Plan*, describes the overall testing activities. These are summarized below.

10.3.1.1 Factory Acceptance Testing. Factory acceptance tests are performed by the vendor on the booster pumps and the monitor and control system.

10.3.1.2 Construction Acceptance Testing. Acceptance tests are conducted by the equipment vendors and the construction contractor to demonstrate compliance with fabrication, assembly, installation, and construction requirements as identified in the procurement and construction specifications.

10.3.1.3 Preoperational Testing. Preoperational testing includes testing of components, subsystems, and system operation to verify setpoints for alarms, control functions, and normal operating values for system parameters.

10.3.1.4 Operational Testing. Operational testing will be performed by operations personnel coincident with initial process operations. Testing will verify the design function of the systems in the actual operating environment.

10.3.2 In-Service Surveillance

Procedures for in-service surveillance testing will be developed in accordance with DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities.*

10.3.3 Maintenance

Procedures for maintenance will be developed in accordance with DOE 5480.19.

11.0 OPERATIONAL SAFETY

This chapter identifies requirements for conduct of operations, fire protection, and the implementing program documents resulting from the operation of the replacement cross-site transfer system (RCSTS).

11.1 REQUIREMENTS

See Section 11.2, "Requirements," of the FSAR for the requirements.

11.2 FACILITY IMPLEMENTATION

See Chapter 11.0, "Operational Safety," of the FSAR for facility implementation.

11.3 PROJECT IMPLEMENTATION

No project-specific requirements related to fire protection were identified for the RCSTS. It was concluded in WHC-SD-W058-PHA-001 that a fire protection system for the RCSTS is not required. Normal fire safety practices will be followed.

One operational safety concern, related to the pit entry doors, has been identified for the diversion box and the vent station. This concern is actually twofold and involves ensuring free and unobstructed egress when the structure is occupied and preventing inadvertent entrapment when the doors are closed and locked prior to initiating waste transfers.

The situation where the structures are occupied is considered first. Because of the mass of the doors and the attendant forces required for opening, industrial safety requirements (as described in 29 CFR 1910, "Occupational Safety and Health Standards", DOE 5480.7A[1], *Fire Protection*, and NFPA 101, *Life Safety Code*) mandate that the doors be locked or blocked in the open position when the pits are occupied. Signs indicating this requirement are posted in both the diversion box and vent station. Adherence to posted personnel protection requirements is mandated through operating procedures.

The entrapment concern arises when the entry doors are closed and locked prior to waste transfers. This concern derives from the structure design which includes a corridor that runs between the entry door and the pit and precludes visual contact with the pit for an operator standing at the door. Prevention of inadvertent entrapment is achieved through maintaining personnel accountability and verifying that the area is unoccupied prior to placing the locks as will be described below.

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[1]Although DOE 5480.7A has been rescinded, the contractor is obligated by the existing contract to meet the requirements stated in this order.

As noted in Chapter 7.0 of this addendum, the diversion box and vent station pits will be considered high radiation zones during waste transfers and the entry doors will be locked. This posting and locking of the doors will occur before initiating any waste transfer. Radiological protection procedures also require that the area be verified to be unoccupied prior to placing the locks.

Additional programmatic controls also protect against the entrapment scenario. The diversion box and vent station will be procedurally defined as hazardous facilities and thus be subject to hazardous facility access controls. Per procedure, access control to hazardous facilities is maintained by the shift manager. These procedures require that the shift manager be notified prior to entry of the facility and upon final exit and securing of the facility.

As discussed above, personnel accountability in the diversion box and vent station pits is maintained through two different sets of controls: radiological protection controls and hazardous facility access controls. These controls provide dual and independent levels of protection against inadvertent entrapment.

12.0 PROCEDURES AND TRAINING

This chapter lists the requirements for the procedures and training programs for the replacement cross-site transfer system (RCSTS).

12.1 REQUIREMENTS

See Section 12.2, "Requirements," of the FSAR for the requirements.

12.2 FACILITY IMPLEMENTATION

See Chapter 12.0, "Procedures and Training," of the FSAR for facility implementation.

12.3 PROJECT IMPLEMENTATION

No project-specific requirements related to training were identified for the RCSTS.

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13.0 HUMAN FACTORS

This chapter lists the requirements for a human factors program to demonstrate that human factors are considered in facility design for the replacement cross-site transfer system (RCSTS) where human actions are relied on for preventive or mitigative actions.

13.1 REQUIREMENTS

See Section 13.2, "Requirements," of the FSAR for the requirements.

13.2 FACILITY IMPLEMENTATION

See Chapter 13.0 "Human Factors," of the FSAR for facility implementation.

13.3 PROJECT IMPLEMENTATION

The application of human factors is graded on project risk, complexity, and level of involvement of the operator at the facility. The TWRS design authority and safety organization are responsible for ensuring human factors are included as an explicit consideration in the modification of TWRS facilities, systems, or equipment that may affect safety. The risk, complexity, and level of operator involvement for the RCSTS are similar to normal DST operations. However, in March of 1995 a human factors programming session was conducted. Consequently, no additional human factors analysis is required.

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14.0 QUALITY ASSURANCE

This chapter lists the requirements for a quality assurance program to ensure the safety of personnel and the public, for environmental protection, and for the implementing program documents for the replacement cross-site transfer system (RCSTS).

14.1 REQUIREMENTS

See Section 14.2, "Requirements," of the FSAR for the requirements.

14.2 FACILITY IMPLEMENTATION

See Chapter 14.0, "Quality Assurance," of the FSAR for facility implementation.

14.3 PROJECT IMPLEMENTATION

Implementation of specific quality assurance requirements for the RCSTS is controlled by HNF-SD-W058-QAPP-001, *Project Specific Quality Assurance Plan Project W-058, Replacement of the Cross-Site Transfer System.*

The quality assurance program consists of the following:

- Personnel performing work on this project have been trained and qualified in accordance with the above quality assurance programs and DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities.*

- Quality improvement processes described in the quality assurance programs provide for the detection and correction of quality problems throughout the design and construction of this project.

- Documents associated with this project have been independently reviewed for completeness and accuracy. A record index is available to classify all quality assurance records to aid in retrieval.

- Work processes associated with this project have been and will be strictly adhered to in accordance with this quality assurance program. Appropriate administrative procedures have been developed and approved to control key aspects in the design and construction of this project.

- Designs associated with this project have been independently reviewed and approved. Completed construction is accurately depicted by as-built drawings.

- Procurement of Safety-Class and Safety-Significant items for this project are in compliance with this quality assurance program in that such items have been purchased from qualified suppliers where applicable and all stated requirements have been met as verified through independent inspections, tests, and assessments. All required Certified Vendor Information has been received and appropriately indexed and filed to support continuity of service for this project.

- Inspection and testing of items associated with this project will meet required standards as verified by properly trained and qualified personnel. Records supplied on project turnover will attest to the accuracy and completeness of the inspection and testing.

- Periodic management assessment of this project has been established to ensure this project is compliant with this quality assurance plan and the objectives stated therein.

- Independent assessments will be planned, scheduled, and conducted to confirm that project deliverables and service quality are adequate to meet operational objectives.

15.0 EMERGENCY PREPAREDNESS PROGRAM

This chapter identifies the requirements for the emergency preparedness functions and response at the site of the replacement cross-site transfer system (RCSTS).

15.1 REQUIREMENTS

See Section 15.2, "Requirements," of the FSAR for the requirements.

15.2 FACILITY IMPLEMENTATION

See Chapter 15.0, "Emergency Preparedness Program," of the FSAR for facility implementation.

15.3 PROJECT IMPLEMENTATION

No project-specific requirements related to emergency preparedness were identified for the RCSTS.

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16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

This chapter describes provisions that facilitate future decontamination and decommissioning (D&D) of the replacement cross-site transfer system (RCSTS).

16.1 REQUIREMENTS

See Section 16.2," Requirements," of the FSAR for the requirements.

16.2 IMPLEMENTATION

See Chapter 16.0, "Provisions for Decontamination and Decomissioning," of the FSAR for implementation.

16.3 PROJECT IMPLEMENTATION

There is no requirement for a specific implementing document for D&D of the RCSTS.

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17.0 MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

This section provides the requirements for organization and institutional safety provisions that are pertinent to the safety analysis and the implementing program documents for the replacement cross-site transfer system (RCSTS).

17.1 REQUIREMENTS

See Section 17.2, "Requirements," of the FSAR for the requirements.

17.2 FACILITY IMPLEMENTATION

See Chapter 17.0, "Management, Organization, and Institutional Safety Provisions," of the FSAR for facility implementation.

17.3 PROJECT IMPLEMENTATION

No project-specific requirements related to management, organization, and institutional safety provisions were identified for the RCSTS.

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18.0 REFERENCES

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APPENDIX A

HAZARDS BASES

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A-1 RCSTS Hazards Identification A-5

A-2 RCSTS Material at Risk A-6

A-3 RCSTS Facility Configurations A-7

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Table A-1. RCSTS Hazards Identification.[a]

Energy classification[b]	RCSTS	
	PF	PE
Corrosive	2	NA
Explosive/pyrophoric	6,7,8,10	NA
Nuclear criticality	NA	NA
Flammable materials	11,13,14	3,7
Thermal radiation	NA	NA
Chemical reactions	1	NA
Friction	NA	NA
Electrical	3,4,5,9,10	NA
Kinetic-rotational	2,3	NA
Kinetic-linear	NA	1,4,5
Mass, gravity, height	2,3,11,13,14, 16	5
Pressure-volume	7,9,11	NA
Thermal (except radiant)	NA	NA

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

[b]Table 3-2, "Hazard Identification Checklist and Energy Designators," in this addendum, has the specific energy classifications represented by the numeric designators.

NA = not applicable.
PE = potentially present elsewhere in/adjacent to facility.
PF = potentially present in the facility.

Table A-2. RCSTS Material at Risk (MAR).

Field Name	MAR-subject	MAR description	MAR classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
RCSTS	Contents of Pipeline or Source tank during transfer	Transfer Piping	NA	NA	NA	Liquid Slurry	NA	NA	NA	Two RCSTS Transfer Lines
Diversion Box 6241-A	Contamination in Sump	RCSTS Diversion Box	Residual	NA	NA	Residue	Unknown	No	1 Pit	
Diversion Box 6241-A	Ventilation Filter Contents	Exhauster HEPA Filter	NA	NA	NA	Particulate	NA	NA	NA	Portable Exhauster
Diversion Box 6241-A	Ventilation Filter Contents	Air Inlet HEPA Filter	NA	NA	NA	Particulate	NA	NA	NA	
Vent Station 6241-V	Contamination in Sump	RCSTS Diversion Box	Residual	NA	NA	Residue	Unknown	No	1 Pit	
Vent Station 6241-V	Ventilation Filter Contents	Exhauster HEPA Filter	NA	NA	NA	Particulate	NA	NA	NA	Portable Exhauster
Vent Station 6241-V	Ventilation Filter Contents	Air Inlet HEPA Filter	NA	NA	NA	Particulate	NA	NA	NA	
RCSTS Water Flush System	Dilute Caustic	RCSTS Water Flush System	Caustic	47,000 gal	Dilute Caustic	Liquid	140 gpm	NA	NA	Flush of the RCSTS after usage with caustic solution
RCSTS Chemical Injection Package	25% NaOH	Chemical Injection Package	Caustic	55 gal	NaOH	Liquid	NA	NA	NA	

Table A-3. RCSTS Facility Configurations.

Facility Name	Type	Ventilation	Comment Ventilation	Flush	Comment Flush
RCSTS	Pipeline	NA	NA	Yes	Pipeline Flushed after usage
Diversion Box 6241-A	Pump Station	Passive	Exhauster connected up with ventilation system when needed	Yes	Pipeline in Diversion Box Flushed after usage
Vent Station 6241-V	Vent Station	Passive	Exhauster connected up with ventilation system when needed	Yes	Pipeline in Vent Station Flushed after usage

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APPENDIX B

ANALYZED ACCIDENTS AND REPRESENTED HAZARDOUS CONDITIONS

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LIST OF TABLES

B-1 Analyzed Accidents B-1-1

B-2 Analyzed Accidents and the Represented Hazardous Conditions . . . B-2-1

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Table B-1. Analyzed Accidents. (3 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
ANALYZED ACCIDENT: Nuclear Criticality								
A-1-a	I-PFP-1-AGT-A	Fission product gases and aerosols from receiver tank.	Release of fission product gases and aerosols from receiver tank due to: Potential for solids to collect in D-5. If mixed later, potential for composition of next batch to exceed Criticality Prevention Specifications (CPS). Potential "Criticality Issue."	Human Error or Agitator fails results in criticality	F3	S2	A05	01
ANALYZED ACCIDENT: HEPA Filter Failure - Exposure to High Temperature or Pressure								
A-1-a	106C-10J	Tank atmosphere and surface contamination on HEPA filters	Release of radioactive and/or hazardous material from Tank 241-C-106 tank due to tank structural damage, HEPA damage caused by high temperature	Fire in or around ventilation system	F2	S2	B09	02A
ANALYZED ACCIDENT: Unfiltered Release								
B-1-a	114SX-04.c.2.a	Radioactive aerosols contained in the tank headspace	Radioactive aerosols released from Tank SX-114 head space to atmosphere due to exhauster HEPA filter seal failure	HEPA filter seal failure	F3	S2	D07	02B
ANALYZED ACCIDENT: Fire in Contaminated Area								
A-1-a	CRN-05	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Human error in positioning crane load	F3	S2	B26	03
ANALYZED ACCIDENT: Subsurface Leak Remaining Subsurface								
B-3-b	102S-01.b3	Radioactive/hazardous material contained in pumpable liquids from S-102.	Radioactive liquid released to the soil subsurface from leaks in transfer Lines SL-140, SN-242. (Plume)	Line leak during salt well pumping (corrosion)	F3	S2	D12	07
ANALYZED ACCIDENT: Caustic Spray Leak								
B-1-a	107AN-02-PRES	Contents of caustic truck	Release of caustic aerosol from caustic truck transfer piping due to spray leak	Piping/hose leak initiated by various causes	F3	S2	D12	09

Table B-1. Analyzed Accidents. (3 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
ANALYZED ACCIDENT: Mixing of Incompatible Material - Toxic Vapor Generation								
C-1-a	XS-26-PRES XS-26-TEMP	DST vapor/aerosols	Release of toxic vapors from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible waste causes chemical reaction	F3	S2	E06	11
ANALYZED ACCIDENT: Mixing of Incompatible Material - Tank Pressurization								
B-1-a	I-222S-1-RXN-A	Aerosols and/or toxic vapors from receiver tank	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste.	Transfer of incompatible waste	F3	S2	D01	12
ANALYZED ACCIDENT: Flammable Gas Deflagrations								
A-1-a	ITK-10-b	DST tank inventory	Release of radioactive material from in-tank fire or explosion due to intrusive activity (Dome Collapse)	Spark from equipment or tools	F3	S3	B04	14A
A-1-a	XS-01-FLOW03	SST and DCRT tank contents	Release of liquids, solids, and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas explosion/fire propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	S3	B07	14B
ANALYZED ACCIDENT: Surface Leak Resulting in Pool								
C-2-b	W058-PRES01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (Pool)	Water hammer plus mitigative features failure	F3	S2	D17	18
ANALYZED ACCIDENT: Subsurface Leak Resulting in Pool								
B-3-b	XS-07-FLOW02	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer piping out of 244-TX DCRT due to leak in primary pipe and encasement	Corrosion of inner and outer pipe	F3	S2	D16	19A
B-3-b	XS-07-FLOW06	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer pipe out of 244-TX-DCRT due to leak in primary pipe and encasement	Water hammer causes failure of primary pipe and encasement	F3	S2	D17	19B
ANALYZED ACCIDENT: Spray Leak in Structure or from Overground Waste Transfer Lines								
B-1-a	XS-06-FLOW02	DCRT waste being transferred to 102-SY	Release of liquid radioactive waste from DCRT transfer piping to Tank 241-SY-102 due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	S3	D12	20
ANALYZED ACCIDENT: Spray Leak from Underground Waste Transfer Lines								
B-1-a	EE-16	Material leaked from transfer line	Release of radioactive and hazardous material from transfer line spray leak due to excavation error	Excavation into waste transfer line during a transfer	F3	S3	D22	21

Table B-1. Analyzed Accidents. (3 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
ANALYZED ACCIDENT: Natural Phenomena - Seismic								
B-1-a	NP-07	Multiple tanks and ventilation systems inventories, 204-AR tanker spill	Radioactive and hazardous material releases from tanks and ventilation systems due to seismic event	Earthquake collapses domes	F1	S3	D18	25

CPS = criticality prevention specifications.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
MISF = miscellaneous inactive storage facility.
NC = no controls.
SST = single-shell tank.

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Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
ANALYZED ACCIDENT: Nuclear Criticality								
A-1-a	I-PFP-1-AGT-A	Fission product gases and aerosols from receiver tank.	Release of fission product gases and aerosols from receiver tank due to: Potential for solids to collect in D-5. If mixed later, potential for composition of next batch to exceed Criticality Prevention Specifications (CPS). Potential "Criticality Issue."	Human Error or Agitator fails results in criticality	F3	S2	A05	01
HAZARDOUS CONDITIONS								
A-1-a	RCSTS-01-FLOW02	Fissile material in waste Tank 241-SY-102	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality.	Mistransfer of material containing organic extractant from east area via the supernate piping route	F1	S2	A01	01X
ANALYZED ACCIDENT: HEPA Filter Failure - Exposure to High Temperature or Pressure								
A-1-a	106C-10J	Tank atmosphere and surface contamination on HEPA filters	Release of radioactive and/or hazardous material from Tank 241-C-106 tank due to tank structural damage, HEPA damage caused by high temperature	Fire in or around ventilation system	F2	S2	B09	02A
HAZARDOUS CONDITIONS								
C-1-c	RCSTS-08-FILTER01*	Residual contamination in Diversion Box 6241-A	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	Tornado or high winds across inlet	F1	S2	D20	02X
C-1-c	RCSTS-09-FILTER01*	Residual contamination in Vent Station 6241-V	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	Tornado or high winds across inlet	F1	S2	D20	02X
ANALYZED ACCIDENT: Unfiltered Release								
B-1-a	114SX-04.c.2.a	Radioactive aerosols contained in the tank headspace	Radioactive aerosols released from Tank 241-SX-114 head space to atmosphere due to exhauster HEPA filter seal failure	HEPA filter seal failure	F3	S2	D07	02B
HAZARDOUS CONDITIONS								
C-1-c	RCSTS-08-FILTER02*	Residual contamination in Diversion Box 6241-A	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	F3	S2	D12	02X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-1-c	RCSTS-09-FILTER02*	Residual contamination in Vent Station 6241-V	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	F3	S2	D12	02X
ANALYZED ACCIDENT: Fire in Contaminated Area								
A-1-a	CRN-05	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Human error in positioning crane load	F3	S2	B26	03
HAZARDOUS CONDITIONS								
B-1-a	RCSTS-03-TEMP01*	Residual contamination in valve pit	Release of radioactive material to the atmosphere from the SY valve pit due to fire in pit.	Fire in the pit caused by maintenance or electrical problem	F2	S2	D09	03X
ANALYZED ACCIDENT: Subsurface Leak Remaining Subsurface								
B-3-b	102S-01.b3	Radioactive/hazardous material contained in pumpable liquids from Tank 241-S-102.	Radioactive liquid released to the soil subsurface from leaks in transfer Lines SL-140, SN-242. (Plume)	Line leak during salt well pumping (corrosion)	F3	S2	D12	07
HAZARDOUS CONDITIONS								
C-3-b	RCSTS-10/11-INTEG02b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	S2	D16	07X
C-3-b	RCSTS-10/11-INTEG05b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	07X
C-3-b	RCSTS-10/11-PRES01b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	S2	D17	07X
C-3-b	RCSTS-12/13-INTEG02b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	S2	D16	07X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-3-b	RCSTS-12/13-INTEG05b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	07X
C-3-b	RCSTS-12/13-PRES01b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	F3	S2	D26	07X
ANALYZED ACCIDENT: Caustic Spray Leak								
B-1-a	107AN-02-PRES	Contents of caustic truck	Release of caustic aerosol from caustic truck transfer piping due to spray leak	Piping/hose leak initiated by various causes	F3	S2	D12	09
HAZARDOUS CONDITIONS								
B-1-a	RCSTS-2FS-FLOW01	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (upstream of flush pump) due to structural failure	F2	S2	D26	09X
B-1-a	RCSTS-2FS-FLOW02	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (downstream of flush pump) due to structural failure	F2	S2	D26	09X
B-1-a	RCSTS-2FS-FLOW03	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	S2	D26	09X
B-1-a	RCSTS-2FS-FLOW04	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	S2	D26	09X
B-1-a	RCSTS-2FS-FLOW05	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure.	Caustic injection pressure relief valve failure	F3	S2	D12	09X
B-1-a	RCSTS-2FS-FLOW07	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Flush line break due to structural failure	F2	S2	D26	09X
B-1-a	RCSTS-2FS-PRES01	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	S2	D26	09X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-2FS-PRES02	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	S2	D26	09X
B-1-a	RCSTS-2FS-PRES03	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a line break.	Flush line break due to structural failure	F2	S2	D26	09X
B-1-a	RCSTS-2FS-TEMP01	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	S2	D26	09X
B-1-a	RCSTS-2FS-TEMP02	Caustic water based solution	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions.	Freezing weather with loss of heat trace function	F2	S2	D24	09X
B-1-a	RCSTS-4FS-FLOW03	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open	F2	S2	D12	09X
B-1-a	RCSTS-4FS-FLOW04	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open.	Back pressure valve fails in closed position	F2	S2	D12	09X
B-1-a	RCSTS-4FS-FLOW05	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package.	Line failure/leak due to structural failure	F2	S2	D19	09X
B-1-a	RCSTS-4FS-FLOW06	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak.	Caustic drain valve leak	F2	S2	D12	09X
B-1-a	RCSTS-4FS-PRES/TEMP01	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open on caustic injection system.	F2	S2	D06	09X
B-1-a	RCSTS-4FS-PRES/TEMP02	Concentrated caustic	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line.	Back pressure relief valve fails in closed position.	F3	S2	D12	09X
B-1-a	RCSTS-5FS-FLOW01	Caustic water based solution	Release of caustic to the atmosphere from caustic line due to a line break.	Line break due to structural failure.	F2	S2	D19	09X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-5FS-FLOW02	Caustic water based solution	Release of caustic to the atmosphere from caustic line due to a line break.	Line plug due to debris buildup causing pressure buildup resulting in pipe failure.	F2	S2	D19	09X
ANALYZED ACCIDENT: Mixing of Incompatible Material - Toxic Vapor Generation								
C-1-a	XS-26-PRES XS-26-TEMP	DST vapor/aerosols	Release of toxic vapors from Tank 241-SY-102 due to chemical reaction	Mistransfer of incompatible waste causes chemical reaction	F3	S2	E06	11
HAZARDOUS CONDITIONS								
A-1-a	RCSTS-01-FLOW05	Ammonia liberated from mixing waste with a limited number of drums of relatively dilute caustic	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic.	Human error	F2	S3	D01	11X
ANALYZED ACCIDENT: Mixing of Incompatible Material - Tank Pressurization								
B-1-a	I-222S-1-RXN-A	Aerosols and/or toxic vapors from receiver tank	Release of aerosols and/or toxic vapors from receiver tank due adverse chemical reactions from incompatible waste.	Transfer of incompatible waste	F3	S2	D01	12
HAZARDOUS CONDITIONS								
A-1-a	RCSTS-01-FLOW04	Amount of reactive chemicals in waste transferred (20,00 to 1,000,000 gallons)	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction.	Mistransfer of incompatible material from east area via the supernate piping route.	F2	S3	D01	12X
ANALYZED ACCIDENT: Flammable Gas Deflagrations								
A-1-a	ITK-10-b	DST tank inventory	Release of radioactive material from in-tank fire or explosion due to intrusive activity (Dome Collapse)	Spark from equipment or tools	F3	S3	B04	14A
A-1-a	XS-01-FLOW03	SST and DCRT tank contents	Release of liquids, solids, and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas explosion/fire propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	S3	B07	14B
HAZARDOUS CONDITIONS								

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-03-INTEG01	Aerosol fraction of supernate or slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	F2	S2	B08	14X
B-1-a	RCSTS-03-INTEG02	Aerosol fraction of slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	S2	B08	14X
C-2-b	RCSTS-08-INTEG03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S2	B08	14X
A-1-a	RCSTS-08-INTEG12	Aerosol fraction of supernate spill	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas.	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	F2	S3	B08	14X
C-2-b	RCSTS-09-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S2	B08	14X
B-1-a	RCSTS-09-INTEG06	Aerosol fraction of supernate spill	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas.	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	F2	S2	B08	14X
B-1-a	RCSTS-09-INTEG14	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S3	B08	14X
C-3-b	RCSTS-18/19-INTEG05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to flammable gas explosion in primary piping	F2	S2	B08	14X
B-1-a	RCSTS-24-INTEG03	Aerosol fraction of supernate or slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	F2	S2	B08	14X
B-1-a	RCSTS-24-INTEG06	Aerosol fraction of slurry spill created by fire or explosion	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	S2	B08	14X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
ANALYZED ACCIDENT: Surface Leak Resulting in Pool								
C-2-b	W058-PRES01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (Pool)	Water hammer plus mitigative features failure	F3	S2	D17	18
HAZARDOUS CONDITIONS								
C-2-b	RCSTS-01-FLOW03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of Tank 241-SY-102 tank due to mistransfer.	Mistransfer of material from east area via the supernate piping route.	F3	S2	D06	18X
C-2-b	RCSTS-03-FLOW/INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error).	F3	S2	E06	18X
C-2-b	RCSTS-03-FLOW/INTEG02a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error)	F3	S2	E06	18X
C-2-b	RCSTS-03-FLOW/INTEG02b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to gasket failure	F2	S2	D12	18X
C-2-b	RCSTS-03-FLOW/INTEG02c	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to corrosion	F2	S2	D12	18X
C-2-b	RCSTS-03-FLOW02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	E06	18X
C-2-b	RCSTS-03-FLOW03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	F2	S2	D12	18X
C-2-b	RCSTS-03-FLOW04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	E06	18X
C-2-b	RCSTS-03-FLOW05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	F2	S2	D12	18X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-2-b	RCSTS-03-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	S2	D23	18X
C-2-b	RCSTS-03-INTEG07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	S2	D23	18X
C-2-b	RCSTS-03-PRES02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	F3	S2	D17	18X
C-2-b	RCSTS-03-PRES03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	F3	S2	D17	18X
C-2-b	RCSTS-08-FLOW03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	S2	D12	18X
C-2-b	RCSTS-08-FLOW04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	S2	D12	18X
C-2-b	RCSTS-08-FLOW05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	S2	D06	18X
C-2-b	RCSTS-08-INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion	F2	S2	D16	18X
C-2-b	RCSTS-08-INTEG02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External event (airplane crash, etc)	F0	S2	D23	18X
C-2-b	RCSTS-08-INTEG04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to material defect	F2	S2	D12	18X
C-2-b	RCSTS-08-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	F1	S2	D26	18X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-2-b	RCSTS-08-INTEG17a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion plus mitigative features failure	F2	S2	D06	18X
C-2-b	RCSTS-08-INTEG17b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to unrecognized material flaw	F2	S2	D12	18X
C-2-b	RCSTS-08-INTEG18	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (airplane crash, volcanism, etc)	F0	S2	D05	18X
C-2-b	RCSTS-08-PRES02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Water hammer	F3	S2	D17	18X
C-2-b	RCSTS-08-PRES03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Water hammer	F3	S2	D17	18X
C-2-b	RCSTS-08-TEMP01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	S2	D24	18X
C-2-b	RCSTS-08-TEMP04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to freezing	F1	S2	D24	18X
C-2-b	RCSTS-09-FLOW01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flow of slurry to vent station due to incomplete closing of vent valves after venting	F3	S2	D06	18X
C-2-b	RCSTS-09-FLOW04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	S2	D12	18X
C-2-b	RCSTS-09-FLOW05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	S2	D12	18X
C-2-b	RCSTS-09-FLOW06	Amount of supernate involved in a transfer (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Flow of supernate to vent station due to incomplete closing of vent valves after venting	F3	S2	D06	18X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-2-b	RCSTS-09-FLOW07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	S2	D06	18X
B-1-a	RCSTS-09-FLOW11	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	S3	D06	18X
C-2-b	RCSTS-09-INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	F2	S2	D16	18X
C-2-b	RCSTS-09-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	F2	S2	D16	18X
C-2-b	RCSTS-09-INTEG03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	F0	S2	D23	18X
C-2-b	RCSTS-09-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	F0	S2	D23	18X
C-2-b	RCSTS-09-INTEG07	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	F2	S2	D12	18X
C-2-b	RCSTS-09-INTEG08	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	F2	S2	D12	18X
C-2-b	RCSTS-09-PRES01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Water hammer	F3	S2	D17	18X
C-2-b	RCSTS-09-PRES02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Water hammer	F3	S2	D17	18X
C-2-b	RCSTS-09-TEMP01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S2	D24	18X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-2-b	RCSTS-09-TEMP02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S2	D24	18X
C-2-b	RCSTS-15/16-INTEG03b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	S2	D12	18X
C-2-b	RCSTS-1FS-LEVEL03	Caustic water based solution mixed with radioactive material being transferred via cross site transfer line	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	F2	S2	D06	18X
B-2-b	RCSTS-22-PRESS03*	Amount of slurry transferrable through a pipe break	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	S2	D12	18X
B-2-b	RCSTS-22-PRESS04*	Amount of supernate transferrable through a pipe break	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	S2	D12	18X
C-2-b	RCSTS-24-FLOW/INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	F2	S2	D16	18X
C-2-b	RCSTS-24-FLOW/INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	F2	S2	D16	18X
C-2-b	RCSTS-24-FLOW/INTEG03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	S2	D12	18X
C-2-b	RCSTS-24-FLOW/INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to gasket failure	F3	S2	D12	18X
C-2-b	RCSTS-24-FLOW/INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to misalignment	F3	S2	D06	18X
C-2-b	RCSTS-24-FLOW/INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to misalignment	F3	S2	D06	18X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-2-b	RCSTS-24-FLOW01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	18X
C-2-b	RCSTS-24-FLOW02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S2	D06	18X
C-2-b	RCSTS-24-FLOW03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	S2	D12	18X
C-2-b	RCSTS-24-FLOW04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External leak of valve or valves to the lift station	F3	S2	D12	18X
C-2-b	RCSTS-24-INTEG01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External event (airplane crash, etc)	F0	S2	D23	18X
C-2-b	RCSTS-24-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External event (airplane crash, etc)	F0	S2	D23	18X
C-2-b	RCSTS-24-PRES01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	F3	S2	D26	18X
C-2-b	RCSTS-24-PRES02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Water hammer	F3	S2	D17	18X
C-2-b	RCSTS-24-PRES03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Water hammer	F3	S2	D17	18X
ANALYZED ACCIDENT: Subsurface Leak Resulting in Pool								
B-3-b	XS-07-FLOW02	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer piping out of 244-TX DCRT due to leak in primary pipe and encasement	Corrosion of inner and outer pipe	F3	S2	D16	19A
B-3-b	XS-07-FLOW06	Liquid radioactive waste transferred out of DCRT	Release of radioactive waste to soil from transfer pipe out of 244-TX-DCRT due to leak in primary pipe and encasement	Water hammer causes failure of primary pipe and encasement	F3	S2	D17	19B

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
HAZARDOUS CONDITIONS								
C-2-b	RCSTS-04/05-INTEG01a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	S2	D06	19X
C-2-b	RCSTS-04/05-INTEG01b	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	19X
C-2-b	RCSTS-04/05-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	S2	D05	19X
C-3-b	RCSTS-04/05-INTEG03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	19X
C-2-b	RCSTS-04/05-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	S2	D12	19X
C-2-b	RCSTS-04/05-TEMP01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	F1	S2	D24	19X
C-3-b	RCSTS-10/11-INTEG01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D19	19X
C-3-b	RCSTS-10/11-INTEG02a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	S2	D16	19X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-3-b	RCSTS-10/11-INTEG03a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	19X
C-3-b	RCSTS-10/11-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	S2	D23	19X
C-3-b	RCSTS-10/11-INTEG05a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	19X
C-3-b	RCSTS-10/11-PRES01a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	S2	D17	19X
C-3-b	RCSTS-10/11-TEMP01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	S2	D24	19X
C-3-b	RCSTS-10/11-TEMP02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	S2	D26	19X
C-3-b	RCSTS-12/13-INTEG01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D19	19X
C-3-b	RCSTS-12/13-INTEG02a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	S2	D16	19X
C-3-b	RCSTS-12/13-INTEG03a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	19X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-3-b	RCSTS-12/13-INTEGO4	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	S2	D23	19X
C-3-b	RCSTS-12/13-INTEGO5a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	19X
C-3-b	RCSTS-12/13-PRESO1a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	F3	S2	D26	19X
C-3-b	RCSTS-12/13-PRESO2	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	S2	D17	19X
C-3-b	RCSTS-12/13-TEMPO1	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	S2	D24	19X
C-3-b	RCSTS-12/13-TEMPO2	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	S2	D26	19X
C-2-b	RCSTS-15/16-INTEGO1a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	S2	D12	19X
C-2-b	RCSTS-15/16-INTEGO1b	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	19X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-3-b	RCSTS-15/16-INTEG02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F2	S2	D22	19X
C-2-b	RCSTS-15/16-INTEG03a	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D12	19X
C-2-b	RCSTS-15/16-INTEG05	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	S2	D05	19X
C-2-b	RCSTS-15/16-TEMP01	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	F1	S2	D24	19X
C-3-b	RCSTS-18/19-INTEG01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	S2	D19	19X
C-3-b	RCSTS-18/19-INTEG02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	S2	D16	19X
C-3-b	RCSTS-18/19-INTEG03a	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	19X
C-3-b	RCSTS-18/19-INTEG04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	S2	D23	19X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-3-b	RCSTS-18/19-INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	S2	D12	19X
C-3-b	RCSTS-18/19-PRES01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	S2	D17	19X
C-3-b	RCSTS-18/19-TEMP01	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	S2	D24	19X
C-3-b	RCSTS-18/19-TEMP02	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	S2	D26	19X
ANALYZED ACCIDENT: Spray Leak in Structure or from Overground Waste Transfer Lines								
B-1-a	XS-06-FLOW02	DCRT waste being transferred to Tank 241-SY-102	Release of liquid radioactive waste from DCRT transfer piping to Tank 241-SY-102 due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	S3	D12	20
HAZARDOUS CONDITIONS								
B-1-a	RCSTS-03-FLOW/INTEG03a	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	F2	S3	E06	20X
B-1-a	RCSTS-03-FLOW/INTEG03b	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	F2	S3	D12	20X
B-1-a	RCSTS-03-FLOW/INTEG03c	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	F2	S3	D16	20X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-03-FLOW/INTEG04a	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	F2	S3	E06	20X
B-1-a	RCSTS-03-FLOW/INTEG04b	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	F2	S3	D12	20X
B-1-a	RCSTS-03-FLOW/INTEG04c	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	F2	S3	D16	20X
B-1-a	RCSTS-03-FLOW06	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	S3	E06	20X
B-1-a	RCSTS-03-FLOW07	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	F2	S3	D12	20X
B-1-a	RCSTS-03-FLOW08	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	S3	E06	20X
B-1-a	RCSTS-03-INTEG03	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	F2	S3	D12	20X
B-1-a	RCSTS-03-INTEG09	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X
B-1-a	RCSTS-03-INTEG11	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-08-FLOW08	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	S3	D12	20X
B-1-a	RCSTS-08-INTEG08	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to corrosion	F2	S3	D16	20X
B-1-a	RCSTS-08-INTEG09	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X
B-1-a	RCSTS-08-INTEG10	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X
B-1-a	RCSTS-08-INTEG11	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	S3	B08	20X
B-1-a	RCSTS-08-INTEG13	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to material defect	F2	S3	D12	20X
B-1-a	RCSTS-08-INTEG14	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	F1	S3	D26	20X
B-1-a	RCSTS-08-PRES04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Water hammer	F3	S3	D17	20X
B-1-a	RCSTS-08-PRES05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Water hammer	F3	S3	D17	20X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-08-TEMP02	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	S3	D24	20X
B-1-a	RCSTS-08-TEMP03	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	S3	D24	20X
B-1-a	RCSTS-09-FLOW10	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	S3	D12	20X
B-1-a	RCSTS-09-INTEG11	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to corrosion	F2	S3	D16	20X
B-1-a	RCSTS-09-INTEG12	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X
B-1-a	RCSTS-09-INTEG13	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X
B-1-a	RCSTS-09-INTEG15	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to material defect	F2	S3	D12	20X
B-1-a	RCSTS-09-PRES04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Water hammer	F3	S3	D17	20X
B-1-a	RCSTS-09-PRES05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Water hammer	F3	S3	D17	20X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-09-TEMP03	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S3	D24	20X
B-1-a	RCSTS-09-TEMP04	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	S3	D24	20X
B-1-a	RCSTS-22-PRESS01*	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	S3	D12	20X
B-1-a	RCSTS-22-PRESS02*	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	S3	D12	20X
B-1-a	RCSTS-24-FLOW/INTEG07	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to corrosion	F2	S3	D16	20X
B-1-a	RCSTS-24-FLOW/INTEG08	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to corrosion	F2	S3	D16	20X
B-1-a	RCSTS-24-FLOW/INTEG09	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	S3	D12	20X
B-1-a	RCSTS-24-FLOW/INTEG10	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	S3	D12	20X
B-1-a	RCSTS-24-FLOW/INTEG11	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to misalignment	F3	S3	D06	20X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-24-FLOW/INTEG12	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to misalignment	F3	S3	D06	20X
B-1-a	RCSTS-24-FLOW05	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	20X
B-1-a	RCSTS-24-FLOW06	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	S3	D06	20X
B-1-a	RCSTS-24-FLOW07	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	S3	D12	20X
B-1-a	RCSTS-24-FLOW08	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	S3	D12	20X
B-1-a	RCSTS-24-INTEG07	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X
B-1-a	RCSTS-24-INTEG08	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External event (airplane crash, etc)	F0	S3	D23	20X
ANALYZED ACCIDENT: Spray Leak from Underground Waste Transfer Lines								
B-1-a	EE-16	Material leaked from transfer line	Release of radioactive and hazardous material from transfer line spray leak due to excavation error	Excavation into waste transfer line during a transfer	F3	S3	D22	21
HAZARDOUS CONDITIONS								
B-1-a	RCSTS-10/11-INTEG03b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	21X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
B-1-a	RCSTS-12/13-INTEG03b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A Lift Station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	21X
B-1-a	RCSTS-18/19-INTEG03b*	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	S2	D22	21X
ANALYZED ACCIDENT: Natural Phenomena - Seismic								
B-1-a	NP-07	Multiple tanks and ventilation systems inventories, 204-AR tanker spill	Radioactive and hazardous material releases from tanks and ventilation systems due to seismic event	Earthquake collapses domes	F1	S3	D18	25
HAZARDOUS CONDITIONS								
B-1-a	RCSTS-03-INTEG04	Amount of supernate transferrable through a limited size orifice	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	S3	D18	25X
C-2-b	RCSTS-03-INTEG06	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	S2	D18	25X
C-2-b	RCSTS-03-INTEG08	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Seismic event	F1	S2	D18	25X
B-1-a	RCSTS-03-INTEG10	Amount of slurry transferrable through a limited size orifice	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	S3	D18	25X
C-2-b	RCSTS-04/05-INTEG05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	S2	D18	25X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-2-b	RCSTS-08-INTEG06	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Seismic event	F1	S2	D18	25X
C-2-b	RCSTS-08-INTEG07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Seismic event	F1	S2	D18	25X
B-1-a	RCSTS-08-INTEG15	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Seismic event	F1	S3	D18	25X
B-1-a	RCSTS-08-INTEG16	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Seismic event	F1	S3	D18	25X
C-2-b	RCSTS-09-INTEG09	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Seismic event	F1	S2	D18	25X
C-2-b	RCSTS-09-INTEG10	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Seismic event	F1	S2	D18	25X
B-1-a	RCSTS-09-INTEG16	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Seismic event	F1	S3	D18	25X
B-1-a	RCSTS-09-INTEG17	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Seismic event	F1	S3	D18	25X
C-3-b	RCSTS-10/11-INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	S2	D18	25X
C-3-b	RCSTS-12/13-INTEG06	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	S2	D18	25X

Table B-2. Analyzed Accidents and the Represented Hazardous Conditions. (25 sheets)

BIN	ID	Material at Risk	Hazardous Condition	Cause	Initial Freq NC	Initial Safety Cons NC	Cause Grp	BIO Acc
C-2-b	RCSTS-15/16-INTEG04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	S2	D18	25X
C-3-b	RCSTS-18/19-INTEG07	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	S2	D18	25X
C-2-b	RCSTS-24-INTEG04	Amount of slurry transferred (20,000 to 1,000,000 gallons)	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Seismic event	F1	S2	D18	25X
C-2-b	RCSTS-24-INTEG05	Amount of supernate transferred (20,000 to 1,000,000 gallons)	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Seismic event	F1	S2	D18	25X
B-1-a	RCSTS-24-INTEG09	Amount of slurry transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Seismic event	F1	S3	D18	25X
B-1-a	RCSTS-24-INTEG10	Amount of supernate transferrable through a limited size orifice	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Seismic event	F1	S3	D18	25X

CPS = criticality prevention specifications.
DCRT = double-contained receiver tank.
DST = double-shell tank.
HEPA = high-efficiency particulate air (filter).
MISF = miscellaneous inactive storage facility.
NC = *no controls.*
SST = single-shell tank.

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APPENDIX C

HAZARDS EVALUATIONS RESULTS

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Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (5 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction.	Mistransfer of incompatible material from east area via the supernate piping route.	F2	E3
RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic.	Human error	F2	E3
RCSTS-03-FLOW/INTEG03a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG03b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	F2	E3
RCSTS-03-FLOW/INTEG03c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW/INTEG04a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG04b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	F2	E3
RCSTS-03-FLOW/INTEG04c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	F2	E3
RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	F2	E3

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (5 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	E3
RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	E3
RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	E3
RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to corrosion	F2	E3
RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3
RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas.	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	F2	E3
RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to material defect	F2	E3
RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	F1	E3

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (5 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Seismic event	F1	E3
RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Seismic event	F1	E3
RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Water hammer	F3	E3
RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Water hammer	F3	E3
RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	E3
RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E3
RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to corrosion	F2	E3
RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3
RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to material defect	F2	E3

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (5 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Seismic event	F1	E3
RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Seismic event	F1	E3
RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Water hammer	F3	E3
RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Water hammer	F3	E3
RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3
RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3
RCSTS-24-FLOW/INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	E3
RCSTS-24-FLOW/INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	E3

Table C-1. Hazardous Conditions With Potential Significant Offsite Consequences (S3). (5 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-24-FLOW/INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to misalignment	F3	E3
RCSTS-24-FLOW/INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to misalignment	F3	E3
RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Seismic event	F1	E3
RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Seismic event	F1	E3

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Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality.	Mistransfer of material containing organic extractant from east area via the supernate piping route	F1	E3
RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of Tank 241-SY-102 due to mistransfer.	Mistransfer of material from east area via the supernate piping route.	F3	E2
RCSTS-03-FLOW/INTEG01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error).	F3	E2
RCSTS-03-FLOW/INTEG02a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error)	F3	E2
RCSTS-03-FLOW/INTEG02b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to gasket failure	F2	E2
RCSTS-03-FLOW/INTEG02c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to corrosion	F2	E2
RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-03-INTEG02	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2
RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	E2
RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Seismic event	F1	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	F3	E2
RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	F3	E2
RCSTS-03-TEMP01*	Release of radioactive material to the atmosphere from the SY valve pit due to fire in pit.	Fire in the pit caused by maintenance or electrical problem	F2	E1
RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2
RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-08-FILTER01*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	Tornado or high winds across inlet	F1	E1
RCSTS-08-FILTER02*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	F3	E1
RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	E2
RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	E2
RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion	F2	E2
RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-08-INTEG03	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2
RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to material defect	F2	E2
RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	F1	E2
RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Seismic event	F1	E2
RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Seismic event	F1	E2
RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion plus mitigative features failure	F2	E2
RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to unrecognized material flaw	F2	E2
RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Water hammer	F3	E2
RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Water hammer	F3	E2
RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to freezing	F1	E2
RCSTS-09-FILTER01*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	Tornado or high winds across inlet	F1	E1

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-09-FILTER02*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	F3	E1
RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flow of slurry to vent station due to incomplete closing of vent valves after venting	F3	E2
RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	E2
RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	E2
RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Flow of supernate to vent station due to incomplete closing of vent valves after venting	F3	E2
RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E2
RCSTS-09-INTEG01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG03	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2
RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas.	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	F2	E2
RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Seismic event	F1	E2
RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Seismic event	F1	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Water hammer	F3	E2
RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Water hammer	F3	E2
RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A Lift Station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	F3	E2
RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F2	E2
RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2
RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to flammable gas explosion in primary piping	F2	E2
RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-1FS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	F2	E2
RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3
RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3
RCSTS-24-FLOW/INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to misalignment	F3	E2
RCSTS-24-FLOW/INTEG06	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to misalignment	F3	E2
RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External event (airplane crash, etc)	F0	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Seismic event	F1	E2
RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Seismic event	F1	E2
RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2
RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Water hammer	F3	E2
RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Water hammer	F3	E2
RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (upstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (downstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2
RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure.	Caustic injection pressure relief valve failure	F3	E2
RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Flush line break due to structural failure	F2	E2
RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2

Table C-2. Hazardous Conditions With Potential Significant Onsite Consequences (S2). (11 sheets)

ID	*Hazardous Conditions*	*Cause*	Freq NC	Env Cons
RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break.	Flush line break due to structural failure	F2	E2
RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions.	Freezing weather with loss of heat trace function	F2	E2
RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open	F2	E2
RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open.	Back pressure valve fails in closed position	F2	E2
RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package.	Line failure/leak due to structural failure	F2	E2
RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak.	Caustic drain valve leak	F2	E2
RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open on caustic injection system.	F2	E2
RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line.	Back pressure relief valve fails in closed position.	F3	E2
RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break.	Line break due to structural failure.	F2	E2
RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break.	Line plug due to debris buildup causing pressure buildup resulting in pipe failure.	F2	E2

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Table C-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (3 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-01-FLOW01	Release of radioactive slurry or supernate to the soil surface from overflow of the 244-S catch station due to reverse flow.	Reverse flow to 244-S catch station caused by improper valve lineup.	F3	E1
RCSTS-03-FLOW01	Release of radioactive slurry or supernate to the SY flush pit from transfer line due to backflow.	Reverse flow to flush pit caused by improper valving sequence	F3	E1
RCSTS-03-PRES01	Release of radioactive material to atmosphere from SY valve pit due to over-pressurization event in Tank 241-SY-102.	Pressure event in Tank 241-SY-102 with loss of valve pit seal loop water	F3	E1
RCSTS-08-AIR01	Release of radioactive vapors to the diversion box atmosphere from accumulated waste in diversion box due to pipe encasement draining.	Draining of the encasement	F3	E0
RCSTS-08-AIR02	Exposure to chemical vapors and liquids in diversion box due to the spill or leak of chemicals in confined space.	Chemicals brought in for decontamination and maintenance	F3	E0
RCSTS-08-AIR03	Release of radioactive vapors to the diversion box atmosphere due to waste being present in box.	Leak of waste solution	F3	E0
RCSTS-08-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution	F3	E0
RCSTS-08-OCC01	Worker injury due to welding gas bottle becoming a missile in diversion box.	Damage from welding gas bottle during maintenance activity in diversion box	F3	E0
RCSTS-08-OCC02	Worker discomfort from cold temperatures in diversion box.	Running an exhauster during cold weather	F3	E0
RCSTS-08-RAD01	Release of radioactive material to the diversion box from transfer piping due to encasement draining.	Draining of the encasement	F3	E0
RCSTS-08-RAD02	Release of radioactive material to the diversion box from transfer line due to pipe leak.	Leak of waste solution	F2	E0
RCSTS-08-RAD03	High radiation dose to worker from the diversion box due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pumps or pipes	F3	E0
RCSTS-09-AIR02	Release of radioactive vapors to the vent station atmosphere due to waste being present in station.	Leak of waste solution	F3	E0
RCSTS-09-AIR03	Exposure to chemical vapors and liquids in vent station due to the spill or leak of chemicals.	Chemicals brought in for decontamination and maintenance	F3	E0
RCSTS-09-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution	F3	E0

Table C-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (3 sheets)

RCSTS-09-OCC01	Worker injury due to welding gas bottle becoming a missile in vent station.	Damage from welding gas bottle during maintenance activity in vent station	F3	E0
RCSTS-09-OCC02	Worker discomfort from cold temperatures in vent station.	Running an exhauster during cold weather	F3	E0
RCSTS-09-RAD02	Release of radioactive material to the vent station from transfer line due to pipe leak.	Leak of waste solution	F2	E0
RCSTS-09-RAD03	High radiation dose to worker from the vent station due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pipes	F3	E0
RCSTS-1FS-LEVEL01	Release of caustic solution to the sump pit from the water flush tank due to over filling of tank.	Operator error - overfill of caustic material	F3	E0
RCSTS-1FS-LEVEL02	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Flush tank receives radioactive waste from transfer line during drainback process. Jumper block valves and raw water block valves opened during the drainback of waste from vent station of the cross site transfer line.	F3	E0
RCSTS-1FS-LEVEL04	Release of caustic solution to the sump pit from the water flush tank due to human error.	Human error - drain valve left open	F3	E0
RCSTS-1FS-LEVEL05	Release of caustic solution to the sump pit from the water flush tank due to drain valve failure.	Drain valve fails open	F1	E0
RCSTS-1FS-LEVEL06	Release of caustic solution to the sump pit from the water flush tank due to tank connection failure.	Structural failure of flush tank connections	F2	E0
RCSTS-1FS-LEVEL07	Release of caustic solution to the sump pit from the water flush tank due to tank structural failure.	Structural failure of flush tank	F1	E0
RCSTS-1FS-PRES01	Release of caustic solution to the sump pit from the water flush tank due to tank failure.	Tank vent and overflow line blockage with flush pump running in flush cycle	F2	E0
RCSTS-1FS-STRUCT01	Release of caustic solution to the sump pit from the water flush tank due to tank connection failure.	Structural failure of pipe connections/expansion joint	F2	E0
RCSTS-1FS-STRUCT02	Release of caustic solution to the sump pit from the water flush tank due to structural failure of tank.	Structural failure of water flush tank	F1	E0
RCSTS-1FS-STRUCT03	Release of caustic solution to the sump pit from the water flush tank due to tank corrosion failure.	External water flush tank corrosion	F1	E0
RCSTS-1FS-STRUCT04	Release of caustic solution to the sump pit from the water flush tank due to tank failure.	Natural phenomena - high winds, seismic event, ash fall	F1	E0
RCSTS-2FS-FLOW06	Release of caustic solution to the atmosphere from the water flush system due to a mistransfer.	Flush line block valve failure, or valve left open due to operator error	F2	E0
RCSTS-3FS-FLOW01	Release of caustic solution to the sump from the water flush system due to rupture of tank fittings.	Raw water line break/rupture, floats flush water tank, damages tank/equipment	F2	E1

Table C-3. Hazardous Conditions With Potential Significant Worker Consequences (S1). (3 sheets)

RCSTS-3FS-FLOW02	Release of caustic to the sump from the caustic system due to rupture of caustic drum.	Raw water line break/rupture, overfilling of chemical addition equipment sump breaching drum containment	F2	E1
RCSTS-4FS-FLOW01	Release of caustic to the sump from the caustic system due to rupture of drum.	Caustic drum failure due to corrosion	F2	E1
RCSTS-4FS-FLOW02	Release of caustic material to caustic storage area from caustic drum due to handling error.	Materials handling accident	F3	EO
RCSTS-4FS-FLOW07	Release of caustic to the sump from the caustic system due to failure of check valve and overfilling of caustic drum with raw water.	Check valve fails open and bypass valve left open, backflow of raw water into caustic addition line of flush system.	F2	E1
RCSTS-5FS-FLOW03	Release of radioactive material into water flush tank due to loss of flush system pump operation.	Loss of pump pressure during flush operation causing back flow of waste	F3	EO
RCSTS-GENERAL-PRES	Release of radioactive material to the soil surface from supernate or slurry piping due to encasement breach (pipe is considered empty except for residual contamination).	Pneumatic leak testing	F3	E1

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Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality.	Mistransfer of material containing organic extractant from east area via the supernate piping route	F1	E3
RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction.	Mistransfer of incompatible material from east area via the supernate piping route.	F2	E3
RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic.	Human error	F2	E3
RCSTS-03-FLOW/INTEG03a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG03b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	F2	E3
RCSTS-03-FLOW/INTEG03c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW/INTEG04a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	F2	E3
RCSTS-03-FLOW/INTEG04b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	F2	E3
RCSTS-03-FLOW/INTEG04c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	F2	E3
RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F2	E3
RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	F2	E3
RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	E3
RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	E3

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	E3
RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to corrosion	F2	E3
RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3
RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas.	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	F2	E3
RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to material defect	F2	E3
RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	F1	E3
RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Seismic event	F1	E3
RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Seismic event	F1	E3
RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Water hammer	F3	E3
RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Water hammer	F3	E3
RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E3

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	E3
RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E3
RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to corrosion	F2	E3
RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E3
RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to material defect	F2	E3
RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Seismic event	F1	E3
RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Seismic event	F1	E3
RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Water hammer	F3	E3
RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Water hammer	F3	E3
RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E3
RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3
RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	F3	E3

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3
RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	F3	E3
RCSTS-24-FLOW/INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to corrosion	F2	E3
RCSTS-24-FLOW/INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	E3
RCSTS-24-FLOW/INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	E3
RCSTS-24-FLOW/INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to misalignment	F3	E3
RCSTS-24-FLOW/INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to misalignment	F3	E3
RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E3
RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	E3
RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External event (airplane crash, etc)	F0	E3
RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Seismic event	F1	E3

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Seismic event	F1	E3
RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of Tank 241-SY-102 due to mistransfer.	Mistransfer of material from east area via the supernate piping route.	F3	E2
RCSTS-03-FLOW/INTEG01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error).	F3	E2
RCSTS-03-FLOW/INTEG02a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error)	F3	E2
RCSTS-03-FLOW/INTEG02b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to gasket failure	F2	E2
RCSTS-03-FLOW/INTEG02c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to corrosion	F2	E2
RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	F2	E2
RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-03-INTEG02	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2
RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	Seismic event	F1	E2
RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	F0	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Seismic event	F1	E2
RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	F3	E2
RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	F3	E2
RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2
RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	E2
RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	F3	E2
RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	F3	E2
RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion	F2	E2
RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External event (airplane crash, etc)	F0	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-08-INTEG03	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2
RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to material defect	F2	E2
RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	F1	E2
RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Seismic event	F1	E2
RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Seismic event	F1	E2
RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion plus mitigative features failure	F2	E2
RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to unrecognized material flaw	F2	E2
RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Water hammer	F3	E2
RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Water hammer	F3	E2
RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to freezing	F1	E2
RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flow of slurry to vent station due to incomplete closing of vent valves after venting	F3	E2
RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	E2
RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	F3	E2
RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Flow of supernate to vent station due to incomplete closing of vent valves after venting	F3	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	F3	E2
RCSTS-09-INTEG01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	F2	E2
RCSTS-09-INTEG03	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	F2	E2
RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas.	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	F2	E2
RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	F2	E2
RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Seismic event	F1	E2
RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Seismic event	F1	E2
RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Water hammer	F3	E2
RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Water hammer	F3	E2
RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2
RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	F2	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A Lift Station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	F3	E2
RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	E2
RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F2	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	F2	E2
RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	F0	E2
RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	F1	E2
RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	F3	E2
RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	F2	E2
RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	F3	E2
RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	F0	E2
RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to flammable gas explosion in primary piping	F2	E2
RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	F2	E2
RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	F1	E2
RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	F3	E2
RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	F1	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	F3	E2
RCSTS-1FS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	F2	E2
RCSTS-24-FLOW/INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	F2	E2
RCSTS-24-FLOW/INTEG03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to gasket failure	F3	E2
RCSTS-24-FLOW/INTEG05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to misalignment	F3	E2
RCSTS-24-FLOW/INTEG06	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to misalignment	F3	E2
RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	F3	E2
RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External leak of valve or valves to the lift station	F3	E2
RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External event (airplane crash, etc)	F0	E2
RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External event (airplane crash, etc)	F0	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	F2	E2
RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Seismic event	F1	E2
RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Seismic event	F1	E2
RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	F2	E2
RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	F3	E2
RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Water hammer	F3	E2
RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Water hammer	F3	E2
RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (upstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (downstream of flush pump) due to structural failure	F2	E2
RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2
RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure.	Caustic injection pressure relief valve failure	F3	E2
RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Flush line break due to structural failure	F2	E2
RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2

Table C-4. Hazardous Conditions with Potential Severe Environmental Consequences (E2 and E3). (14 sheets)

ID	Hazardous Conditions	Cause	Freq NC	Env Cons
RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	F2	E2
RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break.	Flush line break due to structural failure	F2	E2
RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	F2	E2
RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions.	Freezing weather with loss of heat trace function	F2	E2
RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open	F2	E2
RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open.	Back pressure valve fails in closed position	F2	E2
RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package.	Line failure/leak due to structural failure	F2	E2
RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak.	Caustic drain valve leak	F2	E2
RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open on caustic injection system.	F2	E2
RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line.	Back pressure relief valve fails in closed position.	F3	E2
RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break.	Line break due to structural failure.	F2	E2
RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break.	Line plug due to debris buildup causing pressure buildup resulting in pipe failure.	F2	E2

Table C-5. Hazardous Conditions With Potential Radiation Exposure Consequences (RP).

ID	Hazardous Conditions	Cause
RCSTS-03-FLOW01	Release of radioactive slurry or supernate to the SY flush pit from transfer line due to backflow.	Reverse flow to flush pit caused by improper valving sequence
RCSTS-08-AIR01	Release of radioactive vapors to the diversion box atmosphere from accumulated waste in diversion box due to pipe encasement draining.	Draining of the encasement
RCSTS-08-AIR03	Release of radioactive vapors to the diversion box atmosphere due to waste being present in box.	Leak of waste solution
RCSTS-08-RAD01	Release of radioactive material to the diversion box from transfer piping due to encasement draining.	Draining of the encasement
RCSTS-08-RAD02	Release of radioactive material to the diversion box from transfer line due to pipe leak.	Leak of waste solution
RCSTS-08-RAD03	High radiation dose to worker from the diversion box due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pumps or pipes
RCSTS-09-AIR02	Release of radioactive vapors to the vent station atmosphere due to waste being present in station.	Leak of waste solution
RCSTS-09-RAD02	Release of radioactive material to the vent station from transfer line due to pipe leak.	Leak of waste solution
RCSTS-09-RAD03	High radiation dose to worker from the vent station due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pipes
RCSTS-5FS-FLOW03	Release of radioactive material into water flush tank due to loss of flush system pump operation.	Loss of pump pressure during flush operation causing back flow of waste

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Table C-6. Hazardous Conditions With Potential Occupational Safety Consequences (OCC). (2 sheets)

ID	Hazardous Conditions	Cause
RCSTS-08-AIR02	Exposure to chemical vapors and liquids in diversion box due to the spill or leak of chemicals in confined space.	Chemicals brought in for decontamination and maintenance
RCSTS-08-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution
RCSTS-08-OCC01	Worker injury due to welding gas bottle becoming a missile in diversion box.	Damage from welding gas bottle during maintenance activity in diversion box
RCSTS-08-OCC02	Worker discomfort from cold temperatures in diversion box.	Running an exhauster during cold weather
RCSTS-09-AIR03	Exposure to chemical vapors and liquids in vent station due to the spill or leak of chemicals.	Chemicals brought in for decontamination and maintenance
RCSTS-09-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution
RCSTS-09-OCC01	Worker injury due to welding gas bottle becoming a missile in vent station.	Damage from welding gas bottle during maintenance activity in vent station
RCSTS-09-OCC02	Worker discomfort from cold temperatures in vent station.	Running an exhauster during cold weather
RCSTS-1FS-LEVEL01	Release of caustic solution to the sump pit from the water flush tank due to over filling of tank.	Operator error - overfill of caustic material
RCSTS-1FS-LEVEL04	Release of caustic solution to the sump pit from the water flush tank due to human error.	Human error - drain valve left open
RCSTS-1FS-LEVEL05	Release of caustic solution to the sump pit from the water flush tank due to drain valve failure.	Drain valve fails open
RCSTS-1FS-LEVEL06	Release of caustic solution to the sump pit from the water flush tank due to tank connection failure.	Structural failure of flush tank connections
RCSTS-1FS-LEVEL07	Release of caustic solution to the sump pit from the water flush tank due to tank structural failure.	Structural failure of flush tank
RCSTS-1FS-PRES01	Release of caustic solution to the sump pit from the water flush tank due to tank failure.	Tank vent and overflow line blockage with flush pump running in flush cycle
RCSTS-1FS-STRUCT01	Release of caustic solution to the sump pit from the water flush tank due to tank connection failure.	Structural failure of pipe connections/expansion joint
RCSTS-1FS-STRUCT02	Release of caustic solution to the sump pit from the water flush tank due to structural failure of tank.	Structural failure of water flush tank

Table C-6. Hazardous Conditions With Potential Occupational Safety Consequences (OCC). (2 sheets)

ID	Hazardous Conditions	Cause
RCSTS-1FS-STRUCT03	Release of caustic solution to the sump pit from the water flush tank due to tank corrosion failure.	External water flush tank corrosion
RCSTS-2FS-FLOW06	Release of caustic solution to the atmosphere from the water flush system due to a mistransfer.	Flush line block valve failure, or valve left open due to operator error
RCSTS-3FS-FLOW01	Release of caustic solution to the sump from the water flush system due to rupture of tank fittings.	Raw water line break/rupture, floats flush water tank, damages tank/equipment
RCSTS-3FS-FLOW02	Release of caustic to the sump from the caustic system due to rupture of caustic drum.	Raw water line break/rupture, overfilling of chemical addition equipment sump breaching drum containment
RCSTS-4FS-FLOW01	Release of caustic to the sump from the caustic system due to rupture of drum.	Caustic drum failure due to corrosion
RCSTS-4FS-FLOW02	Release of caustic material to caustic storage area from caustic drum due to handling error.	Materials handling accident
RCSTS-4FS-FLOW07	Release of caustic to the sump from the caustic system due to failure of check valve and overfilling of caustic drum with raw water.	Check valve fails open and bypass valve left open, backflow of raw water into caustic addition line of flush system.

APPENDIX D

CONTROL ALLOCATION TABLES

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Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
01X	RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality.	Mistransfer of material containing organic extractant from east area via the supernate piping route	None required	AC: 5.1 Nuclear Criticality Safety: - Establish CPSs - Transfer limits on pH, neutron absorber to plutonium ratio and plutonium concentration - Criticality training program - CSERs for cross-site slurry transfers	None required	None Required	Controls based on Reanalyzed Accident for W058 Project
02X	RCSTS-08-FILTER01*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	Tornado or high winds across inlet	None required	None Required	None required	AC: HEPA Filter Cntrls	Controls based on Original BIO Accident Analysis
02X	RCSTS-08-FILTER02*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	None required	None Required	None required	AC: HEPA Filter Cntrls	Controls based on Original BIO Accident Analysis
02X	RCSTS-09-FILTER01*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	Tornado or high winds across inlet	None required	None Required	None required	AC: HEPA Filter Cntrls	Controls based on Original BIO Accident Analysis
02X	RCSTS-09-FILTER02*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	None required	None Required	None required	AC: HEPA Filter Cntrls	Controls based on Original BIO Accident Analysis
03X	RCSTS-03-TEMP01*	Release of radioactive material to the atmosphere from the SY valve pit due to fire in pit.	Fire in the pit caused by maintenance or electrical problem	None required	AC: 5.2 Ignition Controls: AC: 5.3 Flammable Gas Monitoring Controls	None required	AC: 5.5 Emergency Preparedness	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
07X	RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project
07X	RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project
07X	RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SS: Pipe Encasements	AC: 5.12M Transfer Controls - Config Management - Indep Route Verification	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance	Controls based on Reanalyzed Accident for W058 Project
07X	RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
07X	RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project
07X	RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	SC: Transfer Piping SS: Pipe Encasements	AC: 5.12M Transfer Controls - Config Management - Indep Route Verification	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance	Controls based on Reanalyzed Accident for W058 Project
09X	RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (upstream of flush pump) due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (downstream of flush pump) due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
09X	RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure.	Caustic injection pressure relief valve failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Flush line break due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break.	Flush line break due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions.	Freezing weather with loss of heat trace function	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
09X	RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open.	Back pressure valve fails in closed position	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package.	Line failure/leak due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak.	Caustic drain valve leak	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open on caustic injection system.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line.	Back pressure relief valve fails in closed position.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
09X	RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break.	Line break due to structural failure.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
09X	RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break.	Line plug due to debris buildup causing pressure buildup resulting in pipe failure.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
11X	RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic.	Human error	None required	None required	None required	None required	Controls based on Original BIO Accident Analysis
12X	RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction.	Mistransfer of incompatible material from east area via the supernate piping route.	None required	AC: 5.12 Transfer Controls: - Compat eval for pH 11	SS: HEPA filters	AC: 5.6 HEPA Filter controls: - Aerosol test upon install - Periodic aerosol test	Controls based on Original BIO Accident Analysis
14X	RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	None Required	AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
14X	RCSTS-03-INTEGO2	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	None Required	AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis
14X	RCSTS-08-INTEGO3	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls	SS: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
14X	RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas.	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources -.Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	None required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis
14X	RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	SS: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
14X	RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas.	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis
14X	RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
14X	RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to flammable gas explosion in primary piping	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	SS: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis
14X	RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
14X	RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrls - Manned work act - Unmanned ops	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis
18X	RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of Tank 241-SY-102 due to mistransfer.	Mistransfer of material from east area via the supernate piping route.	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	AC: 5.12M Trans Contrls: - Material Balance AC: 5.13 Encasement Seal Loop Cntrls AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-03-FLOW/INTEG 01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error).	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Sys	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-03-FLOW/INTEG 02a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error)	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Sys	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-03-FLOW/INTEG 02b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to gasket failure	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-03-FLOW/INTEG 02c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to corrosion	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.13 Encasement Seal Loop Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.13 Encasement Seal Loop Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
18X	RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	SS: Trans Leak Detect Sys	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to material defect	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box and Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion plus mitigative features failure	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to unrecognized material flaw	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (airplane crash, volcanism, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Diversion Box and Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to freezing	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flow of slurry to vent station due to incomplete closing of vent valves after venting	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Flow of supernate to vent station due to incomplete closing of vent valves after venting	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	SS: Trans Leak Detect Sys	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	SS: Trans Leak Detect Sys	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-09-INTEGO1	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-INTEGO2	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-INTEGO3	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
18X	RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box and Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-1FS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	SC: Press Switch Interlocks/Alarms (water flush jumper) SC: Press Switch Interlocks/Alarms (water service lines) SC: Backflow Prevention Sys (water flush jumper)	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification	SS: Tank Level Detect Syss	LCO: 3.1.2M Service Water Pres Detection Syss AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-24-FLOW/INTEG 01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to corrosion	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss
18X	RCSTS-24-FLOW/INTEG 02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-24-FLOW/INTEG 03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to gasket failure	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-24-FLOW/INTEG 04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to gasket failure	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-24-FLOW/INTEG 05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to misalignment	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-24-FLOW/INTEG 06	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to misalignment	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External leak of valve or valves to the lift station	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External leak of valve or valves to the lift station	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
18X	RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
18X	RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Water hammer	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss LCO: 3.1.5M Press Relief and Rupture Disk	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
18X	RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Water hammer	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss LCO: 3.1.5M Press Relief and Rupture Disk	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SC: Trans Leak Detection Syss SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.13 Encasement Seal Loop Controls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
19X	RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	SC: Transfer Piping SC: Pipe Encasement	None	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SC: Trans Leak Detection Syss SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
19X	RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary piping and encasement due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SC: Trans Leak Detection Syss SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
19X	RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
19X	RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-03-FLOW/INTEG 03a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing AC: 5.12M Trans Cntrls: - Route verification	SC: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-FLOW/INTEG 03b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-FLOW/INTEG 03c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-FLOW/INTEG 04a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing AC: 5.12M Trans Cntrls: - Independent route verification	SC: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-FLOW/INTEG 04b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-03-FLOW/INTEG 04c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
20X	RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
20X	RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None Required	None Required	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to corrosion	None Required	None Required	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
20X	RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
20X	RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls AC: 5.11 Flam Gas	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to material defect	None Required	None Required	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	None Required	AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External leak of valve or valves to the vent station	None Required	None Required	SC: Entry Doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to corrosion	None Required	None Required	SC: Entry Doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
20X	RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
20X	RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to material defect	None Required	None Required	SC: Entry Doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.14 Emerg Prep AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.5M Pressure Relief and Rupture Disks	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.5M Pressure Relief and Rupture Disks	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW/INTEG 07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW/INTEG 08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW/INTEG 09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW/INTEG 10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-24-FLOW/INTEG 11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to misalignment	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW/INTEG 12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to misalignment	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
20X	RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External leak of valve or valves to the lift station	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External leak of valve or valves to the lift station	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
20X	RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
20X	RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
21X	RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None required	AC: 5.17 Excavation Cntrls - Excavation permit - Coordination of transfers - Aboveground Labeling of Trans Lines - Restrictions on transfers	None required	AC: 5.17 Excavation Cntrls - Surveillance of all transfer lines with transfer in progress	Controls based on Reanalyzed Accident for W058 Project

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
21X	RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A Lift Station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None required	AC: 5.17 Excavation Cntrls - Excavation permit - Coordination of transfers - Aboveground Labeling of Trans Lines - Restrictions on transfers	None required	AC: 5.17 Excavation Cntrls - Surveillance of all transfer lines with transfer in progress	Controls based on Reanalyzed Accident for W058 Project
21X	RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None required	AC: 5.17 Excavation Cntrls - Excavation permit - Coordination of transfers - Aboveground Labeling of Trans Lines - Restrictions on transfers	None required	AC: 5.17 Excavation Cntrls - Surveillance of all transfer lines with transfer in progress	Controls based on Reanalyzed Accident for W058 Project
25X	RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
25X	RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
25X	RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis

Table D-1. Safety SSCs and TSRs For Potential S3 and S2 Consequences. (63 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
25X	RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
25X	RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis

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Table D-2. Safety SSCs and TSRs For Potential S1 Consequences with F3 Frequency. (7 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-01-FLOW01	Release of radioactive slurry or supernate to the soil surface from overflow of the 244-S catch station due to reverse flow.	Reverse flow to 244-S catch station caused by improper valve lineup.	SC: Backflow Prevention Sys SS: Trans Sys Covers	AC: 5.12M Trans Cntrls: - Config Management - Route Verification AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.22M Trans Sys cover removal/entry door closure cntrls	None Required	AC: 5.14 Emerg Prep	Facility worker exposure controlled by Health & Safety Plan
RCSTS-03-FLOW01	Release of radioactive slurry or supernate to the SY flush pit from transfer line due to backflow.	Reverse flow to flush pit caused by improper valving sequence	SC: Backflow Prevention Sys	AC: 5.12M Trans Cntrls: - Config Management - Route Verification	SS: Trans Sys Covers SC: Trans Leak Detec Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Contrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	All of the Controls identified would prevent the worker from being exposed to radiation above the site standards. Facility worker exposure controlled by Health & Safety Plan
RCSTS-03-PRES01	Release of radioactive material to atmosphere from SY valve pit due to over-pressurization event in Tank 241-SY-102.	Pressure event in Tank 241-SY-102 with loss of valve pit seal loop water	SC: DST/AWF Ventilation	LCO: DST and AWF Tank Vent Syss	SC: Trans Sys Covers	LCO: Trans Sys Covers AC: Trans Sys Cover Removal Cntrls	All of the Controls identified would help prevent the worker from being exposed to the waste. Facility worker exposure controlled by Health & Safety Plan Controls taken from the TWRS BIO

Table D-2. Safety SSCs and TSRs For Potential S1 Consequences with F3 Frequency. (7 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-AIR01	Release of radioactive vapors to the diversion box atmosphere from accumulated waste in diversion box due to pipe encasement draining.	Draining of the encasement	SC: Entry Doors SC: Diversion Box Struct SS: Trans Leak Detect Sys SS: Emergency Pumpout Line SS: Air Sample Line SS: Exhauster Hookup SS: Inlet Air HEPA Filter Sys	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1.3M Trans Leak Detect Syss LCO: 3.1M HEPA Filter AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys cover removal/entry door closure cntrls	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would help prevent the worker from being exposed to the waste coming from the encasement piping. Facility worker exposure controlled by Health & Safety Plan
RCSTS-08-AIR02	Exposure to chemical vapors and liquids in diversion box due to the spill or leak of chemicals in confined space.	Chemicals brought in for decontamination and maintenance	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No applicable SSCs or TSRs - Facility worker exposure controlled by Health & Safety Plan
RCSTS-08-AIR03	Release of radioactive vapors to the diversion box atmosphere due to waste being present in box.	Leak of waste solution	SC: Entry Doors SC: Diversion Box Struct SS: Trans Leak Detect Sys SS: Emergency Pumpout Line SS: Air Sample Line SS: Exhauster Hookup SS: HEPA Filter Sys	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1.3M Trans Leak Detect Syss LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls: AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys cover removal/entry door closure cntrls	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would prevent the worker from being exposed to radiation above site standards. Facility worker exposure to injury controlled by Health & Safety Plan

Table D-2. Safety SSCs and TSRs For Potential S1 Consequences with F3 Frequency. (7 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution	None Required	None Required	SC: Entry Doors SC: Diversion Box Struct SS: Air Sample Line SS: Exhauster Hookup SS: HEPA Filter Sys	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Facility worker exposure controlled by Health & Safety Plan
RCSTS-08-OCC01	Worker injury due to welding gas bottle becoming a missile in diversion box.	Damage from welding gas bottle during maintenance activity in diversion box	None Required	None Required	None Required	None Required	No Applicable SSCs or TSRs - Controlled by Health & Safety Plan
RCSTS-08-OCC02	Worker discomfort from cold temperatures in diversion box.	Running an exhauster during cold weather	None Required	None Required	None Required	None Required	No Applicable SSCs or TSRs - Controlled by Health & Safety Plan
RCSTS-08-RAD01	Release of radioactive material to the diversion box from transfer piping due to encasement draining.	Draining of the encasement	SC: Entry Doors SC: Diversion Box Struct SS: Trans Leak Detect Sys SS: Emergency Pumpout Line SS: Air Sample Line SS: Exhauster Hookup SS: HEPA Filter Sys	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1.3M Trans Leak Detect Syss LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys cover removal/entry door closure cntrls	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would prevent the worker from being exposed to radiation above the site standards. Facility worker exposure controlled by Health & Safety Plan

Table D-2. Safety SSCs and TSRs For Potential S1 Consequences with F3 Frequency. (7 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-RAD03	High radiation dose to worker from the diversion box due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pumps or pipes	SC: Entry Doors SC: Diversion Box Struct	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.22M Trans Sys cover removal/entry door closure cntrls	None Required	None Required	All of the Controls identified would prevent the worker from being exposed to radiation above the site standards. Facility worker exposure controlled by Health & Safety Plan
RCSTS-09-AIR02	Release of radioactive vapors to the vent station atmosphere due to waste being present in station.	Leak of waste solution	SC: Entry Doors SC: Vent Station Struct SS: Trans Leak Detect Sys SS: Emergency Pumpout Line SS: Air Sample Line SS: Exhauster Hookup SS: Inlet Air HEPA Filter Sys (6241-A and 6241-V)	AC: 5.12M Trans Cntrls: LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1.3M Trans Leak Detect Syss AC: 5.22M Trans Sys cover removal/entry door closure cntrls	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would prevent the worker from being exposed to radiation above the site standards. Facility worker exposure controlled by Health & Safety Plan
RCSTS-09-AIR03	Exposure to chemical vapors and liquids in vent station due to the spill or leak of chemicals.	Chemicals brought in for decontamination and maintenance	None Required	None Required	SC: Entry Doors SC: Vent Station Struct SS: Air Sample Line SS: Exhauster Hookup SS: HEPA Filter Sys	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls AC: 5.18M HEPA Filter Cntrls	Facility worker exposure controlled by Health & Safety Plan

Table D-2. Safety SSCs and TSRs For Potential S1 Consequences with F3 Frequency. (7 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution	None Required	None Required	SC: Entry Doors SC: Diversion BoxStruct SS: Air Sample Line SS: Exhauster Hookup SS: HEPA Filter Sys	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls AC: 5.18M HEPA Filter Cntrls	Facility worker exposure controlled by Health & Safety Plan
RCSTS-09-OCC01	Worker injury due to welding gas bottle becoming a missile in vent station.	Damage from welding gas bottle during maintenance activity in vent station	None Required	None Required	None Required	None Required	No Applicable SSCs or TSRs - Controlled by Health & Safety Plan
RCSTS-09-OCC02	Worker discomfort from cold temperatures in vent station.	Running an exhauster during cold weather	None Required	None Required	None Required	None Required	No Applicable SSCs or TSRs - Controlled by Health & Safety Plan
RCSTS-09-RAD03	High radiation dose to worker from the vent station due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pipes	SC: Entry Doors SC: Vent Station Struct	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1.3M Trans Leak Detect Syss AC: 5.22M Trans Sys cover removal/entry door closure cntrls	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would prevent the worker from being exposed to radiation above the site standards. Facility worker exposure controlled by Health & Safety Plan
RCSTS-1FS-LEVEL01	Release of caustic solution to the sump pit from the water flush tank due to over filling of tank.	Operator error - overfill of caustic material	None Required	None Required	None Required	None Required	Facility worker exposure controlled by Health & Safety Plan

Table D-2. Safety SSCs and TSRs For Potential S1 Consequences with F3 Frequency. (7 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-1FS-LEVEL02	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Flush tank receives radioactive waste from transfer line during drainback process. Jumper block valves and raw water block valves opened during the drainback of waste from vent station of the cross site transfer line.	SC: Press Switch Interlocks/Alarms (water flush jumper) SC: Backflow Prevention Sys (water flush jumper)	AC: 5.12M Trans Cntrls: - Config Management - Route Verification	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would help prevent the worker from being exposed to the waste. Facility worker exposure controlled by Health & Safety Plan
RCSTS-1FS-LEVEL04	Release of caustic solution to the sump pit from the water flush tank due to human error.	Human error - drain valve left open	None Required	None Required	None Required	None Required	Facility worker exposure controlled by Health & Safety Plan
RCSTS-4FS-FLOW02	Release of caustic material to caustic storage area from caustic drum due to handling error.	Materials handling accident	None Required	None Required	None Required	None Required	Facility worker exposure controlled by Health & Safety Plan
RCSTS-5FS-FLOW03	Release of radioactive material into water flush tank due to loss of flush system pump operation.	Loss of pump pressure during flush operation causing back flow of waste	SC: Press Switch Interlocks/Alarms (water flush jumper) SC: Backflow Prevention Sys (water flush jumper)	AC: 5.12M Trans Cntrls: - Config Management - Route Verification	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would prevent the worker from being exposed to radiation above the site standards. Facility worker exposure controlled by Health & Safety Plan

Table D-2. Safety SSCs and TSRs For Potential S1 Consequences with F3 Frequency. (7 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-GENERAL-PRES	Release of radioactive material to the soil surface from supernate or slurry piping due to encasement breach (pipe is considered empty except for residual contamination).	Pneumatic leak testing	SC: Transfer Piping SC: Encasement Piping	None Required	None Required	AC: 5.14 Emerg Prep	All of the Controls identified would help prevent the worker from being exposed to the waste coming from the encasement piping. Facility worker exposure and injury controlled by Health & Safety Plan

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Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-012 due to criticality.	Mistransfer of material containing organic extractant from east area via the supernate piping route	None required	AC: 5.1 Nuclear Criticality Safety: - Establish CPSs - Transfer limits on pH, neutron absorber to plutonium ratio and plutonium concentration - Criticality training program - CSERs for cross-site slurry transfers	None required	None Required	Controls based on Reanalyzed Accident for W058 Project
RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of Tank 241-SY-102 due to mistransfer.	Mistransfer of material from east area via the supernate piping route.	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	AC: 5.12M Trans Contrls: - Material Balance AC: 5.13 Encasement Seal Loop Cntrls AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY due to chemical reaction.	Mistransfer of incompatible material from east area via the supernate piping route.	None required	AC: 5.12 Transfer Controls: - Compat eval for pH 11	SS: HEPA filters	AC: 5.6 HEPA Filter controls: - Aerosol test upon install - Periodic aerosol test	Controls based on Original BIO Accident Analysis
RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic.	Human error	None required	None required	None required	None required	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-FLOW/INTEG01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error).	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Sys	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW/INTEG02a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error)	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Sys	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW/INTEG02b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to gasket failure	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-FLOW/INTEG02c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to corrosion	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW/INTEG03a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing AC: 5.12M Trans Contrls: - Route verification	SC: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW/INTEG03b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW/INTEG03c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW/INTEG04a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing AC: 5.12M Trans Contrls: - Independent route verification	SC: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-FLOW/INTEG04b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW/INTEG04c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Cntrls: - Material Balance - Pit floor drains open AC: 5.13 Encasement Seal Loop Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.13 Encasement Seal Loop Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	None Required	AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-03-INTEG02	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	None Required	AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SC: Trans Leak Detection Syss SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	SS: Trans Leak Detect Sys	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None Required	None Required	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-08-INTEG03	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls	SS: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to material defect	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box and Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to corrosion	None Required	None Required	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls AC: 5.11 Flam Gas	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas.	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	None required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to material defect	None Required	None Required	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	None Required	AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry Doors SC: Diversion Box Struct SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion plus mitigative features failure	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to unrecognized material flaw	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (airplane crash, volcanism, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Diversion Box and Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Diversion box structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to freezing	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flow of slurry to vent station due to incomplete closing of vent valves after venting	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Flow of supernate to vent station due to incomplete closing of vent valves after venting	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	SS: Trans Leak Detect Sys	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External leak of valve or valves to the vent station	None Required	None Required	SC: Entry Doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	SS: Trans Leak Detect Sys	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors LCO: 3.1M Inlet Air HEPA Filter AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-INTEG01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-INTEG02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-INTEG03	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	SS: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas.	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box and Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	SC: Trans Piping SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to corrosion	None Required	None Required	SC: Entry Doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to material defect	None Required	None Required	SC: Entry Doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Water hammer	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Trans Cntrls - Config Management - Route Verification	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Water hammer	None Required	AC: 5.12M Trans Cntrls: - Config Management - Indep Route Verification AC: 5.20 Trans Pump Admin Lock Cntrls	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.14 Emerg Prep AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Vent Station Struct SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None Required	None Required	SC: Entry doors SC: Vent station structure SS: HEPA filter Sys SS: Emergency pumpout line SS: Air sample line SS: Exhauster hookup	LCO: 3.1.1M Trans Sys Covers/Entry Doors AC: 5.14 Emerg Prep AC: 5.18M HEPA Filter Cntrls AC: 5.22M Trans Sys Cover Removal/Entry Door Closure Cntrls	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement - piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.13 Encasement Seal Loop Controls AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None required	AC: 5.17 Excavation Cntrls - Excavation permit - Coordination of transfers - Aboveground Labeling of Trans Lines - Restrictions on transfers	None required	AC: 5.17 Excavation Cntrls - Surveillance of all transfer lines with transfer in progress	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SS: Pipe Encasements	AC: 5.12M Transfer Controls - Config Management - Indep Route Verification	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance	Controls based on Reanalyzed Accident for W058 Project
RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	SC: Transfer Piping SC: Pipe Encasement	None	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SC: Trans Leak Detection Syss SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A Lift Station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None required	AC: 5.17 Excavation Cntrls - Excavation permit - Coordination of transfers - Aboveground Labeling of Trans Lines - Restrictions on transfers	None required	AC: 5.17 Excavation Cntrls - Surveillance of all transfer lines with transfer in progress	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SS: Pipe Encasements	None Required	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance - Monitor Intercon Tanks	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	SC: Transfer Piping SS: Pipe Encasements	AC: 5.12M Transfer Controls - Config Management - Indep Route Verification	SS: Tank Level Detection Syss SS: Trans Leak Detection Sys	LCO: 3.1.3 Trans Leak Detection Syss AC: 5.12M Trans Cntrls - Material Balance	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary piping and encasement due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SC: Trans Leak Detection Syss SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss	SC: Entry Doors SC: Diversion Box Struct SS: Tank Level Detect Syss	LCO: 3.1.1M Trans Sys Cover/Entry Doors AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal/entry door closure cntrls LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	SC: Press Switch Interlocks/alarms (water service line) SC: Transfer Piping SC: Pipe Encasement	LCO: 3.1.2M Service Water Press Detection Sys	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	SC: Transfer Piping SC: Pipe Encasement	AC: 5.17 Excavation Controls	SS: Trans Leak Detection Sys SS: Tank Level Detection Syss	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None required	AC: 5.17 Excavation Cntrls - Excavation permit - Coordination of transfers - Aboveground Labeling of Trans Lines - Restrictions on transfers	None required	AC: 5.17 Excavation Cntrls - Surveillance of all transfer lines with transfer in progress	Controls based on Reanalyzed Accident for W058 Project
RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to flammable gas explosion in primary piping	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	SS: Trans Leak Detect Sys	LCO: 3.1.3M Trans Leak Detect Syss AC: 5.14 Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	SC: Transfer Piping SC: Pipe Encasement	None Required	SS: Trans Leak Detect Sys SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	SC: Transfer Piping SC: Pipe Encasement	None	SC: Trans Leak Detect Syss SS: Tank Level Detection Syss	AC: 5.12M Transr Cntrls: - Material balance AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-1FS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	SC: Press Switch Interlocks/Alarms (water flush jumper) SC: Press Switch Interlocks/Alarms (water service lines) SC: Backflow Prevention Sys (water flush jumper)	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification	SS: Tank Level Detect Syss	LCO: 3.1.2M Service Water Pres Detection Syss AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.5M Pressure Relief and Rupture Disks	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.5M Pressure Relief and Rupture Disks	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-FLOW/INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to corrosion	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss
RCSTS-24-FLOW/INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-FLOW/INTEG03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to gasket failure	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW/INTEG04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to gasket failure	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW/INTEG05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to misalignment	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-FLOW/INTEG06	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to misalignment	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Jumper Leak Testing LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW/INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW/INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to corrosion	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW/INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW/INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to gasket failure	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-FLOW/INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to misalignment	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW/INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to misalignment	None Required	AC: 5.12M Trans Cntrls: - Jumper Leak Testing	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls LCO: 3.1.3M Trans Leak Detect Syss	SS: Trans Sys Covers SS: Tank Level Detect Syss SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance - Pit floor drains open AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External leak of valve or valves to the lift station	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External leak of valve or valves to the lift station	SC: Trans Leak Detect Syss	LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Contrls: - Material Balance AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None Required	AC: 5.12M Trans Cntrls: - Double valve isolation on intercon lines - Config Management - Route Verification - Caps/blanks on open nozzles AC: 5.20 Trans Pump admin lock cntrls	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External leak of valve or valves to the lift station	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External leak of valve or valves to the lift station	None Required	None Required	SS: Trans Sys Covers	LCO: 3.1.1M Trans Sys Cover AC: 5.14 Emerg Prep AC: 5.22M Trans Sys cover removal	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis
RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None required	AC: Ign Cntrls - Cntrls sparking - Cntrls electrostatic ign sources - Polymer material cntrls - Surface temp for equip contact waste - NFPA 70 Class 1 Div 1 & 2 requirements - Purged and pres equip cntrls AC: 5.11 Flam Gas Mon Cntrl	None Required	AC: Emerg Prep	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External event (airplane crash, etc)	None Required	None Required	None Required	AC: 5.14 Emerg Prep	No controls required based on the TWRS BIO
RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Seismic event	None required	None Required	None required	AC: Emergency Preparedness	Controls based on Original BIO Accident Analysis
RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	SC: Trans Leak Detect Syss	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Cntrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Water hammer	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss LCO: 3.1.5M Press Relief and Rupture Disk	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Cntrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Water hammer	SC: Trans Leak Detect Syss SC: Press Relief Sys SC: Rupture Disk	AC: 5.12M Trans Cntrls: - Config Management - Route Verification LCO: 3.1.3M Trans Leak Detect Syss LCO: 3.1.5M Press Relief and Rupture Disk	SS: Tank Level Detect Syss SS: Trans Sys Covers SC: Trans Leak Detect Syss	LCO: 3.1.1M Trans Sys Cover AC: 5.12M Trans Cntrls: - Material Balance - Pit floor drains open AC: 5.22M Trans Sys cover removal AC: 5.14 Emerg Prep LCO: 3.1.3M Trans Leak Detect Syss	Controls based on Reanalyzed Accident for W058 Project
RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (upstream of flush pump) due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (downstream of flush pump) due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure.	Caustic injection pressure relief valve failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Flush line break due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break.	Flush line break due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions.	Freezing weather with loss of heat trace function	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open.	Back pressure valve fails in closed position	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package.	Line failure/leak due to structural failure	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak.	Caustic drain valve leak	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis

Table D-3. Safety SSCs and TSRs for Potentially Severe (E3 and E2) Environmental Consequences. (53 sheets)

ID	Hazardous Conditions	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO
RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open on caustic injection system.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line.	Back pressure relief valve fails in closed position.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break.	Line break due to structural failure.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis
RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break.	Line plug due to debris buildup causing pressure buildup resulting in pipe failure.	None Required	AC: 5.23 Caustic Transfer Cntrls	None required	AC: 5.23 Caustic Transfer Cntrls	Controls based on Original BIO Accident Analysis

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Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
01X	RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality.	Mistransfer of material containing organic extractant from east area via the supernate piping route	None	None
02X	RCSTS-08-FILTER01*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	Tornado or high winds across inlet	None	Periodic Surveillance of HEPA HEPA filter Replacement
02X	RCSTS-08-FILTER02*	Release of residual contamination from Diversion Box 6241-A due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	None	Periodic Surveillance of HEPA HEPA filter Replacement
02X	RCSTS-09-FILTER01*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	Tornado or high winds across inlet	None	Periodic Surveillance of HEPA HEPA filter Replacement
02X	RCSTS-09-FILTER02*	Release of residual contamination from Vent Station 6241-V due to failure of inlet HEPA filter.	HEPA filter structural failure or seal failure	None	Periodic Surveillance of HEPA HEPA filter Replacement
03X	RCSTS-03-TEMP01*	Release of radioactive material to the atmosphere from the SY valve pit due to fire in pit.	Fire in the pit caused by maintenance or electrical problem	Fire Protection Prog	Rad Prot Program Contamination Cntrl Prog
07X	RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
07X	RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
07X	RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
07X	RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
07X	RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
07X	RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
09X	RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (upstream of flush pump) due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (downstream of flush pump) due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure.	Caustic injection pressure relief valve failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
09X	RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Flush line break due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break.	Flush line break due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions.	Freezing weather with loss of heat trace function	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open.	Back pressure valve fails in closed position	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package.	Line failure/leak due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
09X	RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak.	Caustic drain valve leak	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open on caustic injection system.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line.	Back pressure relief valve fails in closed position.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break.	Line break due to structural failure.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
09X	RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break.	Line plug due to debris buildup causing pressure buildup resulting in pipe failure.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
11X	RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic.	Human error	Industrial Hygiene Program	None
12X	RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction.	Mistransfer of incompatible material from east area via the supernate piping route.	Tank Farm Waste Compat Prog Waste Trans Proc Cntrls	None
14X	RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	None	None
14X	RCSTS-03-INTEG02	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
14X	RCSTS-08-INTEG03	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	None
14X	RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas.	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	None	None
14X	RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	None
14X	RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas.	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	None	None
14X	RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	None
14X	RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to flammable gas explosion in primary piping	None	None
14X	RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	None	None
14X	RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None	None
18X	RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of Tank 241-SY-102 due to mistransfer.	Mistransfer of material from east area via the supernate piping route.	None	None
18X	RCSTS-03-FLOW/INTEG01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error).	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
18X	RCSTS-03-FLOW/INTEG02a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error)	None	None
18X	RCSTS-03-FLOW/INTEG02b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to gasket failure	None	None
18X	RCSTS-03-FLOW/INTEG02c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to corrosion	None	None
18X	RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None
18X	RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	None	None
18X	RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None
18X	RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	None	None
18X	RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	None
18X	RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
18X	RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	None	None
18X	RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	None	None
18X	RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None	None
18X	RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None	None
18X	RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	None	None
18X	RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion	None	None
18X	RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External event (airplane crash, etc)	None	None
18X	RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to material defect	None	None
18X	RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	None	None
18X	RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion plus mitigative features failure	None	None
18X	RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to unrecognized material flaw	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
18X	RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (airplane crash, volcanism, etc)	None	None
18X	RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Water hammer	None	None
18X	RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Water hammer	None	None
18X	RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None	None
18X	RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to freezing	None	None
18X	RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flow of slurry to vent station due to incomplete closing of vent valves after venting	None	None
18X	RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	None	None
18X	RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	None	None
18X	RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Flow of supernate to vent station due to incomplete closing of vent valves after venting	None	None
18X	RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	None	None
18X	RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	None	None
18X	RCSTS-09-INTEG01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
18X	RCSTS-09-INTEG02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	None	None
18X	RCSTS-09-INTEG03	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None	None
18X	RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None	None
18X	RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	None	None
18X	RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	None	None
18X	RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Water hammer	None	None
18X	RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Water hammer	None	None
18X	RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	None
18X	RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	None
18X	RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
18X	RCSTS-1FS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
18X	RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	None	None
18X	RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	None	None
18X	RCSTS-24-FLOW/INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to corrosion	None	None
18X	RCSTS-24-FLOW/INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	None	None
18X	RCSTS-24-FLOW/INTEG03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to gasket failure	None	None
18X	RCSTS-24-FLOW/INTEG04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to gasket failure	None	None
18X	RCSTS-24-FLOW/INTEG05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to misalignment	None	None
18X	RCSTS-24-FLOW/INTEG06	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to misalignment	None	None
18X	RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None
18X	RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None
18X	RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External leak of valve or valves to the lift station	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
18X	RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External leak of valve or valves to the lift station	None	None
18X	RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External event (airplane crash, etc)	None	None
18X	RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External event (airplane crash, etc)	None	None
18X	RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	None	None
18X	RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Water hammer	None	None
18X	RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Water hammer	None	None
19X	RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
19X	RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
19X	RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
19X	RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
19X	RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
19X	RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	None	None
19X	RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
19X	RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
19X	RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
19X	RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None	None
19X	RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
19X	RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	None	None
19X	RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	None	None
19X	RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	None	None
19X	RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
19X	RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
19X	RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
19X	RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None	None
19X	RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
19X	RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
19X	RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to water hammer	None	None
19X	RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary piping and encasement due to freezing	None	None
19X	RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	None	None
19X	RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
19X	RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
19X	RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
19X	RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
19X	RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
19X	RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	None	None
19X	RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
19X	RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
19X	RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
19X	RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None	None
19X	RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
19X	RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	None	None
19X	RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	None	None
19X	RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
20X	RCSTS-03-FLOW/INTEG03a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW/INTEG03b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW/INTEG03c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW/INTEG04a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW/INTEG04b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW/INTEG04c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None	Trans Leak Detection Material Balance
20X	RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection Material Balance

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
20X	RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None	Trans Leak Detection Material Balance
20X	RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
20X	RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
20X	RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None	Trans Leak Detection Material Balance
20X	RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to corrosion	None	Trans Leak Detection Material Balance
20X	RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
20X	RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
20X	RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	Trans Leak Detection Material Balance
20X	RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to material defect	None	Trans Leak Detection Material Balance

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
20X	RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	None	Trans Leak Detection Material Balance
20X	RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Water hammer	None	Trans Leak Detection Material Balance
20X	RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Water hammer	None	Trans Leak Detection Material Balance
20X	RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None	Trans Leak Detection Material Balance
20X	RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None	Trans Leak Detection Material Balance
20X	RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External leak of valve or valves to the vent station	None	Trans Leak Detection Material Balance
20X	RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to corrosion	None	Trans Leak Detection Material Balance
20X	RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
20X	RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
20X	RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to material defect	None	Trans Leak Detection Material Balance
20X	RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Water hammer	None	Trans Leak Detection Material Balance
20X	RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Water hammer	None	Trans Leak Detection Material Balance
20X	RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	Trans Leak Detection Material Balance
20X	RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	Trans Leak Detection Material Balance
20X	RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	None	Trans Leak Detection Material Balance
20X	RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW/INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW/INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection Material Balance

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
20X	RCSTS-24-FLOW/INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW/INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW/INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to misalignment	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW/INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to misalignment	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External leak of valve or valves to the lift station	None	Trans Leak Detection Material Balance
20X	RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External leak of valve or valves to the lift station	None	Trans Leak Detection Material Balance
20X	RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
20X	RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
21X	RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	Material Balance
21X	RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A Lift Station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	Material Balance
21X	RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	Material Balance
25X	RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None	None
25X	RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None	None
25X	RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Seismic event	None	None
25X	RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
25X	RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
25X	RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None	None
25X	RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None	None
25X	RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Seismic event	None	None
25X	RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Seismic event	None	None
25X	RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Seismic event	None	None
25X	RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Seismic event	None	None
25X	RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Seismic event	None	None
25X	RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Seismic event	None	None
25X	RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None

Table D-4. Defense In Depth Controls For Potential S3 and S2 Consequences. (23 sheets)

BIO Acc	ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
25X	RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
25X	RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
25X	RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
25X	RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Seismic event	None	None
25X	RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Seismic event	None	None
25X	RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Seismic event	None	None
25X	RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Seismic event	None	None

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Table D-5. Defense In Depth For Potential S1 Consequences With F3 Frequency. (2 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-01-FLOW01	Release of radioactive slurry or supernate to the soil surface from overflow of the 244-S catch station due to reverse flow.	Reverse flow to 244-S catch station caused by improper valve lineup.	None	None
RCSTS-03-FLOW01	Release of radioactive slurry or supernate to the SY flush pit from transfer line due to backflow.	Reverse flow to flush pit caused by improper valving sequence	None	None
RCSTS-03-PRES01	Release of radioactive material to atmosphere from SY valve pit due to over-pressurization event in Tank 241-SY-102.	Pressure event in Tank 241-SY-102 with loss of valve pit seal loop water	None	None
RCSTS-08-AIR01	Release of radioactive vapors to the diversion box atmosphere from accumulated waste in diversion box due to pipe encasement draining.	Draining of the encasement	None	None
RCSTS-08-AIR02	Exposure to chemical vapors and liquids in diversion box due to the spill or leak of chemicals in confined space.	Chemicals brought in for decontamination and maintenance	None	None
RCSTS-08-AIR03	Release of radioactive vapors to the diversion box atmosphere due to waste being present in box.	Leak of waste solution	None	None
RCSTS-08-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution	None	None
RCSTS-08-OCC01	Worker injury due to welding gas bottle becoming a missile in diversion box.	Damage from welding gas bottle during maintenance activity in diversion box	None	None
RCSTS-08-OCC02	Worker discomfort from cold temperatures in diversion box.	Running an exhauster during cold weather	None	None
RCSTS-08-RAD01	Release of radioactive material to the diversion box from transfer piping due to encasement draining.	Draining of the encasement	None	None
RCSTS-08-RAD03	High radiation dose to worker from the diversion box due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pumps or pipes	Diversion Box Design Features	Diversion Box Design Features ALARA Program
RCSTS-09-AIR02	Release of radioactive vapors to the vent station atmosphere due to waste being present in station.	Leak of waste solution	None	None
RCSTS-09-AIR03	Exposure to chemical vapors and liquids in vent station due to the spill or leak of chemicals.	Chemicals brought in for decontamination and maintenance	None	None
RCSTS-09-AIR04	Release of chemical waste into diversion box from leak of waste solution resulting in worker exposure.	Leak of waste solution	None	None

Table D-5. Defense In Depth For Potential S1 Consequences With F3 Frequency. (2 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-09-OCC01	Worker injury due to welding gas bottle becoming a missile in vent station.	Damage from welding gas bottle during maintenance activity in vent station	None	None
RCSTS-09-OCC02	Worker discomfort from cold temperatures in vent station.	Running an exhauster during cold weather	None	None
RCSTS-09-RAD03	High radiation dose to worker from the vent station due to the presence of residual radioactive contamination.	Holdup of radionuclides due to trapped radioactive material in pipes	None	None
RCSTS-1FS-LEVEL01	Release of caustic solution to the sump pit from the water flush tank due to over filling of tank.	Operator error - overfill of caustic material	Water Flush System Design	Flush Tank Sump
RCSTS-1FS-LEVEL02	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Flush tank receives radioactive waste from transfer line during drainback process. Jumper block valves and raw water block valves opened during the drain back of waste from vent station of the cross site transfer line.	None	None
RCSTS-1FS-LEVEL04	Release of caustic solution to the sump pit from the water flush tank due to human error.	Human error - drain valve left open	None	None
RCSTS-4FS-FLOW02	Release of caustic material to caustic storage area from caustic drum due to handling error.	Materials handling accident	None	None
RCSTS-5FS-FLOW03	Release of radioactive material into water flush tank due to loss of flush system pump operation.	Loss of pump pressure during flush operation causing back flow of waste	None	None
RCSTS-GENERAL-PRES	Release of radioactive material to the soil surface from supernate or slurry piping due to encasement breach (pipe is considered empty except for residual contamination).	Pneumatic leak testing	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-01-FLOW02	Release of radioactive aerosols and entrained solids to the atmosphere from Tank 241-SY-102 due to criticality.	Mistransfer of material containing organic extractant from east area via the supernate piping route	None	None
RCSTS-01-FLOW03	Release of radioactive supernate to the soil surface from overflow of Tank 241-SY-102 due to mistransfer.	Mistransfer of material from east area via the supernate piping route.	None	None
RCSTS-01-FLOW04	Release of radioactive aerosols/entrained solids and/or toxic gases to the atmosphere from Tank 241-SY-102 due to chemical reaction.	Mistransfer of incompatible material from east area via the supernate piping route.	Tank Farm Waste Compat Prog Waste Trans Proc Cntrls	None
RCSTS-01-FLOW05	Release of ammonia to atmosphere from a fire or a gas release resulting in an explosion due to addition of inadequately diluted caustic.	Human error	Industrial Hygiene Program	None
RCSTS-03-FLOW/INTEG01	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error).	None	None
RCSTS-03-FLOW/INTEG02a	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to misalignment (human error)	None	None
RCSTS-03-FLOW/INTEG02b	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to gasket failure	None	None
RCSTS-03-FLOW/INTEG02c	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Failure of jumper due to corrosion	None	None
RCSTS-03-FLOW/INTEG03a	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None	Trans Leak Detection: Material Balance
RCSTS-03-FLOW/INTEG03b	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection: Material Balance

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-03-FLOW/INTEG03c	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection: Material Balance
RCSTS-03-FLOW/INTEG04a	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to misalignment (human error)	None	Trans Leak Detection: Material Balance
RCSTS-03-FLOW/INTEG04b	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection: Material Balance
RCSTS-03-FLOW/INTEG04c	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection: Material Balance
RCSTS-03-FLOW02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None
RCSTS-03-FLOW03	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	None	None
RCSTS-03-FLOW04	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None
RCSTS-03-FLOW05	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	External leak of valve or valves to the valve pit	None	None
RCSTS-03-FLOW06	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection: Material Balance

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-03-FLOW07	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None	Trans Leak Detection: Material Balance
RCSTS-03-FLOW08	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection: Material Balance
RCSTS-03-INTEG01	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion in the valve pit caused by buildup of flammable gas because of spill of supernate or slurry	None	None
RCSTS-03-INTEG02	Release of radioactive aerosols to the atmosphere from the SY valve pit due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None	None
RCSTS-03-INTEG03	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External leak of valve or valves to the valve pit	None	Trans Leak Detection: Material Balance
RCSTS-03-INTEG04	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None	None
RCSTS-03-INTEG05	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	None
RCSTS-03-INTEG06	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None	None
RCSTS-03-INTEG07	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	None
RCSTS-03-INTEG08	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Seismic event	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-03-INTEG09	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
RCSTS-03-INTEG10	Release of radioactive slurry aerosols to the atmosphere caused by spray leak of slurry from the SY-A or SY-B valve pit due to piping system leak.	Seismic event	None	None
RCSTS-03-INTEG11	Release of radioactive supernate aerosols to the atmosphere caused by spray leak of supernate from the SY-A or SY-B valve pit due to piping system leak.	External event (airplane crash, etc)	None	Mass Balance
RCSTS-03-PRES02	Release of radioactive slurry to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	None	None
RCSTS-03-PRES03	Release of radioactive supernate to the soil surface from overflow in the SY-A or SY-B valve pit due to piping system leak (pool).	Water hammer	None	None
RCSTS-04/05-INTEG01a	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
RCSTS-04/05-INTEG01b	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
RCSTS-04/05-INTEG02	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None	None
RCSTS-04/05-INTEG03	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-04/05-INTEG04	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
RCSTS-04/05-INTEG05	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
RCSTS-04/05-TEMP01	Release of radioactive supernate to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	None	None
RCSTS-08-FLOW03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None	None
RCSTS-08-FLOW04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None	None
RCSTS-08-FLOW05	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto diversion box floor	None	None
RCSTS-08-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External leak of valve or valves to the diversion box	None	Trans Leak Detection: Material Balance
RCSTS-08-INTEG01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion	None	None
RCSTS-08-INTEG02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	External event (airplane crash, etc)	None	None
RCSTS-08-INTEG03	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	None
RCSTS-08-INTEG04	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to material defect	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-08-INTEG05	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe	None	None
RCSTS-08-INTEG06	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None	None
RCSTS-08-INTEG07	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Seismic event	None	None
RCSTS-08-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to corrosion	None	Trans Leak Detection: Material Balance
RCSTS-08-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
RCSTS-08-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
RCSTS-08-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	Trans Leak Detection: Material Balance
RCSTS-08-INTEG12	Release of radioactive aerosols to the atmosphere from the 6241-A diversion box due to fire or explosion of flammable gas.	Fire or explosion in the diversion box caused by buildup of flammable gas because of spill of supernate to diversion box sump	None	None
RCSTS-08-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Failure of piping due to material defect	None	Trans Leak Detection: Material Balance
RCSTS-08-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Slurry pump overspeed causing catastrophic failure of pump with missiles damaging pipe and challenging diversion box confinement	None	Trans Leak Detection: Material Balance

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-08-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Seismic event	None	None
RCSTS-08-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Seismic event	None	None
RCSTS-08-INTEG17a	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to corrosion plus mitigative features failure	None	None
RCSTS-08-INTEG17b	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to unrecognized material flaw	None	None
RCSTS-08-INTEG18	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (airplane crash, volcanism, etc)	None	None
RCSTS-08-PRES02	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Water hammer	None	None
RCSTS-08-PRES03	Release of radioactive supernate to soil surface from overflow of diversion box due to piping system leak.	Water hammer	None	None
RCSTS-08-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Water hammer	None	Trans Leak Detection: Material Balance
RCSTS-08-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Water hammer	None	Trans Leak Detection: Material Balance
RCSTS-08-TEMP01	Release of radioactive slurry to soil surface from overflow of diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None	None
RCSTS-08-TEMP02	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None	Trans Leak Detection: Material Balance

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-08-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from diversion box due to piping system leak.	Freezing of piping within the diversion box due to cold temperatures caused by running the exhauster	None	Trans Leak Detection: Material Balance
RCSTS-08-TEMP04	Release of radioactive supernate to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to freezing	None	None
RCSTS-09-FLOW01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flow of slurry to vent station due to incomplete closing of vent valves after venting	None	None
RCSTS-09-FLOW04	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	None	None
RCSTS-09-FLOW05	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External leak of valve or valves to the vent station	None	None
RCSTS-09-FLOW06	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Flow of supernate to vent station due to incomplete closing of vent valves after venting	None	None
RCSTS-09-FLOW07	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	None	None
RCSTS-09-FLOW10	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External leak of valve or valves to the vent station	None	Trans Leak Detection: Material Balance
RCSTS-09-FLOW11	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Backflow of supernate to sump pump line, through sump pump and onto vent station floor	None	None
RCSTS-09-INTEG01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	None	None
RCSTS-09-INTEG02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to corrosion	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-09-INTEG03	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None	None
RCSTS-09-INTEG04	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	External event (airplane crash, etc)	None	None
RCSTS-09-INTEG05	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	None
RCSTS-09-INTEG06	Release of radioactive aerosols to the atmosphere from the vent station due to fire or explosion of flammable gas.	Fire or explosion in the vent station caused by buildup of flammable gas because of spill of supernate or slurry to vent station	None	None
RCSTS-09-INTEG07	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	None	None
RCSTS-09-INTEG08	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Failure of piping due to material defect	None	None
RCSTS-09-INTEG09	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Seismic event	None	None
RCSTS-09-INTEG10	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Seismic event	None	None
RCSTS-09-INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to corrosion	None	Trans Leak Detection: Material Balance
RCSTS-09-INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
RCSTS-09-INTEG13	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-09-INTEG14	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Flammable gas explosion from release of trapped flammable gas within pipe combined with ignition source	None	None
RCSTS-09-INTEG15	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Failure of piping due to material defect	None	Trans Leak Detection: Material Balance
RCSTS-09-INTEG16	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Seismic event	None	None
RCSTS-09-INTEG17	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Seismic event	None	None
RCSTS-09-PRES01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Water hammer	None	None
RCSTS-09-PRES02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Water hammer	None	None
RCSTS-09-PRES04	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Water hammer	None	Trans Leak Detection: Material Balance
RCSTS-09-PRES05	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Water hammer	None	Trans Leak Detection: Material Balance
RCSTS-09-TEMP01	Release of radioactive slurry to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	None
RCSTS-09-TEMP02	Release of radioactive supernate to soil surface from overflow of vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	None
RCSTS-09-TEMP03	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	Trans Leak Detection: Material Balance

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-09-TEMP04	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from vent station due to piping system leak.	Freezing of piping within the vent station due to cold temperatures caused by running the exhauster	None	Trans Leak Detection: Material Balance
RCSTS-10/11-INTEG01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
RCSTS-10/11-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
RCSTS-10/11-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
RCSTS-10/11-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
RCSTS-10/11-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	Material Balance
RCSTS-10/11-INTEG04	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None	None
RCSTS-10/11-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
RCSTS-10/11-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-10/11-INTEG06	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
RCSTS-10/11-PRES01a	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	None	None
RCSTS-10/11-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
RCSTS-10/11-TEMP01	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	None	None
RCSTS-10/11-TEMP02	Release of radioactive supernate to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	None	None
RCSTS-12/13-INTEG01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
RCSTS-12/13-INTEG02a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
RCSTS-12/13-INTEG02b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to corrosion	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
RCSTS-12/13-INTEG03a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-12/13-INTEG03b*	Release of radioactive supernate to the atmosphere from the underground piping between the vent station and the 244-A Lift Station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	Material Balance
RCSTS-12/13-INTEG04	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None	None
RCSTS-12/13-INTEG05a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
RCSTS-12/13-INTEG05b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
RCSTS-12/13-INTEG06	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
RCSTS-12/13-PRES01a	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east	None	None
RCSTS-12/13-PRES01b*	Release of radioactive supernate to the soil subsurface from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to steam hammer caused by loss of flushwater flow to steam mixing chamber in east area	Operator Training Operating Procedures Press/Leak Testing Transfer Piping	Emergency Response Plan/Proc
RCSTS-12/13-PRES02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to water hammer	None	None
RCSTS-12/13-TEMP01	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary piping and encasement due to freezing	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-12/13-TEMP02	Release of radioactive supernate to the soil from the underground piping between the vent station and the 244-A Lift Station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	None	None
RCSTS-15/16-INTEG01a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
RCSTS-15/16-INTEG01b	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
RCSTS-15/16-INTEG02	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
RCSTS-15/16-INTEG03a	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
RCSTS-15/16-INTEG03b	Release of radioactive slurry to the soil surface from overflow of diversion box due to piping system leak.	Failure of piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
RCSTS-15/16-INTEG04	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and the diversion box due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
RCSTS-15/16-INTEG05	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism, etc)	None	None
RCSTS-15/16-TEMP01	Release of radioactive slurry to the soil surface from the underground piping between the SY-A or SY-B valve pit and a diversion box due to piping system leak.	Failure of primary and encasement piping due to freezing	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-18/19-INTEG01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (undermining from broken fluid transfer lines in vicinity)	None	None
RCSTS-18/19-INTEG02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to corrosion	None	None
RCSTS-18/19-INTEG03a	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	None
RCSTS-18/19-INTEG03b*	Release of radioactive slurry to the atmosphere from the underground piping between the diversion box and the vent station due to excavation of piping system and subsequent leak.	Failure of primary and encasement piping due to external event (excavation accident)	None	Material Balance
RCSTS-18/19-INTEG04	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to external event (airplane crash, volcanism etc)	None	None
RCSTS-18/19-INTEG05	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to flammable gas explosion in primary piping	None	None
RCSTS-18/19-INTEG06	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to unrecognized material flaw	None	None
RCSTS-18/19-INTEG07	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to seismic event	None	None
RCSTS-18/19-PRES01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to water hammer	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-18/19-TEMP01	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary piping and encasement due to freezing	None	None
RCSTS-18/19-TEMP02	Release of radioactive slurry to the soil from the underground piping between the diversion box and the vent station due to piping system leak.	Failure of primary and encasement piping due to thermal stress	None	None
RCSTS-1FS-LEVEL03	Release of caustic solution and radionuclides to the sump pit from the water flush tank due to over filling of tank.	Overfilling of flush tank from flow of radioactive waste from transfer line. Block valves open, valve limit switch and pressure switch fail and administrative control of raw water block valves fail	None	None
RCSTS-22-PRESS01*	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	None	Trans Leak Detection: Material Balance
RCSTS-22-PRESS02*	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from 244-A Lift Station due to piping system leak.	Dead heading of flow through the 244-A Lift Station with failure of PRV and development of crack in downstream piping	None	Trans Leak Detection: Material Balance
RCSTS-22-PRESS03*	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	None	None
RCSTS-22-PRESS04*	Release of radioactive slurry to soil surface from overflow of 244-A Lift Station due to piping break.	Dead heading of flow through the 244-A Lift Station with failure of PRV and subsequent downstream pipe failure	None	None
RCSTS-24-FLOW/INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to corrosion	None	None
RCSTS-24-FLOW/INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to corrosion	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-24-FLOW/INTEG03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to gasket failure	None	None
RCSTS-24-FLOW/INTEG04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to gasket failure	None	None
RCSTS-24-FLOW/INTEG05	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Failure of jumper due to misalignment	None	None
RCSTS-24-FLOW/INTEG06	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Failure of jumper due to misalignment	None	None
RCSTS-24-FLOW/INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW/INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to corrosion	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW/INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW/INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to gasket failure	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW/INTEG11	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Failure of jumper due to misalignment	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW/INTEG12	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Failure of jumper due to misalignment	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-24-FLOW02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	None
RCSTS-24-FLOW03	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External leak of valve or valves to the lift station	None	None
RCSTS-24-FLOW04	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External leak of valve or valves to the lift station	None	None
RCSTS-24-FLOW05	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW06	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Computer failure or human error causing misrouting of material when flow path is not completely connected	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External leak of valve or valves to the lift station	None	Trans Leak Detection: Material Balance
RCSTS-24-FLOW08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External leak of valve or valves to the lift station	None	Trans Leak Detection: Material Balance
RCSTS-24-INTEG01	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	External event (airplane crash, etc)	None	None
RCSTS-24-INTEG02	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	External event (airplane crash, etc)	None	None
RCSTS-24-INTEG03	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion in the lift station caused by buildup of flammable gas because of spill of supernate or slurry	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-24-INTEG04	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Seismic event	None	None
RCSTS-24-INTEG05	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Seismic event	None	None
RCSTS-24-INTEG06	Release of radioactive aerosols to the atmosphere from the lift station due to fire or explosion of flammable gas.	Fire or explosion due to leakage of flammable gas due to pipe breach in slurry line caused by gas release from slurry	None	None
RCSTS-24-INTEG07	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
RCSTS-24-INTEG08	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	External event (airplane crash, etc)	None	Material Balance
RCSTS-24-INTEG09	Release of radioactive aerosols to the atmosphere caused by spray leak of slurry from lift station due to piping system leak.	Seismic event	None	None
RCSTS-24-INTEG10	Release of radioactive aerosols to the atmosphere caused by spray leak of supernate from lift station due to piping system leak.	Seismic event	None	None
RCSTS-24-PRES01	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Steam hammer or thermal stress caused by loss of flushwater flow to steam mixing chamber in east area	None	None
RCSTS-24-PRES02	Release of radioactive slurry to soil surface from overflow of lift station due to piping system leak.	Water hammer	None	None
RCSTS-24-PRES03	Release of radioactive supernate to soil surface from overflow of 244-A Lift Station due to piping system leak.	Water hammer	None	None

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-2FS-FLOW01	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (upstream of flush pump) due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-FLOW02	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line break (downstream of flush pump) due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-FLOW03	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-FLOW04	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-FLOW05	Release of caustic solution spray to the atmosphere from the water flush system due to a relief valve failure.	Caustic injection pressure relief valve failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-FLOW07	Release of caustic solution spray to the atmosphere from the water flush system due to a transfer line break.	Flush line break due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-PRES01	Release of caustic solution spray to the atmosphere from the water flush system due line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-PRES02	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - after heaters due to debris buildup causing pressure buildup at the heater and resulting in heater pipe failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-PRES03	Release of caustic solution spray to the atmosphere from the water flush system due to a line break.	Flush line break due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-2FS-TEMP01	Release of caustic solution spray to the atmosphere from the water flush system due to a line plug.	Flush line plug - before heaters due to debris buildup causing a pressure buildup and failure of line	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-2FS-TEMP02	Release of caustic solution spray to the atmosphere from the water flush system due to freezing conditions.	Freezing weather with loss of heat trace function	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-4FS-FLOW03	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-4FS-FLOW04	Release of caustic to the atmosphere from the caustic system due to over pressurization of line and failure of pressure relief valve to open.	Back pressure valve fails in closed position	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-4FS-FLOW05	Release of caustic to the atmosphere from the caustic system due to line failure in chemical injection package.	Line failure/leak due to structural failure	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-4FS-FLOW06	Release of caustic to the atmosphere from the caustic system due to a caustic system drain valve leak.	Caustic drain valve leak	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-4FS-PRES/TEMP01	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing open.	Pressure relief valve fails open on caustic injection system.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-4FS-PRES/TEMP02	Release of caustic to the atmosphere from the caustic system due to pressure relief valve failing in closed position and rupture of line.	Back pressure relief valve fails in closed position.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response
RCSTS-5FS-FLOW01	Release of caustic to the atmosphere from caustic line due to a line break.	Line break due to structural failure.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response

Table D-6. Defense In Depth Controls For Potentially Severe (E3 and E2) Environmental Consequences. (22 sheets)

ID	Hazardous Conditions	Cause	DID-Preventive	DID-Mitigative
RCSTS-5FS-FLOW02	Release of caustic to the atmosphere from caustic line due to a line break.	Line plug due to debris buildup causing pressure buildup resulting in pipe failure.	Operator Training TWRS Hazardous Mat Protect Prog	Emergency Response

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702-AZ VENTILATION SYSTEM
(241-AZ-702)
SAFETY ANALYSIS

ADDENDUM 3

September 1999

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EXECUTIVE SUMMARY

ES.1 FACILITY BACKGROUND AND MISSION

The Aging Waste Facility (AWF) provides underground tank storage of high-level radioactive waste at the Hanford Site. The four tanks in the AWF require ventilation for confinement, cooling, and flammable gas mitigation. This document is the basis for the operation of the 241-AZ-702 ventilation system. The 241-AZ-702 ventilation system (28.3 m^3/min [1,000 scfm] maximum) replaces the existing 241-A-702 ventilation system (113.3 m^3/min [4,000 scfm] maximum). This document provides the safety analysis for closure of the Unreviewed Safety Question Evaluation (USQ TF-93-0055, *Tank Farm Ventilation Upgrade*, *Project W-030*) for this change to the AWF. It is important to note this Addendum was previously attached to the Basis for Interim Operation (BIO) and has been modified where necessary to assure compatibility with the FSAR. It is important to note that the hazards information presented in Appendices A, B, and C has been updated as necessary and incorporated into the FSAR hazards analysis database. Appendices A, B and C are retained in this Addendum for information only and should not be used in the Unreviewed Safety Question process.

ES.2 SCOPE

This Addendum to the HNF-SD-WM-SAR-067, *Tank Waste Remediation System Final Safety Analysis Report*, (FSAR), document provides safety analysis for the operation of the 241-AZ-702 ventilation system for normal operations of the AWF.

ES.3 FACILITY OVERVIEW

The AWF, 241-AY and 241-AZ Tank Farms, are located in the 200 East Area of the Hanford Site as shown in Figure 1-1. The AWF is described in the FSAR, Chapter 2.0, "Facility Description." A detailed description of the 241-AZ-702 ventilation system is found in Section 2.0 "Facility Description" of this addendum.

The 241-AZ-702 ventilation system provides a maximum 28.3 m^3/min (1,000 scfm) flow from the four tanks (2.83 m^3/min [100 scfm] nominal from each tank) as described in Section 2.5.1.2 of this addendum.

ES.4 FACILITY HAZARD CATEGORY

The AWF Tank Farms are identified in the FSAR as Hazard Category 2 facilities.

ES.5 SAFETY ANALYSIS OVERVIEW

The operation of the 241-AZ-702 ventilation system is compared with the 29 accident analyses in the FSAR and is found to be bounded by all accidents.

In addition, before initial release of the BIO as part of the Authorization Basis, hazards associated with operation of the 241-AZ-702 ventilation system were evaluated using preliminary hazard analysis (PHA) and hazards and operability (HazOp) evaluation techniques. From the results of the hazard analysis, five accidents were identified as representative of the significant hazards. These accidents are the high-efficiency particulate air (HEPA) filter failure due to high temperature, HEPA filter failure due to high pressure, Flammable Gas Deflagration, Tank Bump, and tank dome collapse. The risk evaluation guidelines are identified in Revision 1, Section 7.0, "Risk" of WHC-CM-4-46[1], *Safety Analysis Manual*.

An expansion of an existing FSAR control unique to the 241-AZ-702 ventilation system is required to protect the assumption on the filter source term used in the comparisons with the FSAR. It is required that the high-efficiency mist eliminator (HEME), assumed to be equivalent to four HEPA filter volumes, be monitored and replaced at $\leq$ 800 mrem/h. The high efficiency gas adsorber (HEGA) must be replaced before the upstream HEPA filter in the associated filter train has been replaced 20 times and when the upstream HEPA filter in the associated filter train is determined to have a particulate removal efficiency of < 99.95% by performance of an aerosol test, or other indication of degraded HEPA filter performance.

ES.6 ORGANIZATIONS

The AWF is part of the Tank Waste Remediation System which is operated by Lockheed Martin Hanford Corporation (LMHC) under contract to the Fluor Daniel Hanford, Inc. (FDH). This document was developed by Duke Engineering and Services Hanford, Incorporated (DESH) for LMHC.

ES.7 SAFETY ANALYSIS CONCLUSIONS

The findings of this document conclude that the 241-AZ-702 ventilation system provides those controls and features necessary and sufficient to ensure the protection of workers, the environment, and the public during its operation.

ES.8 DOCUMENT ORGANIZATION

This document is organized in the format of DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*. For those sections where information would be provided about Site-wide programmatic controls, only the portions of those programs directly applicable to the 241-AZ-702 ventilation system are described. The remaining portions of the Addendum sections reference the FSAR.

---

[1]Refer to Appendix G, "Sitewide Controlled Manual Cross-Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., Procedures (e.g., HNF-PRO-XXX).

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LIST OF TERMS

AC	Administrative Control
ALARA	As Low As Reasonably Achievable
ALC	airlift circulator
AMCA	Air Movement Contractor Association
AWF	Aging Waste Facility
ASME	American Society of Mechanical Engineers
ATP	acceptance test procedure
BEU	beyond extremely unlikely
BIO	Basis for Interim Operation
CAM	continuous air monitor
CGM	combustible gas meter
D&D	decontamination and decommissioning
DBA	design basis accidents
DCRT	double-contained receiver tanks
DESH	Duke Engineering and Services, Hanford Incorporated
DOE	U.S. Department of Energy
DST	double-shell tank
EIS	Environmental Impact Statement
ERPG	Emergency Response Planning Guideline
EWS	export water system
FDH	Fluor Daniel Hanford, Inc.
FGEAB	Flammable Gas Equipment Advisory Board
FG JCO	Flammable Gas Justification for Continued Operation
FHA	fire hazards analysis
GC	gas chromatograph
GFCI	ground fault circuit interrupters
GRE	gas release event
HazOp	hazard and operability study
HEGA	high-efficiency gas adsorber
HEME	high-efficiency mist eliminator
HEPA	high-efficiency particulate air (filter)
HVAC	Heating, Ventilation, and Air Conditioning
IOSR	Interim Operational Safety Requirement
LCO	Limiting Condition for Operation
LFL	Lower Flammability Limit
LMHC	Lockheed Martin Hanford Corporation
MCC	motor control center
MCS	monitor and control system
MOV	motor-operated valve
NFPA	National Fire Protection Association
NESHAP	National Emission Standards for Hazardous Air Pollutants
OSD	Operating Specification Document
OTP	operational test procedures
OVM	Organic Vapor Meter

LIST OF TERMS (Cont'd)

PEL-TWA	permissible exposure limit-time weighted average
PFP	Plutonium Finishing Plant (Z Plant)
PHA	preliminary hazard analysis
PIC	person-in-charge
POTP	pre-operational test procedures
PUREX	Plutonium Uranium Extraction (facility)
RCT	radiological control technician
RWS	raw water system
SDC	Standard Design Criteria
SHMS	Standard Hydrogen Monitoring System
SL	Safety Limit
SSC	structure, system, and component
SST	single-shell tank
SWS	Sanitary Water System
TMACS	Tank Monitoring and Control System
TOC	total organic carbon
TSR	Technical Safety Requirements
TWRS	Tank Waste Remediation System
UL	Underwriters Laboratories
ULD	unit liter dose
USQ	Unreviewed Safety Question
WG	water gauge

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1.0 SITE CHARACTERISTICS

1.1 INTRODUCTION

This section describes the Hanford Site characteristics applicable to the Aging Waste Facility (AWF) ventilation upgrade project (Project W-030) at the Tank Waste Remediation System (TWRS) facilities. The ventilation upgrade is referred to as the 241-AZ-702 ventilation system. The AWF is located in the 200 East Area of the Hanford Site.

It is not the intent of this section to provide all of the information required by the guidance of DOE-STD-3009-94, but to provide the information necessary to describe the facility's location, and critical parameters used in Section 3.0, "Hazard and Accident Analyses."

1.2 REQUIREMENTS

The following standards, regulations, and U.S. Department of Energy (DOE) Orders establish the site characterization requirements for support of safety analysis and design unique to 241-AZ-702 ventilation system.

- DOE 4700.1, *Project Management System*, Change 1 (1992)
- HPS-SDC 4.1, Hanford Plant Standards, Revision 11, (for natural phenomena loading).

Additional requirements related to site characteristics can be found in HNF-SD-WM-SAR-067, Chapter 1.0, "Site Characteristics," Section 1.2, "Requirements."

1.3 SITE DESCRIPTION

This section addresses the site boundary and site location with respect to the AWF. See the FSAR, Chapter 1.0, Section 1.3, "Site Description" for site geography, general site description and demography.

The TWRS AWF is located in the 200 East Area of the Hanford Site (Figure 1-1). For this analysis, the site boundary used for calculations is 8.7 km (5.44 mi) to the north (the near side of the Columbia River) (FSAR, Section 3.4.1, "Methodology").

1.4 ENVIRONMENTAL DESCRIPTION

The meteorological, hydrological and geological characteristics of the site, in conjunction with the 241-AZ-702 ventilation system, do not create any new, unique hazards for the 241-AZ-702 ventilation system (FSAR, Section 1.4, "Environmental Description").

1.5 NATURAL PHENOMENA THREATS

No changes result from the installation or operation of the 241-AZ-702 ventilation system. See FSAR, Section 1.5, "Natural Phenomena Threats," for the description of the natural phenomena threats.

1.6 EXTERNAL MAN-MADE THREATS

There are no unique external man-made threats for the 241-AZ-702 ventilation system (FSAR, Section 1.6, "External Man-Made Threats").

1.7 NEARBY FACILITIES

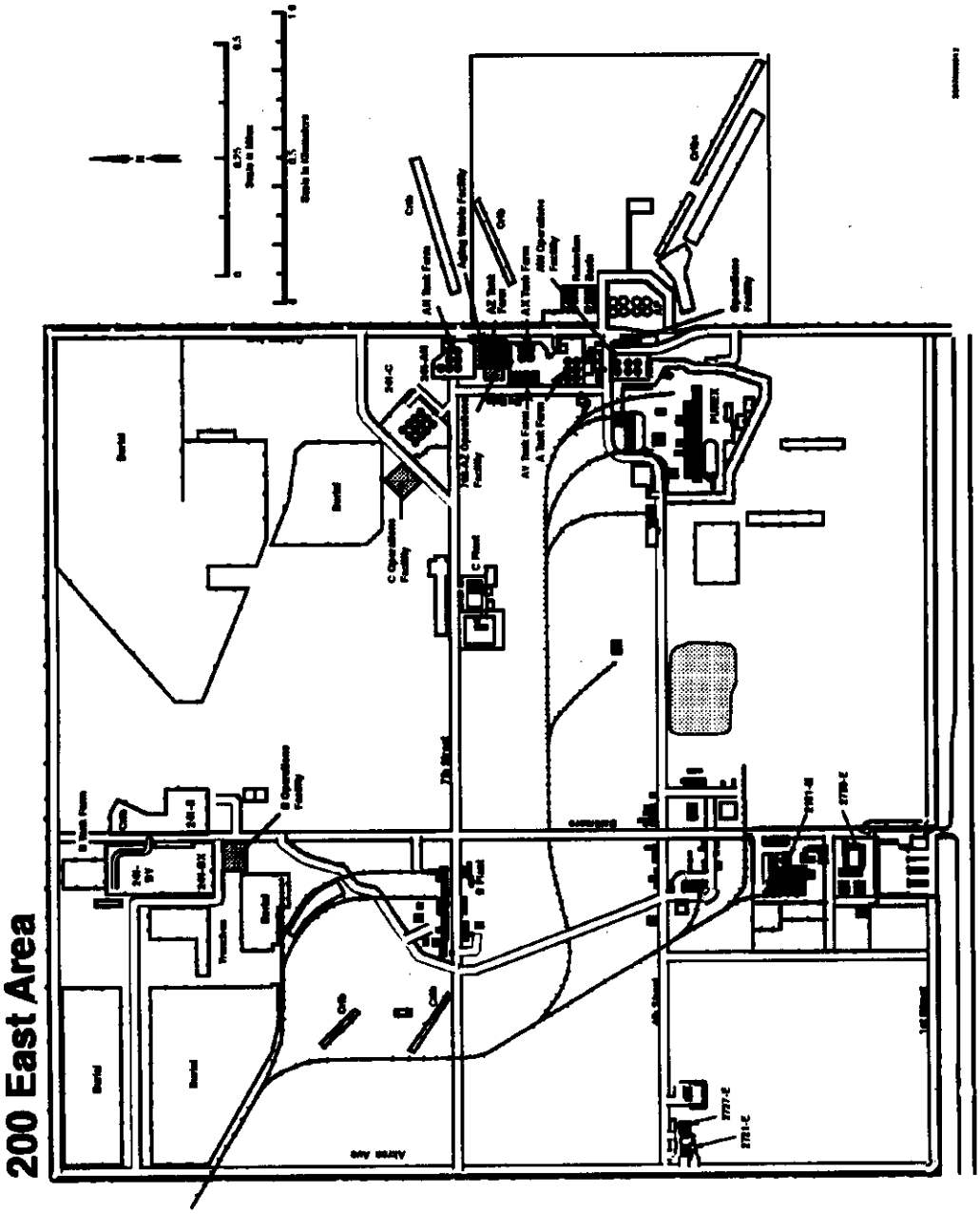
Accidents attributed to nearby facilities are discussed in FSAR, Section 1.7, "Nearby Facilities." There are no unique accidents from nearby facilities identified for the 241-AZ-702 ventilation system.

The AWF accidents with the potential to affect the onsite individual at 100 m (which may include persons at some of the facilities discussed in the FSAR, Section 1.7) are discussed in Section 3.0.

1.8 VALIDITY OF EXISTING ENVIRONMENTAL ANALYSES

The 241-AZ-702 ventilation system was evaluated in WHC-SD-W030-EE-001, *Environmental Evaluation*, and found to be within the scope of the existing Environmental Impact Statement, DOE/EIS-0113, *Final Environmental Impact Statement: Disposal of Hanford Defense High-Level, Transuranic, and Tank Waste, Hanford Site, Richland, Washington*. The consequences of all analyzed accidents for the project do not create any additional and unreviewed insults to the environment. In fact, WHC-SD-W030-EE-001 shows that normal operations of this system enhance environmental compliance by reducing liquid effluents. The system design requirements were based on analyses to meet environmental requirements and therefore provide compliance with 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants (NESHAP)," *Code of Federal Regulations*, by reducing stack effluents.

Figure 1-1. The 200 East Area.



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2.0 FACILITY DESCRIPTION

2.1 INTRODUCTION

The purpose of this section is to provide a general description of the 241-AZ-702 ventilation system. Defense-in-Depth and Safety-Class or Safety-Significant structures, systems, and components (SSCs) are addressed in Sections 3.0, "Hazard and Accident Analyses," and 4.0, "Safety Structure, Systems, and Components," of this addendum.

The 241-AZ-702 ventilation system safety documentation does not include in its scope the operation of the Project W-151 mixer pump in Tank 241-AZ-101 nor the Project W-320 activities for the receipt of waste from Tank 241-C-106. Each of these projects is preparing separate safety documentation.

2.2 REQUIREMENTS

The design codes, standards, regulations, and U.S. Department of Energy (DOE) Orders relevant to the design and construction of the 241-AZ-702 ventilation system are listed in the functional design criteria, WHC-SD-600-FDC-001, *Functional Design Criteria for the Tank Farm Ventilation Upgrade, Project W-030*. The safety SSCs were designed to DOE 6430.1A, *General Design Criteria*, as SC-2. After the system was designed and built, the safety analysis required changing some of these to SC-1. See Section 4.0 of this addendum for details.

2.3 FACILITY OVERVIEW

The Aging Waste Facility (AWF), 241-AY and 241-AZ Tank Farms, is located in the 200 East Area of the Hanford Site in a complex of tank farms known as the Plutonium Uranium Extraction (Facility) (PUREX) 241-A Tank Farm Complex, situated to the northeast of the PUREX Plant. As shown in Figure 1-1, the 241-AZ Tank Farm is located in the northernmost fringe of the 241-A Tank Farm Complex. The 241-AY Tank Farm is located southwest of the 241-AZ tanks west of AX Tank Farm. The 241-AZ-702 ventilation system supports the currently defined mission of waste storage for the AWF.

2.4 FACILITY STRUCTURE

The 241-AZ-702 ventilation system includes three new buildings: a ventilation building, a generator/service building, and a control building. It also includes four recirculation/cooling cells. The location of the new buildings and cells are shown on Figure 2-1. The ventilation, generator/service, and control buildings were designed to DOE 6430.1A and Hanford Plant Standard SDC 4.1, *Architectural - Civil Design Criteria, Design Loads for Facilities*, as described in the functional design criteria for 241-AZ-702 (WHC-SD-600-FDC-001). Floor plans for these buildings and facility are shown in Figures 2-2 through 2-5.

The new ventilation building houses the primary tank ventilation equipment, including condensers, high-efficiency mist eliminator (HEME), heater coils, high-efficiency particulate air (HEPA) filters, high-efficiency gas adsorbers (HEGAs), fans, near isokinetic stack sampling, continuous air monitoring instruments, and ventilation facility local control units. The ventilation building has a floor area of approximately 1394 m^2 (15,000 ft^2) and is made of cast-in-place reinforced concrete. The building has four exterior doors. Two of these doors have a double door arrangement. Doors, frames, and hardware are designed to maintain a negative pressure inside the building.

The new generator/service building houses one diesel generator and standby power distribution equipment. Backflow preventers, strainers, and flow meters for the raw water supply are located in the service room. The generator/service building has a floor area of approximately 288 m^2 (3,100 ft^2) and is made of cast-in-place reinforced concrete. The building is constructed of non-combustible materials.

The control building is a prefabricated metal structure on a reinforced concrete slab. The control building houses the automated control and indication information such as tank head space pressure.

The recirculation/cooling cells house the process cooling equipment for recirculation cooling of the tank ventilation off gas. The process equipment included is a shell-and-tube heat exchanger, moisture separator, electric motor driven fan, flow control valve, miscellaneous remote/manual actuated valves, interconnecting piping and instrumentation. The cells were constructed of reinforced concrete with outside dimensions of 4.6 m (15 ft) by 4.9 m (16 ft) by 3.4 m (11 ft) high. A cover block is provided in the roof for future removal of the heat exchanger. A steel door is provided for personnel access into the cell for maintenance. The cell has capped connections for hookup of temporary ventilation when personnel access is required.

2.5 PROCESS DESCRIPTION

The activities and operations performed within the AWF include waste storage, transfer, characterization, concentration, and other miscellaneous activities. Other than tank ventilation, the 241-AZ-702 ventilation system does not impact the currently-defined storage mission or the basic processes in use in the facility. This section describes the new ventilation system process.

2.5.1 System Overview

2.5.1.1 System Functional Overview

2.5.1.1.1 Confinement and Heat Removal. The 241-AZ-702 ventilation system provides uninterrupted operations during normal operation, maintenance or testing. Selected components of the 241-AZ-702 tank ventilation system are redundant. Automatic transfer of ventilation system functions from the

primary system components to the redundant system components is provided. Transfer of functions is activated at the first indication of system failure to prevent the loss of system confinement.

The 241-AZ-702 ventilation system is sized such that a negative differential pressure with respect to atmospheric pressure can be maintained under normal operating conditions to contain radioactive and non-radioactive gases, vapors, suspended droplets, and airborne particulates within the system until appropriately treated and discharged. Sufficient controls are provided to maintain the tank at less than atmospheric pressure. The primary tank ventilation system is capable of removing heat and water vapor from the tank vapor space, and compensate for normal air infiltration and process air introduced into the tank through the airlift circulators. Pressure sensors in the head space of each tank provide pressure indication in the control room and on strip chart recorders in the instrumentation buildings, 241-AY-801 and 241-AZ-801.

Heat removal is provided primarily by recirculation ventilation cooling with some additional cooling provided by once through air flow. See Table 2-1 for system heat removal and operating temperatures.

The 241-AZ-702 ventilation system does not compromise the present tank operating capabilities and requirements. Features provided by the 241-AZ-702 ventilation system are listed below:

- Active and/or passive cold weather protection for all new heating, ventilation, and air conditioning (HVAC) instrumentation, duct work, fans, exhaust stacks, drains, and sealpots.
- Features to prevent moisture accumulation on HEPA filters (e.g., deentrainers, HEME filters).
- Provisions for measuring pressure differential across, and in-place testing of, individual filters in accordance with American Society of Mechanical Engineers (ASME) N510, *Testing of Nuclear Air Treatment Systems*; gauges and instruments are located and/or suitably protected to prevent moisture accumulation.
- Electrical equipment enclosures with temperature controls to provide a suitable environment for the installed equipment.
- Safe access provided to all areas of operation, including ladders, walkways, platforms, as applicable.
- Stack airflow and discharge volume measurement.
- Near isokinetic particulate sampling for the exhaust stack.
- Features (HEME, condenser, and recirculation system) to prevent ammonium nitrate or other soluble compound accumulation on the filters.

- Instrumentation to provide monitoring of the equipment operation for each stage of exhaust treatment and ports for future additional monitoring and control.

- A HEGA to remove organic carbon vapors and iodine gas.

2.5.1.1.2 Air Cleaning and Treatment. Exhaust air from the primary tank system is treated to minimize releases of radioactive and hazardous effluents to the atmosphere. The filtered airstream is continuously sampled for radioactive and known hazardous substances, and continuously monitored for gross beta and gamma. Instruments record radioactive releases and alarm before allowable radioactive release limits are exceeded.

The listing of radioactive and hazardous effluents to the atmosphere to be measured can be found in Bauer (1994a and 1994b). These documents are the Notices for Construction sent from the DOE to the Environmental Protection Agency and the Washington State Department of Ecology, respectively.

2.5.1.1.3 Condensate Collection and Disposal. Water vapor removed from the tanks is condensed, and the condensate is returned to AY and/or AZ high heat tanks. The design for condensate collection and disposal complies with WAC-173-460, "Controls for New Sources of Toxic Air Pollutants," as amended, and 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants (NESHAP)," *Code of Federal Regulations*, as amended.

2.5.1.1.4 Monitoring and Control. A new instrument/control center is provided to house the new instrumentation for the tank ventilation. Environmental controls are provided for the new facility, commensurate with the requirements for equipment to be installed.

Instrumentation is installed to provide safe and reliable operation of the tank ventilation system and standby power systems. Continuous air monitors (CAM) and record air samplers are provided on the primary tank ventilation system to detect and measure hazardous and/or radioactive releases to the atmosphere, with alarms for low flow conditions and for loss of sample flow. The alarms are separate and distinct from that used for high radiation. Stack record air sampling is continuous and representative of the airflow in the duct work. The flow meters are Safety-Class instrumentation for the 241-AZ-702 ventilation system (HNF-SD-WM-SEL-040, *TWRS Facility Safety Equipment List*).

Temperature and leak detector alarms and signals are sent to the Tank Monitoring and Control System (TMACS) (Table 2-2). New instrument and electrical wire runs are enclosed in separate raceways where practicable and to facilitate future mission flexibility.

Instrumentation that has alarm features, are designed to alarm on loss of signal.

2.5.1.2 System Design Overview. The Primary Tank Ventilation System for the 241-AY-101, 241-AY-102, 241-AZ-101, and 241-AZ-102 tanks contains individually controlled air inlets, independent cooling systems, and a common ventilation off gas exhaust. A functional overview of the 241-AZ-702 ventilation system is found in Figure 2-6.

The tank ventilation off gas from each tank is exhausted through a flow control valve, processed through a condenser, mist eliminator, heater, and then filtered before being exhausted to the atmosphere through a stack. The filter/fan train is redundant to maintain tank pressures during anticipated maintenance shutdowns or component failure. Likewise, the flow control valve can be bypassed during anticipated maintenance shutdowns or valve failure.

The entire system is automatically controlled by the monitor and control system (MCS). Should the MCS fail, the ventilation system will remain in its current state but can then be run manually. The approach will be to shut down all ancillary equipment and to manually operate primary exhaust fans while monitoring the primary stack CAM and tank pressure instrumentation. The failure of the computer controlled equipment, from an individual component to an entire system failure, has appropriate alarm response procedures and guidance to the operators' actions to restore the system to a safe configuration and restore primary tank ventilation. Once stable operation is achieved, the remainder of the system would be restored.

The Primary Tank Ventilation System performs the following functions:

- Provides filtered inlet air for tank cooling and gas dilution for any flammable gases
- Maintains a negative pressure in the waste storage tanks of approximately 3 to 8 cm (1 to 3 in.) water gauge during normal operation
- Provides cooling-condensing of the off gas streams for tritium removal, in a recirculation loop for each tank.
- Removes particulates and condensable vapors from the radioactive off gas streams
- Exhausts the primary tank ventilation stream from the four tanks to the atmosphere through a primary exhaust stack
- Monitors exhaust emissions.

The system has three operating modes: 1) recirculation (Figure 2-7), 2) bypass (Figure 2-8), and 3) high heat (Figure 2-9). The alignment of the ventilation system on any one tank is independent of the alignment of the ventilation system on the other tanks:

1. Each tank's recirculation mode directs tank headspace gases through their respective Recirculation Ventilation Cooling System with, typically, 80% of the airstream returned back into the tank and 20% to the common exhaust system. The common exhaust system draws enough air to maintain a negative pressure in all of the tanks, relative to atmospheric pressure, with the majority of the flow back to the tank. The air flow through the recirculation loop is fixed by equipment design, however each tank's exhaust flow rate is actively-controlled and held constant.

2. The bypass mode directs tank headspace gases directly to the common exhaust system, bypassing the Recirculation Ventilation Cooling System.

3. The high heat mode directs tank headspace gases through the Recirculation Ventilation Cooling System then into the common exhaust system with no air returning to the tank. When any tank is in the high heat mode, the common exhaust fan flow is increased in order to increase evaporative cooling of the tank operating in high heat mode. Exhaust flow is routed through the Recirculation Ventilation Cooling System to help remove moisture.

Operation of the three modes is controlled with valving within the duct work. The selection of the operating mode is manually established. The operating mode is thus established by the configuration of the valves in the recirculation system. The lineups and flow paths of the different operating modes are illustrated in Figures 2-7, 2-8, and 2-9.

Normal operation, with all of the recirculation systems available, results in 14.2 m^3/min (500 scfm) being withdrawn from each tank. In this case, 80%, or 11.3 m^3/min (400 scfm), is returned to the tank while the remaining 20%, or 2.8 m^3/min (100 scfm), goes out the stack. This 2.8 m^3/min (100 scfm) is compensated by introducing atmospheric air through the inlet filter system into the tank. This results in 56.6 m^3/min (2,000 scfm) being withdrawn from the four AWF tanks and only 11.3 m^3/min (400 scfm) going into the main ventilation system. Each tank can be set at a different flow rate (e.g., one tank could be set to send 17.0 m^3/min [600 scfm] to the main ventilation system, and each of the others can be set at 2.8 m^3/min [100 scfm], for a total flow of 25.5 m^3/min [900 scfm] at the main ventilation system). The total ventilation flow is limited by the system capacity of 28.3 m^3/min (1,000 scfm). Each 241-AZ-702 fan is capable of 59.8 mmHg (32 in. WG) vacuum at peak. The recirculation fans add 33 mmHg (17.5 in. WG) vacuum at peak.

The airlift circulators (ALCs) are designed to operate at a minimum of 1.6 m^3/min (55 scfm) with normal operation of 2.3 m^3/min (80 scfm) for each tank. The maximum airflow for one tank is 12.5 m^3/min (440 scfm). The total ALC compressor capacity for all of the AWF tanks is limited to either 11.3 m^3/min (400 scfm) or 14.2 m^3/min (500 scfm) depending on whether the primary or backup compressor is being used. This additional ALC airflow remains within the operating capacity for the 241-AZ-702 ventilation system since the flow can be adjusted for each tank.

Instrumentation is provided at each tank to monitor and control pressure. The MCS is provided with its own uninterruptible power supply that ensures the MCS remains operational while the diesel generator comes on line. The diesel generator provides the backup electric power to the exhaust fans which are safety equipment (HNF-SD-WM-SEL-040).

Because flammable gas generation is a concern during the operation of any equipment with direct communication with the tank headspace, such equipment is required to meet National Fire Protection Association (NFPA) Class 1 Division 2 criteria or its equivalent (FSAR, Appendix K, "Flammable Gas Hazards and Controls in Hanford Waste Storage Tanks and Waste Transfer

Facilities"). The 241-AZ-702 equipment meets these requirements before the first mixing point as defined in the FG JCO through compliance with the Flammable Gas Equipment Advisory Board (FGEAB) direction. The board reviewed three aspects of the 241-AZ-702 ventilation system: 1) the equipment before the first mixing point (Inlet Filter Arrangement and Recirculation Module), 2) the equipment after the first mixing point, and 3) tie-ins related to construction. The board's directions are summarized below.

- Inlet Filter Arrangement
  - Equipment not listed below complies with Appendix K of the FSAR.
  - Heater, control/electrical Box, HEPA filter differential pressure switch and heat trace require either modifications or de-energizing during waste disturbing activities (FGEAB 97-005a, "Operation of new ventilation system to support the AWF (INLET FILTER ARRANGEMENT)" [FGEAB 1997]). The heater has been modified per the directions and the others will be de-energized as directed.
- Recirculation Module
  - Equipment not listed below either complies with FSAR Appendix K requirements or is beyond the first mixing point.
  - The fans require modification. The board directed a stop plate near the sheave to prevent axial movement of the shaft and this modification was performed (FGEAB 97-005b, "Operation of New Ventilation System to Support the Aging Waste Facility (RE-CIRCULATION MODULE)" [FGEAB 1997]).
- Equipment Beyond First Mixing Point
  - No requirements are on this equipment (FGEAB 97-031, "Project W-030, Activity and equipment located after the first mixing point" [FGEAB 1997]).

The 241-AZ-702 ventilation system equipment complies with the board's recommendations. Another report was issued dealing with the tie-in activities (FGEAB 97-005c, "Hot Tie-in of the New Ventilation System to Support the Aging Waste Facility" [FGEAB 1997]). Although performed before the issuance of the FG JCO and determination of the AWF tank Facility Group (all are Facility Group 2 tanks), a mixing study was performed for the 241-AZ-702 ventilation system that corroborates the board's findings (WHC-SD-WM-ER-592, *Assessment of the Project W-030 Ventilation System Following a Hypothetical Gas Release Event*).

2.5.2 Inlet Breather

The tank air inlet breather, installed on each of the AWF tanks, consists of a heater, prefilter, HEPA filter, flow control valve, flow meter, and a vacuum relief valve. The functions performed by these components are described below.

- The heaters protect the pre-filters from excessive humidity or frost.
- The prefilters protect the HEPA filters from excessive particulate loading that would shorten their lives.
- The HEPA filters protect the environment against potential backflow from the waste tank inlet.
- The flow control valves are automatically modulated to maintain a negative pressure range in the waste storage tanks.
- The flow meters monitor air flow into each of the waste storage tanks.
- The vacuum relief valves are provided to prevent excessive negative pressure in the waste storage tank. The vacuum relief valves have direct communication between the tank vapor space and the atmosphere. The valves are actuated before a pressure of 1.49 kPa (-6 in. WG) by a diaphragm that senses tank pressure.

2.5.3 Recirculation Ventilation Cooling

The four Recirculation Ventilation Cooling systems help to reduce moisture and remove the heat generated in the tanks. The cooling equipment for each tank is located in concrete vaults. This system consists of four basic parts: 1) ductwork, 2) the condenser, 3) the Recirculation Ventilation Cooling Module, and 4) the Evaporator Cooling Tower. The vaults are reinforced concrete structures with equipment access from the top and personnel access through a door. The Recirculation Ventilation Cooling Module does not have backup power. Backup power is not needed because if the Recirculation Ventilation Cooling Module fails, once-through cooling is sufficient to maintain tank temperature below limits (Table 2-1).

There is an independent recirculation cooling system for each tank in the AWF. Each system is similar in design but differs in cooling capacity. The cooling capacity for Tank 241-AZ-101 is higher than the other three tanks (i.e., the evaporative cooling tower has a higher capacity). A continuous cable leak detection system is located around the condenser, moisture separator, and recirculation fan to sense condensate leaks. An alarm is activated upon leak detection.

2.5.3.1 Duct Work. The duct work of the recirculation cooling sub-system provides gas and moisture confinement for the exhaust stream during the cooling process. The duct work is buried, double-encased piping with 35.6 cm (14-in.) carbon steel pipe around 25.4 cm (10-in.) stainless steel pipe. The

buried ducting is cathodically protected with an active system. A leak detector is located at the low spot of both the inlet and outlet encased piping to the waste tanks. The detector monitors for liquid condensate that has entered the encasement (presumably from a leaking liner pipe). When a leak is detected, an alarm is activated (e.g., alarm to the control room) and corrective action is taken according to the requirements of the radioactive and hazardous waste management program (HNF-SD-WM-SAR-067, Chapter 9.0, "Radioactive and Hazardous Waste Management"). This corrective action in the case of the 241-AZ-702 ventilation system is in the form of pumping out the encasement.

2.5.3.2 Recirculation Ventilation Cooling Module. The recirculation ventilation cooling module consists of the following:

- Condenser
- Recirculation Fan
- Moisture Separator.

2.5.3.2.1 Condenser. Each condenser is a shell-and-tube heat exchanger. The ventilation gas stream is cooled by circulating 1,900 L (500 gal) of 50% propylene glycol, 50% water solution through the tubes. This 50/50 mixture cannot be demonstrated to have a flashpoint. Condensate collected in the condenser is drained back to the tank by means of a drain line that is connected to the return ventilation duct. The drain line is isolated from the ventilation duct by a seal loop. Instrumentation monitors differential pressure across the condenser, inlet temperature, and outlet temperature.

2.5.3.2.2 Recirculation Fan. Each recirculation fan is single housing, single impeller, centrifugal type, non-overloading, and direct driven by an electric motor. Each fan operates at 14 m^3/min (500 scfm). The recirculation fan circulates the tank headspace gases through the Recirculation Ventilation Cooling Module.

Instrumentation is provided to monitor motor current and differential pressure across the fan. A low differential pressure across the condenser indicates that the fan is not operating properly and activates an alarm. Flow meters monitor air flow from each of the waste storage tanks.

2.5.3.2.3 Moisture Separator. Each vertical gas-liquid separator is designed to remove entrained liquid, which prevents erosion of the fan wheel. The separator removes liquids from the air stream by centrifugal force and gravity. Moisture removed from the exhaust stream drains by gravity back to the tank along the return ventilation duct. The drain line from the condenser to the ventilation duct is isolated by a seal loop.

2.5.3.3 Evaporator Cooling Tower. The Evaporator Cooling Tower consists of an evaporative cooling tower, two circulation pumps, an expansion tank, an air separator, and instruments for monitoring the closed loop cooling system. The cooling medium is a propylene glycol solution that is circulated between the evaporative cooling tower and the recirculation condenser. A propylene glycol solution is used for freeze protection and corrosion prevention. The

propylene glycol solution receives heat in the recirculation ventilation condenser and rejects heat to the atmosphere in the evaporative cooler. The evaporator is provided with a fan and a spray water system to remove heat from the fluid. The fan may be run without the spray pump operating, as necessary to more efficiently meet tank waste cooling needs.

A circulation line transports the propylene glycol solution to and from the recirculation condenser and the evaporative cooling tower. A manually operated globe valve is provided for initial propylene glycol flow adjustment. Instrumentation is provided to monitor the line for flow, pressure, and temperature. The main piping is carbon steel with welded fittings.

2.5.3.3.1 Condenser Pumps. Each evaporator cooling tower has two pumps (one active and one standby) to circulate the propylene glycol solution through the condenser and the evaporator cooling tower. Both pumps are provided with isolation valves. The pumps also are provided with suction and discharge local pressure indicators.

The pumps are provided with current indication and alarms to show whether the pump is running or has failed. Status alarms are used to indicate a disagreement between the hand switch position and the pump operation. To facilitate equal pump wear, indication of total pump operation time is provided.

During a low-flow condition, the operating pump is shut down, a low-flow alarm is activated, and the standby pump becomes the operating pump. If the flow is not reestablished, then the standby pump also is shut down. Both pumps must be reset for the system to operate again. Low flow could be a warning sign of a leak, a clogged line, a low level in the propylene glycol tank, or a malfunctioning pump.

2.5.3.3.2 Expansion Tank. Each propylene glycol expansion tank will provide adequate system pressurization under all operating conditions. The tank provides for system expansion and contraction. A low-level alarm will notify the operator of a pending problem.

2.5.3.3.3 Evaporative Fluid Cooler. The evaporative fluid cooler removes heat from the propylene glycol solution returning from the recirculation condenser. The cooler is equipped with a heat exchanger, cooling fan, spray pump, and water collection pan. A closed-loop sump water recirculation system also is provided for water quality control.

The cooling fan has temperature-controlled dampers to modulate air flow for greater power savings over the operating season. The damper package consists of a single airfoil-type damper blade located in the fan discharge housing. The controls consist of a control transformer, damper motor actuator with linkage, and end switches to cycle fan motors. A proportional-acting temperature controller to control the damper actuators is installed on the outlet line of the evaporative fluid cooler.

The spray pump circulates sump water to spray nozzles, which spray onto a heat exchanger and the water drains back into the sump. The level control automatically provides raw water for sump water makeup. A low water level switch prevents operation of the spray pump. The sump water is provided with a heater controlled by a thermostat with the sensing bulb located in the sump water. The heater protects sump water from freezing.

Sump water quality is maintained by a closed-loop circulation system. Sump water is recirculated by means of a recirculation pump through a strainer and centrifugal separator for particulate removal. Particulates removed by the separator are captured in a bag filter as the separator drain discharges back to the pump suction. Particulate buildup on the filter will initiate an alarm.

Water conductivity is measured by a conductivity probe in the circulation system. A circulation flow is passed over the probe for indication of salts and dissolved solids buildup in the sump water. At a predetermined operator setpoint, high conductivity will actuate the sump water drain valve to drain the sump water to manhole No. 1. Raw water makeup is automatically provided by means of the sump water level controls. A flow switch is provided to prevent operation of the conductivity controls without water flow.

2.5.4 Common Exhaust System

The common exhaust system consists of five basic parts: 1) duct work, 2) a condenser subsystem, 3) a HEME, 4) two filtration trains, and 5) a primary tank ventilation exhaust stack. The common exhaust system provides flammable gas removal and confinement of radiological particulates by maintaining air flow out of the tank and a negative pressure relative to atmospheric pressure in the tank headspace.

The common exhaust flow is taken from the Recirculation Ventilation Cooling Module return line. The flow rate is determined by an automatic control valve that responds to the flow rate setpoint. The exhaust lines from each tank are combined and routed to the ventilation facility. The line then passes through the condenser, where it is cooled, and then through the HEME to eliminate any water droplet carryover into the filter system. The condensate from the condenser and HEME is drained into a seal pot and then passes to catch Tank 241-AZ-151. The condenser and/or the HEME can be valved out and bypassed for maintenance or replacement purposes.

Upon exiting the HEME, the gas stream is heated. Heating the exhaust air extends the service life of the HEPA filters downstream by providing air with reduced humidity relative to the filter unit inlet. The inlet motor-operated valves to both trains are normally open and are closed only during maintenance on the train or when high temperatures are present at the outlet to the filter bank. To smother any possible fires, both the inlet and outlet valves are closed automatically when high temperatures occur at the train outlet.

Upon heater startup, the associated outlet motor-operated valve (MOV) is automatically opened. Under normal operations, only one of the outlet MOVs may be closed at any one time. The outlet MOVs close upon de-energization of the heater, high radiation in the exhaust stack, high differential pressure across the filter train, or high temperature at the outlet to the filter bank. The system can be manually configured by individually setting each MOV.

In a high radiation condition, interlocks from the K1 exhaust duct radiation monitor will open the outlet valve to the standby filter train and close the outlet valve to the operating filter train in the K1 exhaust system. Manual over-ride of this interlock is possible only by changes to the MCS. The MCS uses a password-oriented security system so only authorized personnel can make changes involving over-rides.

Each heater system and associated filter bank are contained in a train. Normally, one train will be in operation while the second train is in standby. Each filter bank consists of two HEPA filters and a HEGA. Instrumentation provided for each filter bank monitors the pressure differential across each stage and the temperature downstream of each bank. The system will shut down and switch over to the standby train upon high differential pressure across any stage of the filter train, upon heater failure, or when the heater high temperature setpoint is tripped.

Once the ventilation gas stream has passed through one of the two filter banks, it is exhausted by the exhaust fan through the monitor system and then through the exhaust stack into the atmosphere. One fan will be in standby while the operating fan maintains a vacuum on the four storage tanks. The second filter bank is provided to allow operation of the ventilation system during routine maintenance activities (e.g., filter replacement). Manually-operated valves are located upstream and downstream of each primary fan. The purpose of these isolation valves is to facilitate maintenance activities. As an additional feature, each fan includes a back draft damper on its discharge. Either fan can exhaust through either ventilation train through the cross-over capability of the system. This provides isolation and maintenance capability for each ventilation train and for each main system fan.

2.5.4.1 Duct Work. The duct work provides gas and moisture confinement for the exhaust stream. It is double-encased piping with carbon steel around stainless steel. The duct work is buried until it enters the Ventilation Building. The buried ducting is cathodically protected with an active system.

2.5.4.2 Ventilation Condenser Cooling System. The closed-loop Ventilation Condenser Cooling System provides cooling for the primary tank ventilation exhaust air from the tanks.

The Ventilation Condenser Cooling System consists of an air-cooled liquid chiller, two circulation pumps, an expansion tank, an air separator, a condenser, and instruments for monitoring the closed-loop cooling system. The cooling medium used is a propylene glycol solution that is circulated between the chiller and the ventilation condenser. Instrumentation monitors the line for flow, inlet temperature, and outlet temperature. The main piping is carbon steel with welded fittings. A manual globe valve in the discharge piping adjusts the flow.

The closed-loop cooling system removes moisture from the gas stream and removes heat from the ventilation condenser. This process reduces the temperature of the vapor. The propylene glycol solution absorbs heat from the condenser and rejects heat in the air-cooled chiller.

2.5.4.2.1 Condenser. The condenser is a shell-and-tube heat exchanger located in the Vent Cell (Figure 2-2) of the Ventilation Building. The ventilation gas stream is cooled by 3800 L (1,000 gal) of 50% propylene glycol, 50% water solution through the tubes. Instrumentation monitors inlet temperature, outlet temperature, and pressure differential across the condenser.

2.5.4.2.2 Pumps. Two pumps (one active and one standby) circulate the propylene glycol solution through the condenser and the chiller cooler. The pumps also have suction and discharge local pressure indicators.

Pump operation is monitored through flow in the recirculation line. If low flow occurs, a flow switch activates the standby pump and an alarm sounds. If the flow is still low after the standby pump is activated, both pumps are shut down until they are reset. The flow switch is also used to send a signal to the chiller indicating that flow has been established.

The pumps are provided with current indication and alarms to show whether the pump is running or has failed. To facilitate equal pump wear, an indication of the pumps' total operating time is measured.

2.5.4.2.3 Chiller. An air-cooled liquid chiller removes heat from the propylene glycol solution as it returns from the ventilation condenser. The chiller is a complete, factory assembled, single-skid package, equipped with compressors, evaporator, condenser, refrigerant circuits, cooler, and controls.

The chiller is equipped with a common trouble alarm to indicate when there is an equipment failure. The chiller is also interlocked with the flow in the propylene glycol line to prevent operation during low flow.

2.5.4.3 High-Efficiency Mist Eliminator. The HEME is a cartridge type and is located in the Ventilation Building Vent Cell (Figure 2-2). The HEME will remove water droplets carried over from the condenser, and drain it into the condensate tank. Instrumentation monitors pressure differential across the HEME. In the case of high differential pressure, the filter can be changed.

All liquid collected in the HEME is drained to a seal pot, and then to catch tank 241-AZ-151.

2.5.4.4 Filtration Trains. The two independent filtration trains consist of a heater, HEPA filters, HEGA unit, and an exhaust fan. One operates as the primary train and the other a standby.

If the outlet valve to an operating filter train is not open, or is subsequently closed, the filter train will shut down and a failure alarm will be activated. Also, automatic switch over to the standby heater and filter train will occur.

2.5.4.4.1 Heaters. Upstream of each HEPA filter train is an electric heater system that heats the saturated air and prevents condensation on the filters. The heater capacity is based on the worst case scenario of loss of cooling and the resulting maximum gas stream conditions.

Each heater is equipped with an internal low flow switch, a high temperature cutout switch, and a manual cutout switch.

Instrumentation monitors temperature upstream of the heater and downstream of the HEPA filter train. Local temperature controllers for each heater are controlled by temperature differential controllers. The differential temperature is measured from the inlet of the heater to the outlet of the HEPA filter train. Low temperature differential will activate separate independent alarms. High temperatures on heater inlet or outlet will also activate alarms. Total airflow is monitored at the exhaust stack.

If the active heater fails, automatic switch over to the standby heater and filter train will occur and a failure alarm will be activated. If the inlet valve to an operating heater is not open or is subsequently closed, the heater will be shut down and a failure alarm will be activated. Switch over to the standby heater and filter train also will occur if the standby system is available.

2.5.4.4.2 High-Efficiency Particulate Air Filters. The filter system is designed for a high particulate removal efficiency. This will be achieved by using two HEPA filters in series. The filters have provisions for in-place efficiency testing. The filter bank can be isolated to facilitate filter change out or other maintenance procedures.

2.5.4.4.3 High-Efficiency Gas Adsorber Filter. The HEGA is a charcoal filter designed to remove organic carbon vapors and iodine gas. The carbon cartridges are located between stages of HEPA filters. The filter bank can be isolated to allow HEGA change out or other maintenance procedures.

2.5.4.4.4 Exhaust Fans. Each exhaust fan is belt driven with a variable speed motor. The maximum flow rate is 28 m^3/min (1,000 scfm), but is normally operated at 11 m^3/min (400 scfm). The fans are centrifugal type with low leakage construction. The fans are sufficient to cover all identified operating modes.

If a failure occurs in the operating exhaust fan, switch over to the standby fan will occur and an alarm will be activated. The fan can be isolated to facilitate change out or other maintenance actions.

2.5.5 Exhaust Stack

The primary tank ventilation exhaust stack is located just outside of the ventilation building, approximately 1 m (3.5 ft) from the external face of the building. The stack extends 16.8 m (55 ft) above grade and is the point of discharge for the primary tank ventilation system. The primary exhaust air stream is sampled and monitored for radioactive particulate before discharge through the stack. The exhausted air stream is also monitored for flow.

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2.6 CONFINEMENT SYSTEMS

The 241-AZ-702 ventilation system has been designed to limit the release of radioactive and hazardous materials to the environment. This section provides an overview of confinement features incorporated into the design.

The underground ducting is comprised of individual underground ducts for each tank. Each individual tank is connected to a common header within each Tank Farm.

The 241-AZ-702 underground ducting is double contained from the Tank Farm tie-in to the connection at the ventilation building. Leak detection, for either condensate or pipe leakage is provided at low points between the outer and inner ducting.

2.7 SAFETY SUPPORT SYSTEMS

Safety support systems impacted by the 241-AZ-702 ventilation system consist of effluent monitoring and fire protection. These systems are discussed in the following subsections.

2.7.1 Effluent Monitoring

State-of-the-art instrumentation will monitor and analyze temperature and stack flows of the systems. The instrumentation and electrical systems will read out and/or alarm on the MCS in the control room.

The MCS provides monitoring and control for ventilation system processes and equipment as well as limited monitoring of tank processes in the AWF Tank Farms.

The primary tank ventilation exhaust system discharges the treated gas to the atmosphere. The effluent is monitored and sampled for radioactivity (Bauer 1994a and 1994b) before discharge into the atmosphere. High radioactivity levels will activate control alarms and enable interlocks to secure operation of the primary filter train and transfer to the secondary filter train thus maintaining continuous operation.

The building ventilation system stack is monitored and sampled for radioactivity before discharge of the air. The ventilation building HVAC system discharges the building exhaust air through the ventilation building exhaust stack. Interlocks from the radiation monitoring system cause the switch over to the standby bank on high radiation level. All annunciator response procedures require operator action to determine cause and corrective action.

2.7.2 Fire Protection Systems

The ventilation and generator service buildings are protected throughout by an automatic dry-pipe sprinkler system. The system complies with the requirements of NFPA 13, *Installation of Sprinkler Systems*, for ordinary hazard group occupancy classification (HNF-SD-WM-FHA-020, *Fire Hazards Analysis for Tank Farms*).

System fire alarm and supervisory signals for both buildings will annunciate at the fire alarm control panel located outside the 241-AZ-271 control room on the west wall. The fire alarm system for both buildings complies with the requirements of NFPA 72, *National Fire Alarm Code*. All alarm system components in both buildings are Underwriters Laboratories (UL) listed or Factory Mutual approved for the use intended. A radio fire alarm master box is located inside the 241-AZ-271 control room on the west wall. This master box transmits fire alarm and trouble signals to the Hanford Fire Department.

The control building is protected throughout by a wet pipe sprinkler system.

All sprinkler system components in both buildings are UL listed or Factory Mutual approved for the use intended.

2.8 UTILITY DISTRIBUTION SYSTEMS

Utility distribution systems impacted by the 241-AZ-702 ventilation system include the following:

- Water supply systems
- Electrical power distribution system.

Each system is discussed below.

2.8.1 Water Supply Systems

All water for the 200 East Area is supplied from the Hanford Site Export Water System (EWS). Water is distributed throughout the area by two separate systems, the Raw Water System (RWS) and the Sanitary Water System (SWS). Untreated, and unchlorinated raw water is used principally for cooling, and dilution systems. Sanitary water is treated (e.g., filtered, purified) water used for drinking and sanitary facilities. These provide water for sanitary, process, and fire protection uses.

The RWS supplies makeup water to the recirculation condenser cooling system and the evaporative coolers through the diesel generator building. The RWS consists of the duplex strainer, a pressure-reducing valve, a certified backflow preventer, and associated instrumentation.

The RWS routes raw water from a 30.5-cm (12-in.) polyvinyl chloride underground header into the diesel generator building through a 5.1-cm (2-in.) carbon steel line. The raw water enters the building through a duplex strainer and backflow preventer.

Instrumentation is provided to monitor differential pressure across the strainer and activate an alarm on high differential pressure. Upon detection of high differential pressure, maintenance personnel must manually switch to the standby filter. Local pressure gauges are provided upstream of the strainer and downstream of the backflow preventer. In addition, instrumentation is provided to monitor header flow rate, totalization, and pressure downstream of the backflow preventer. Upon detection of low pressure, an alarm is sent to the MCS, however, no automatic control is provided.

2.8.2 Electric Power Systems

Power is provided to the new facilities from an existing 13.8 kV aerial line to a newly-installed unit substation. In this substation, voltage is reduced by a 300 kVA transformer to 480/277 V ac for distribution to system loads. Standby power is available to the main ventilation train and the MCS.

Standby power is provided by a 325 KVA diesel generator through two automatic transfer switches to the service distribution switchboards, motor control centers (MCCs), transformers, and lighting and power panels. The automatic transfer switch will actuate and standby power will be supplied to the bus located in the MCC and bus located in the ventilation building. All non-motor loads such as lighting will be immediately energized. Critical motor loads will be automatically started in sequence to reduce the initial load on the generator. Non-critical loads will remain secured until manually started after return of normal power.

The diesel fuel storage tank is sized to provide at least 24 hours of fully loaded engine operation. The 241-AZ-702 ventilation system diesel generator is equipped with a 3 Kw jacket water heater that maintains the jacket water temperature above 32 °C (90 °F). The jacket water is not circulated unless the engine is running. The diesel generator building is cooled or heated to the approximate temperature range of 4 to 32 °C (40 to 90 °F).

An uninterruptible power supply is provided to maintain a continuous supply of power to the MCS during the transition from normal to standby power. The uninterruptible power supply is continuously on-line and will supply standby power on a loss of normal power.

2.9 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

No systems or facilities other than those described in the previous sections were identified as requiring descriptions in this document.

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Figure 2-1. 241-AZ-702 Ventilation System Building and Equipment Additions.

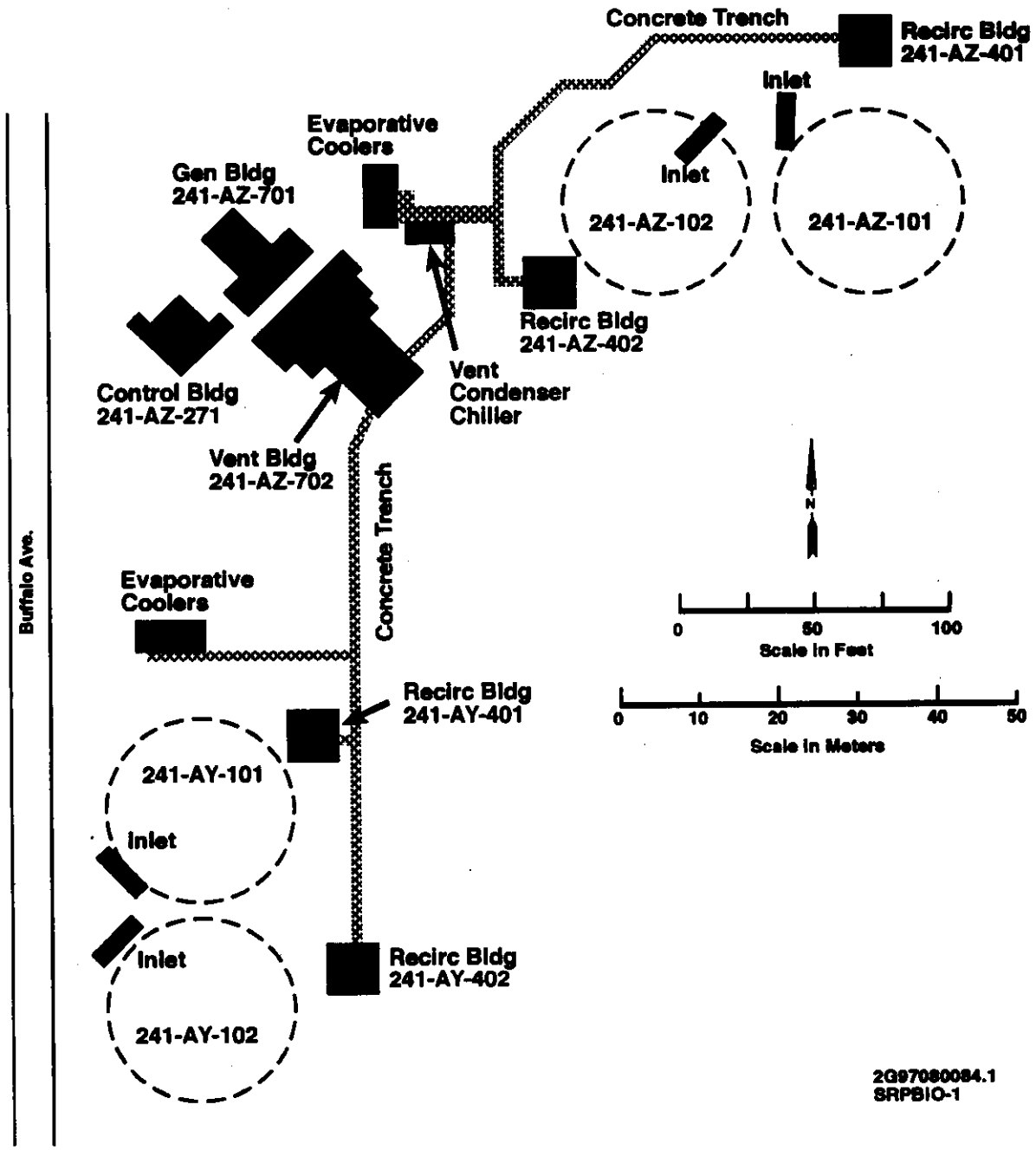


Figure 2-2. Building 241-AZ-702 First Floor Plan.

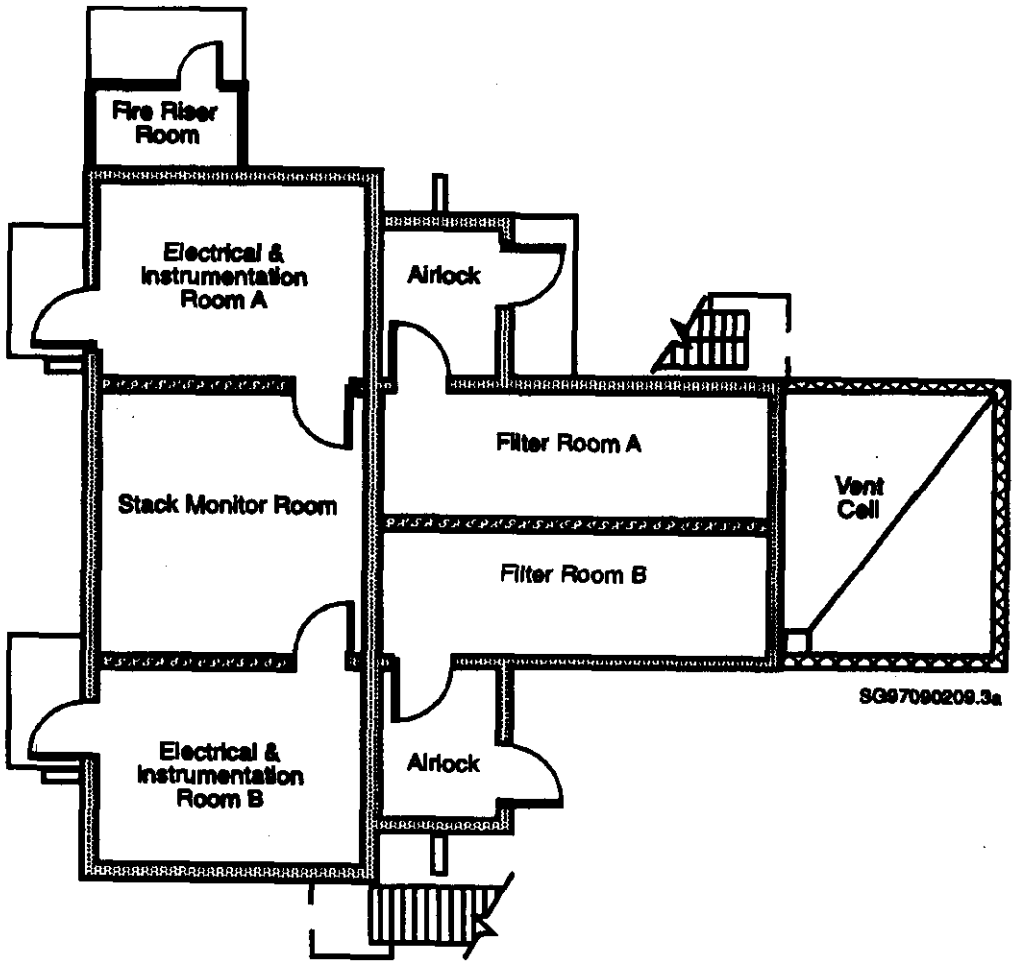


Figure 2-3. Building 241-AZ-702 Second Floor and Roof Plan.

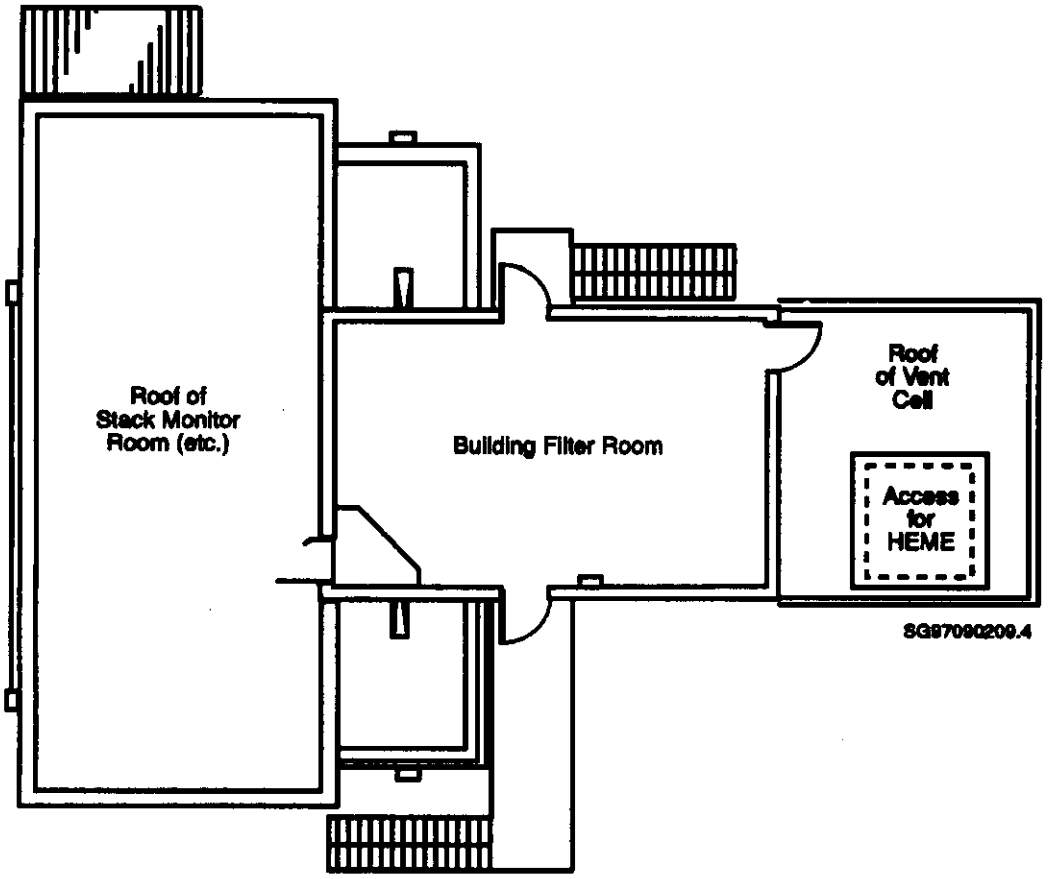


Figure 2-4. Generator/Service Building Floor Plan, 701-AZ.

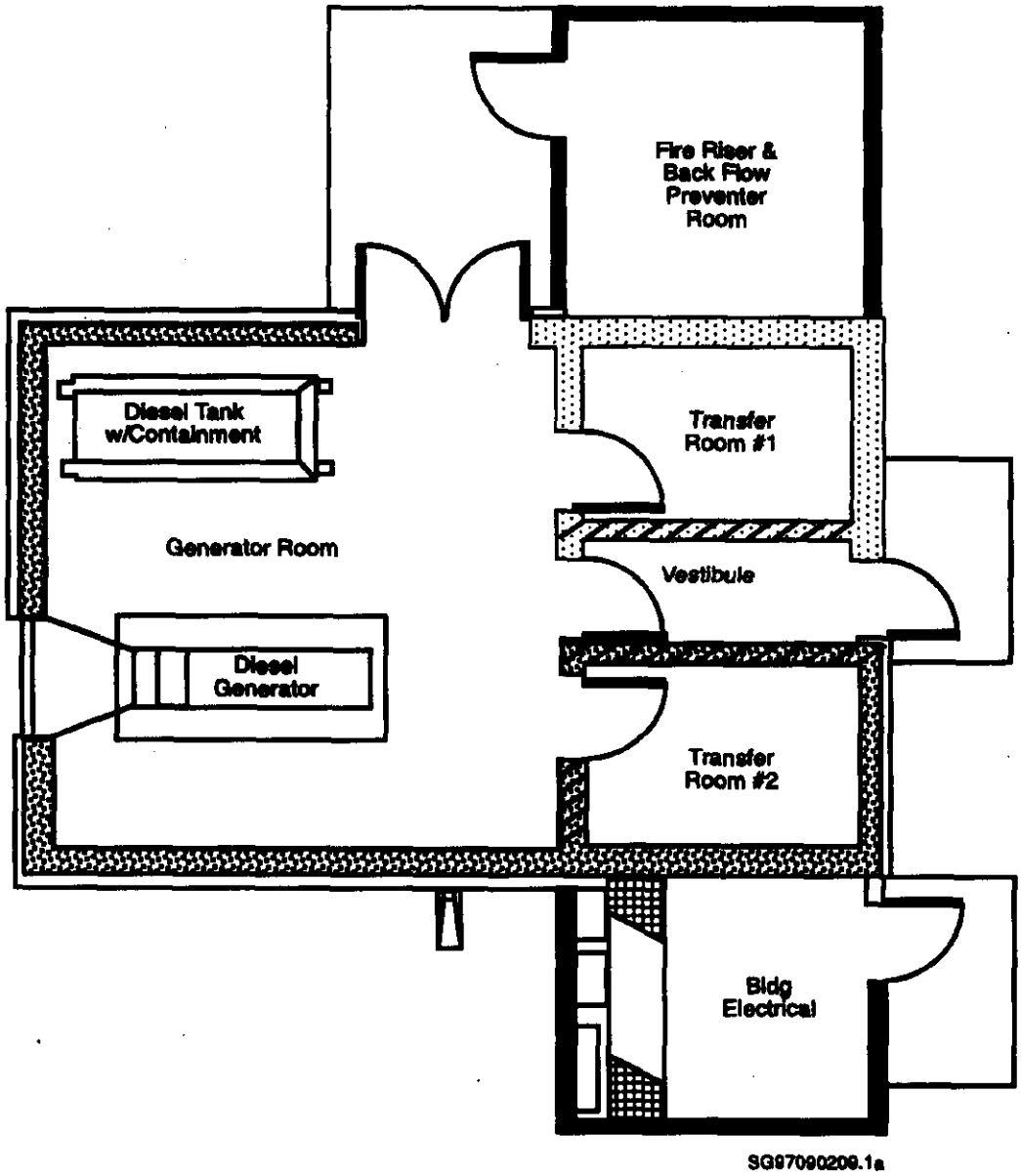
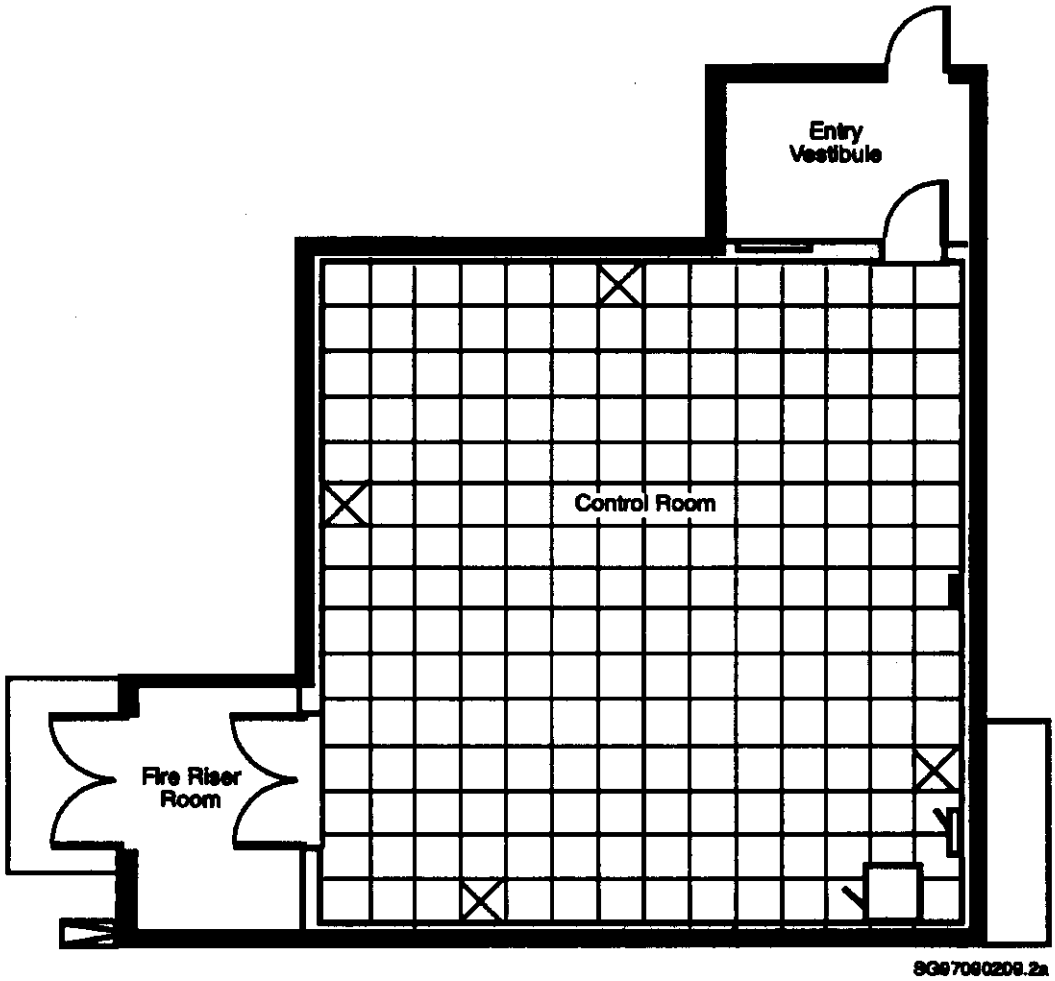


Figure 2-5. Control Building, 241-AZ-271 Plan View.



Floor Plan

Figure 2-6. Project W-030 Ventilation Upgrade System.

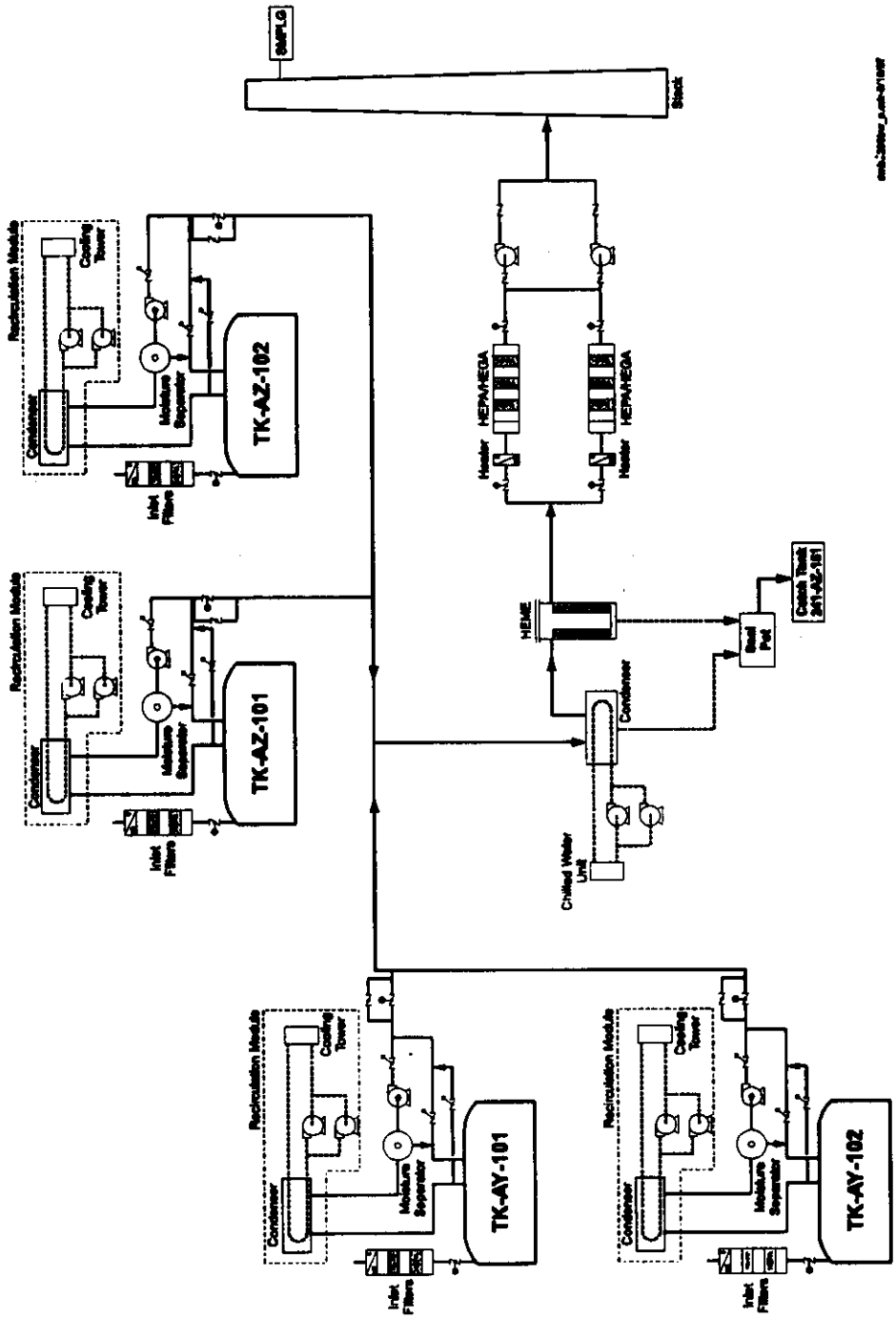


Figure 2-7. Recirculation Flow.

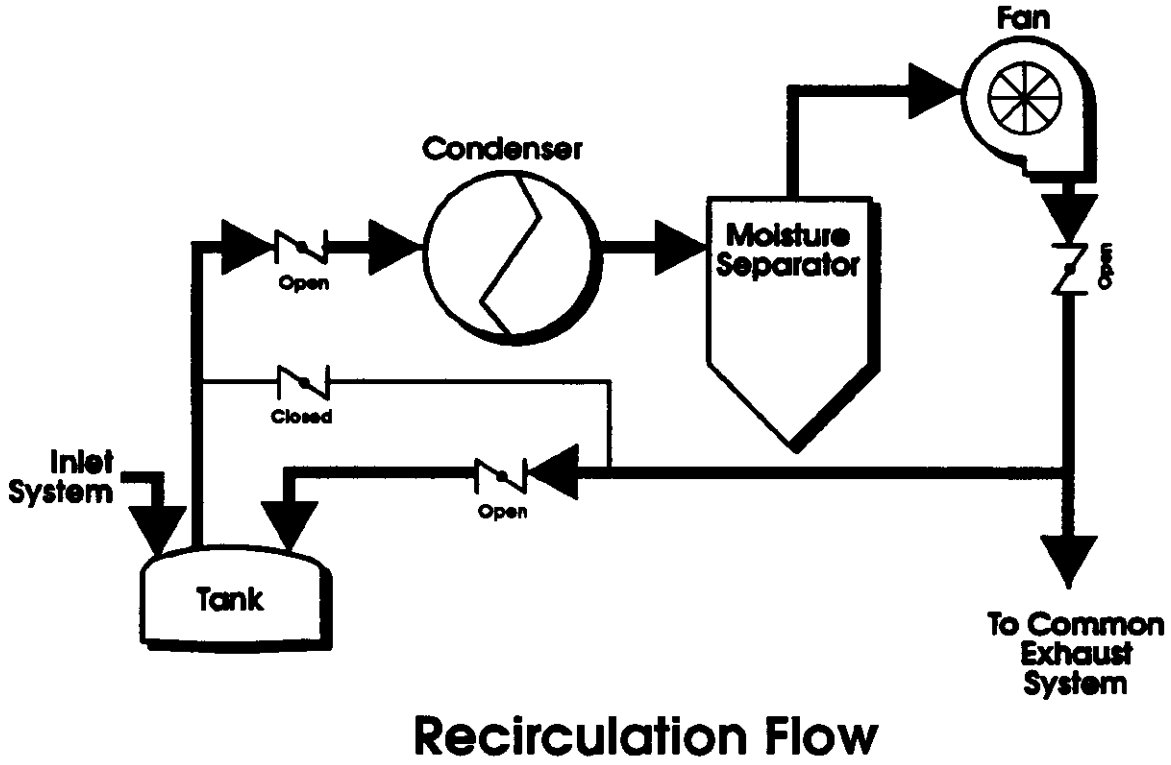


Figure 2-8. Bypass Flow.

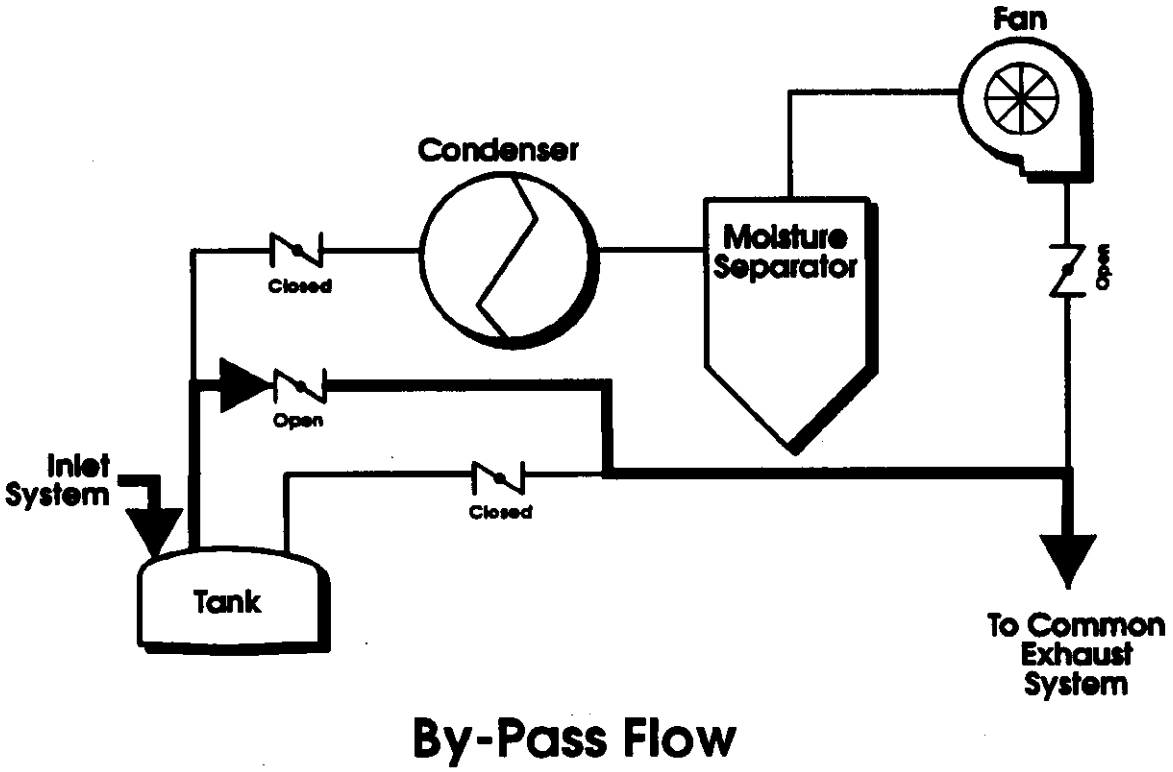


Figure 2-9. High Heat Flow.

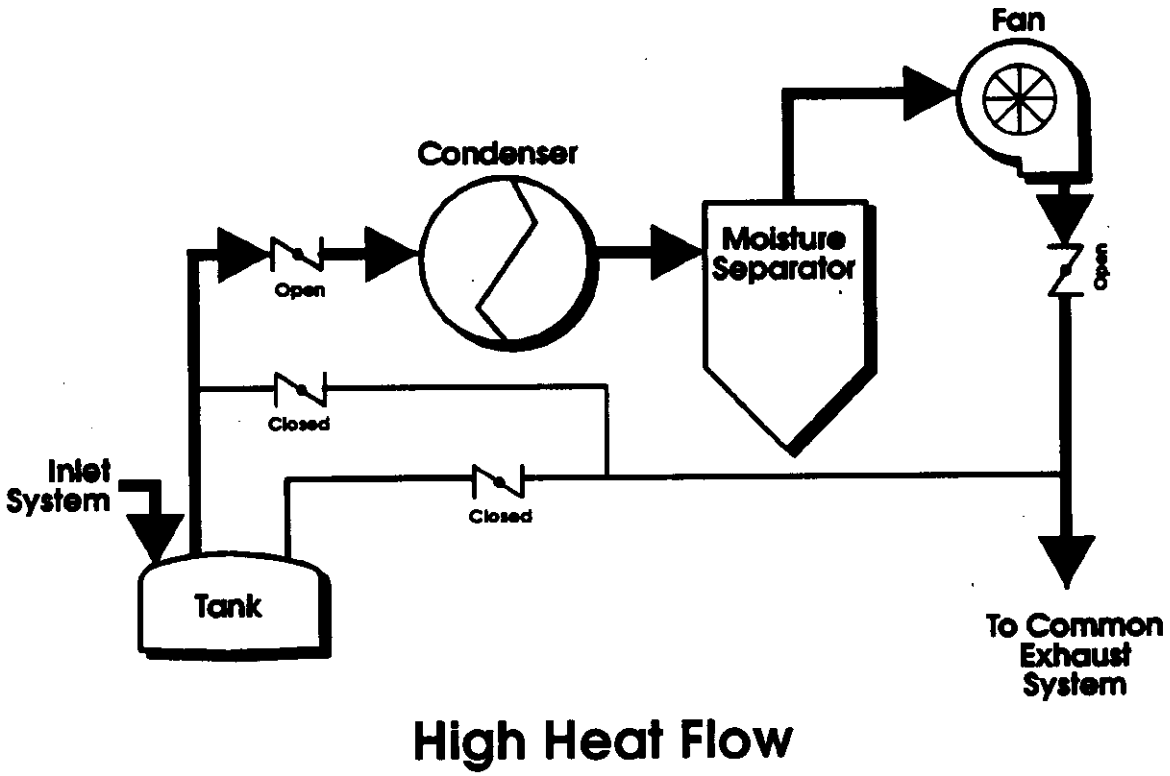


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Table 2-1. 241-AZ-702 Ventilation System Design Heat Loads and Tank Waste Temperatures.

Tank	AZ-101	AZ-102	AY-101	AY-102
Current heat load,[a] kW (Btu/h)	70.81 (241,600)	56.74 (193,600)	12.02 (41,000)	9.67 (33,000)
Design heat load removal with recirculation,[b] kW (Btu/h)	486.79 (1,661,000)	293.07 (1,000,000)	293.07 (1,000,000)	293.07 (1,000,000)
Ventilation flow rate allocated in the by-pass mode[a,c] m^3/min (cfm)	9.9 (350)	9.9 (350)	4.2 (150)	4.2 (150)
Supernate temperature with current tank contents and by-pass mode,[a] °C (°F)	65.6 (150)	61.1 (142)	41.7 (107)	38.9 (102)
Peak sludge temperature with current tank contents and by-pass mode,[a] °C (°F)	93.3 (200)	94.4 (202)	58.9 (138)	43.9 (111)

[a]HNF-SD-W030-ER-004, 1997, Evaluation of Waste Temperatures in Aging Waste Facility Tanks for By-Pass Mode Operation of the 702-AZ Ventilation System (Project W-030), Rev. 0, Numatec Hanford Corporation, Richland, Washington.

[b]WHC-SD-600-FDC-001, 1997, Functional Design Criteria for the Tank Farm Ventilation Upgrade, Project W-030, Rev. 4, Numatec Hanford Company, Richland, Washington.

[c]The by-pass mode is the lowest heat removal configuration. It involves no heat removal by the recirculation/cooling system (which is by-passed). The heat is only removed by the once-through air flow.

Table 2-2. Detailed Description of 241-AZ-702 Ventilation System TMACs Instrumentation Connections.

Tag Description	Detailed Description
AY FARM PRIM TK VENT LINES LEAK DETECTED	Leak detected in piping encasement associated with the 241-AY primary tank ventilation.
AY FARM RECIRC BLDGS LEAK DETECTED	Liquid detected on the floor of either the 241-AY-401 or 241-AY-402 buildings. Liquid likely condensate leaking from condenser, moisture separator, fan, or piping.
TK-AY-101 PRESS HI/LO	241-AY-101 tank pressure (head space) is outside its normal operating range.
TK-AY-102 PRESS HI/LO	241-AY-102 tank pressure (head space) is outside its normal operating range.
AZ FARM PRIM TK VENT LINES LEAK DETECTED	Leak detected in piping encasement associated with the 241-AZ primary tank ventilation.
AY FARM RECIRC BLDGS LEAK DETECTED	Liquid detected on the floor of either the 241-AZ-401 or 241-AZ-402 buildings. Liquid likely condensate leaking from condenser, moisture separator, fan, or piping.
TK-AZ-101 PRESS HI/LO	241-AZ-101 tank pressure (head space) is outside its normal operating range.
TK-AZ-102 PRESS HI/LO	241-AZ-102 tank pressure (head space) is outside its normal operating range.
CATCH TK 241-AZ-151 LEAK DETECTED	Liquid detected in either the piping encasement for the 241-AZ-702 condensate discharge line (piping to 241-AZ-151 from 241-AZ-702), or liquid detected in the piping encasement associated with the 241-AZ-151 catch tank ventilation line.
PRIMARY TK VENT STACK DISCHARGE RAD HI/FAIL	Either high levels of radiation have been detected by the 241-AZ-702 primary tank ventilation stack's beta/gamma CAM, or the CAM has failed.
PRIMARY TK VENT SAMPLE SYSTEMS FLOW HI/LO	The sample flow rate is too high or too low through the beta/gamma CAM, or the record sampler (which are associated with the 241-AZ-702 primary tank ventilation stack).
AZ702 BLDG VENT STACK DISCHARGE RAD HI/FAIL	Either high levels of radiation have been detected in the 241-AZ-702 building ventilation stack beta/gamma CAM, or CAM has failed.
AZ702 BLDG VENT SAMPLE SYSTEMS FLOW HI/LO	The sample flow rate is too high or too low through the beta/gamma CAM, or through the record sampler (which are associated with the 241-AZ-702 building ventilation stack).
AZ702 BLDG LEAK DETECTED	Liquid has been detected in the 241-AZ-702 cell's sump, or on the floor of Filter Room A, or on the floor of Filter Room B.

CAM = continuous air monitor.

3.0 HAZARD AND ACCIDENT ANALYSES

3.1 INTRODUCTION

The 241-AZ-702 ventilation system is designed to replace the existing 241-A-702 ventilation system for the Aging Waste Facility (AWF) waste storage tanks. These tanks contain radioactive materials in the form of liquid and sludges. The radionuclides, their concentrations, and the resulting unit liter doses (ULDs) used for radiological consequence calculations are found in WHC-SD-WM-SARR-037, *Development of Radiological Concentrations and Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations.*

This section identifies and evaluates hazards associated with the operation of the 241-AZ-702 ventilation system. It evaluates the consequences of accidents from potential internal, external, and natural phenomena-related events that could potentially release hazardous materials. Potential consequences to the public and to workers are considered, as are the corresponding preventive and mitigative features.

The following safety analysis is based on a Preliminary Hazard Analysis (PHA) technique that qualitatively or semi-quantitatively evaluated the identified hazards. From this evaluation, design basis accidents are identified (Section 3.3, "Hazard Analysis Results") and analyzed. In addition, the 241-AZ-702 ventilation system is compared with the *Tank Waste Remediation System Final Safety Analysis Report*, HNF-SD-WM-SAR-067 (FSAR), accident scenarios (Section 3.4.2, "Design Basis Accidents" of this addendum). All the accident scenarios for further analysis are also contained in FSAR, Sections 3.3.2.4, "Accidents with Potential Onsite Consequences," and 3.4.2, "Accident Analysis Scenarios."

This addendum to the FSAR and associated Technical Safety Requirements (TSRs), will be the basis for future Unreviewed Safety Question (USQ) (DOE 5480.21, *Unreviewed Safety Questions*) evaluations related to the ventilation system for the AWF.

3.2 REQUIREMENTS

The design codes, standards, regulations, and DOE Orders that are required for establishing the safety basis of the 241-AZ-702 ventilation system are as listed in the BIO. Only portions of these documents are relevant to this safety document, namely those that cover requirements pertinent to safety analysis.

3.3 HAZARD ANALYSIS RESULTS

Results of the hazard identification activities for the 241-AZ-702 ventilation system are provided in the following sections. Details of the hazard analysis are presented in the following appendices to this addendum.

- Appendix A, "Hazard Basis"
- Appendix B, "Hazard Analysis Summary"

- Appendix C, "Hazard Evaluation Result"
- Appendix D, "Control Allocation Tables."

The results of the hazard analysis were used to select candidate accidents for analysis and identify controls. The detailed methodology and results of the hazard analysis are recorded in Appendix B, "Hazard Analysis Summary," of this addendum.

Section 3.3.1 below discusses the methodology used for the hazard analysis summarized in the appendices. Section 3.3.2 below provides a summary of the hazard analysis results.

3.3.1 Methodology

The first step in performing an accident analysis is to identify and qualitatively assess the facility hazards. The results of the assessment are then used to determine the events that could initiate accidents with the potential to expose site personnel or the general public to radioactive or chemical materials. See Appendix B of this addendum for a more thorough description of methodology.

3.3.1.1 Hazard Identification. Hazard means a source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to a facility or to the environment (without regards for the likelihood or credibility of accident scenarios or consequence mitigation). As in the FSAR, the hazard identification methods and techniques include the following:

- Review of past safety documents
- Review of reportable event history (e.g., Hanford Site and Tank Waste Remediation System [TWRS] unusual occurrence reports)
- Review of historical records of similar operations (e.g., unusual occurrence reports from the existing 241-A-702 ventilation system, the SY farm ventilation system, the AN farm ventilation system, and the SX farm ventilation system)
- Participation by current and former operations and engineering personnel in the hazard analysis effort
- Use of standardized checklists of potential hazardous materials and energy sources
- Use of material at risk information
- Use of facilities and operations descriptions
- Use of existing TWRS hazard analyses.

3.3.1.2 Hazard Evaluation. The hazards analysis consists of the hazards identification and evaluation process performed for the AWF Tank Farms and includes the comprehensive evaluation of potential process-related hazards,

natural phenomena hazards, external hazards, and hazards intrinsic to the facility. These hazards arise from the type, form, location, and quantities of nuclear chemical waste stored in the aging waste underground storage tanks. The hazard identification and evaluation process provides a qualitative evaluation of the spectrum of potential accidents involving the hazards identified. This effort forms the basis for: 1) identifying any additional, unique facility worker protection issues and environmental considerations, and 2) selecting potential design basis accidents (DBAs) to be further developed and quantified in Section 3.4.2.

Those hazards identified as credible by the review team were recorded in the Hazard Summary Table Appendix B, Table B-1. Categories of hazardous materials evaluated included radioactive material, toxic materials, corrosive materials, reactive materials, asphyxiants, explosives, and combustibles and flammables. Types of energy sources evaluated included potential energy sources, kinetic energy sources, and radiant energy sources.

3.3.2 Hazard Analysis Results

Using the PHA and hazard and operability study (HazOp) techniques, a Hazard Analysis Summary table was constructed. Hazard Analysis Summary tables have been used to compile the results of the hazard identification and evaluation process for the 241-AZ-702 ventilation system. The tables are presented in Appendix B along with the supplemental information that was considered for each hazard category during the identification process.

3.3.2.1 Hazard Identification. The hazards identified for the 241-AZ-702 ventilation system are listed in Appendix B, Table B-1.

Review of past safety documents (e.g., unusual occurrence reports) indicates that no major accidents or hazardous situations that are ventilation related were identified for the AWF since 1985. No data was available before 1985. The hazards associated with the AWF waste storage tanks have been summarized in Tables 3-1 through 3-6.

3.3.2.2 Hazard Classification. The AWF Tank Farms have been identified in the FSAR as Hazard Category 2 (FSAR, Section 3.3.2.2, "Hazard Classification").

3.3.2.3 Accident Evaluation. In the PHA and HazOp study, estimates were made of the likelihood of each scenario (or class of accidents) to determine the frequency category of the scenario. There are four frequency categories. There are also four severity categories as previously defined. These values are used to establish a risk matrix bin number. Those events in bin numbers 1, 2, 3, 4, 5, and 7 are considered for accident selection (Table B-5).

The accidents having a potential severity category of S2 and S3 were grouped according to the accident scenarios (see Appendix B, Table B-4 for a definition of severity categories). This second grouping allows for the selection of a representative scenario to be developed in Section 3.4 below that will bound the other accidents within the group (Section 3.3.4.2).

3.3.2.3.1 Accidents Identified with the Monitor and Control System. The monitor and control system (MCS) was reviewed for hazards and accident initiators related to the 241-AZ-702 ventilation system. Hazards and accident initiators associated with the loss or malfunction of the MCS were identified as a loss of ventilation airflow, ventilation imbalance, excessive vacuum, excessive pressure, and excessive airflow. The associated accidents that would result from these have been included in Table B-1, Event Numbers 28, 35, 36, and 39.

3.3.2.3.2 Accidents Identified with Instrumentation. The instrumentation was reviewed for its potential impact on the 241-AZ-702 ventilation system. The monitoring and alarm systems provide indications that the pressure, flow, radiation levels, etc., exceed trip limits. Lack of these indications, unless later identified as performing a safety function, was not identified as initiating any accident.

Reaching certain instrumentation trip limits results in ventilation configuration changes. An example of this would be exceeding the trip limit associated with differential pressure across the high-efficiency particulate air (HEPA) filters, resulting in an automatic change of the filter trains. Premature changes in configuration, failure to make the configuration changes, or slow changes in the configuration did not result in any identified hazards for the 241-AZ-702 ventilation system.

The instruments and equipment in regions of potential flammable gas concentrations meet the ignition source controls as defined in the FSAR, Appendix K, "Flammable Gas Hazards and Controls in Hanford Waste Storage Tanks and Waste Transfer Facilities."

3.3.2.3.3 Accidents Identified with Loss of Utilities. Accident initiators associated with the loss of utilities were evaluated. The only accident initiator from the loss of utilities that could seriously impact the 241-AZ-702 ventilation system was the loss of electrical power. This was evaluated and recorded in Table B-1, Event Number 28. Loss of water or instrument air (there are no natural gas or steam lines associated with the 241-AZ-702 ventilation system) did not result in any identified hazards.

3.3.2.3.4 Accidents Identified with Nuclear Criticality. A nuclear criticality accident within the AWF ventilation system was deemed to be beyond extremely unlikely (BEU) by the HazOp team (Appendix B, Table B-1, Event Number 43). Section 6.3, "Project Implementation" of this addendum provides additional information and detail to confirm the team's assessment for a criticality accident in the AWF ventilation system.

3.3.2.4 Accident Selection. Accident selection for hazards associated with the 241-AZ-702 ventilation system was performed by the hazards analysis team, as part of the hazards analysis process.

The hazards analysis team consisted of the 241-AZ-702 ventilation system designers, TWRS Tank Farm plant operators, and safety analysts. The hazards analysis team met and performed a PHA, HazOp, and hazard identification on the 241-AZ-702 ventilation system. Each component of the system was considered

for failure including the MOVs (PHA) and flow from each component (HazOp). The PHA emphasized the components of the design. The HazOp emphasized the processes involved with ventilation. Also, a checklist for all high energy sources in the system was performed (Table B-6). This was the method used to capture all the potential hazards and accidents associated with the system.

The hazards analysis scope included all aspects of the 241-AZ-702 ventilation system including the recirculation systems of the four tanks (241-AZ-101,-AZ-102, 241-AY-101,-AY-102), the chiller, chiller pumps, condenser, seal pot, 241-AZ-151 catch tank, HEME, both trains of electric heaters, HEPA, HEGA, fans, monitoring instrumentation, the buildings, the secondary HVAC in the ventilation building, the ducts, the hangers, and 55-ft exhaust stack.

Appendix B, Table B-1, provides summary results for the 241-AZ-702 ventilation system PHA and HazOp. Identified hazards were related to corresponding postulated accident scenarios. Each of the postulated accident scenarios were further evaluated by the hazards analysis team.

The results of the PHA analyses were a number of postulated abnormal events which were ranked by the team members with respect to safety consequences. The initial, qualitative, consensus estimates of the severity of the consequences were ranked according to the criteria shown in Appendix B, Table B-4, "Radiological and Chemical Consequence Evaluation Levels for Hazard Receptors."

The initial, qualitative, consensus estimates of the frequency of the abnormal events were also ranked by the hazards analysis team members. An alphanumeric system was used to designate the frequency as shown in Appendix B, Table B-3, "Frequency Evaluation Levels."

In the process of completing the PHA, risk matrix numbers were added to each column considering events both with and without mitigation. Table B-5 was used to help identify event scenarios that required further attention. The risk matrix numbers 1, 2, 3, 4, 5, and 7 indicated that accident analyses would be required to envelope postulated event consequences. These risk matrix numbers also indicated the need for consideration of safety structures, systems, and components, and interim operational safety requirements. Risk bin numbers 6, 8, and 9 indicated the need for consideration of administrative or operating specification level controls.

Those events which resulted in risk binning matrix numbers which indicated the need for further accident analyses included the following:

- Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc. (facility worker only)
- Release of radiological and toxicological material due to Tank Bump
- Release of radiological and toxicological material due to dome collapse caused by flammable gas headspace deflagration
- Release of radiological and toxicological material due to dome collapse caused by excessive vacuum

- Release of radiological and toxicological material due to dome collapse caused by excessive pressure
- Criticality caused by buildup of radiological material in the ducting.

Safety analysts then further considered the above identified events. The criticality event was determined to be beyond extremely unlikely after consideration of the plutonium chemistry of high level neutralized wastes in the Hanford Site underground storage tanks. It was determined that the plutonium would not be subject to transport and accumulation in the tank ventilation systems (Section 6.0). The criticality event was thus eliminated from further consideration.

The remaining events were then reviewed to determine appropriate bounding, unique, and representative accident scenarios. The safety analysts determined that the following accidents are specific to the 241-AZ-702 ventilation system and were the appropriate bounding, unique, and representative accidents for analysis.

- HEPA filter failure - exposure to high temperature (filter fire)
- HEPA filter failure - exposure to high pressure
- Tank dome collapse (regarding ventilation)
- Flammable Gas Deflagration event
- Tank Bump.

3.4 ACCIDENT ANALYSIS

This section provides the analysis for the five accidents (HEPA filter failure - exposure to high temperature [filter fire], HEPA filter failure - exposure to high pressure, tank dome collapse, Flammable Gas Deflagration event, Tank Bump) that need to be revisited for the 241-AZ-702 ventilation system. To provide a complete picture of how the 241-AZ-702 ventilation system relates to the FSAR accident scenarios, all other FSAR accident scenarios are discussed with a focus on any interfaces with the 241-AZ-702 ventilation system (Table 3-7).

In accordance with DOE-STD-3009-94, each FSAR accident used in the safety analysis was quantitatively evaluated and found to be applicable.

The five reanalyzed accidents are presented in the same order as that of the FSAR. Note that only the new controls are shown in this addendum. The existing controls that remain applicable are provided by reference to the FSAR.

Section 3.4.1 below summarizes the important aspects of the consequence calculation methods common to the accidents analyzed.

3.4.1 Methodology

It is important to note that this Addendum was originally attached to the BIO. Therefore, the level of this addendum detail in the descriptions of the accident analyses and the section headings correspond to that found in the BIO.

3.4.1.1 Radiological Dose and Toxicological Exposure Methodology. Five accidents previously analyzed in the FSAR (HEPA filter failure - exposure to high temperature, HEPA filter failure - exposure to high pressure, tank dome collapse, Flammable Gas Deflagration, Tank Bump) were identified for analysis with respect to the 241-AZ-702 ventilation system. These accidents are addressed in this chapter. The methodology associated specifically with radiological dose and toxicological exposure is as detailed in WHC-SD-WM-SARR-037, WHC-SD-WM-SARR-011, *Toxic Chemical Considerations for Tank Farm Releases*, and WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmosphere Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, which comprise the same basis for the source terms used in the FSAR. This section summarizes the radiological and toxicological consequence calculation values necessary and particular to the 241-AZ-702 ventilation system analyses of operational accidents, natural phenomena, and external events selected for further analysis in Section 3.3.2.4, "Accident Selection." Consequence calculation methods specific to individual accidents are summarized in the individual analyses presented in Section 3.4.2 below.

Accident consequences are combined with the accident frequency and compared to the risk guidelines as shown in Tables 3-8 and 3-9. Radiological risk guidelines for the 241-AZ-702 ventilation system, (Project W-030) are from Revision 1 of Section 7.0, "Risk," of WHC-CM-4-46[2].

Toxicological consequence calculation methodology is as shown in WHC-SD-WM-SARR-011. Toxicological risk guidelines are shown in Table 3-9. Application of these guidelines using the sum-of-fractions methodology means that all consequences with the sum-of-fraction values less than one (1) are within the risk guidelines.

3.4.1.2 Natural Phenomena Methodology. The process to analyze natural phenomena effects on facilities is twofold. First the facilities are analyzed for their failure with respect to natural phenomena and the associated consequences. Then the design is modified to preclude that failure, if necessary and possible, by designing the system to meet specified criteria as found in DOE 6430.1A and SDC 4.1 for each natural phenomenon (e.g., design basis earthquakes, wind loads, etc.).

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[2]Refer to Appendix G, "Sitewide Controlled Manual Cross-Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., Procedures (e.g., HNF-PRO-XXX).

3.4.2 Design Basis Accidents

The following accidents are specific to the 241-AZ-702 ventilation system and bound all other accidents resulting from hazards shown in the Hazards Analysis Summary Table B-1: HEPA filter failure - exposure to high pressure, HEPA filter failure - exposure to high temperature, tank dome collapse, Flammable Gas Deflagration, and Tank Bump. This section evaluates each of these accident scenarios and dispositions the balance of the FSAR accidents with respect to the 241-AZ-702 ventilation system.

3.4.2.1 Nuclear Criticality. The FSAR evaluated the potential for nuclear criticality and concluded that no credible scenario has been identified that leads to a criticality in a double-contained receiver tank (DCRT), double-shell tank(DST), or single-shell tank (SST), according to the existing inventory of plutonium that is in the Tank Farms.

Build-up of plutonium in the 241-AZ-702 ventilation system ductwork was considered but deemed BEU due to the low concentrations involved. See Section 6.3 of this addendum for a more detailed discussion.

3.4.2.1.1 Controls. No additional controls are needed. The other criticality controls listed in the FSAR are still applicable.

3.4.2.2 High-Efficiency Particulate Air Filter Failure - Exposure to High Temperature or Pressure. Potential releases from HEPA filter failure - exposure to high temperature are evaluated in the FSAR. The heat from a fire in close proximity to a ventilation system degrades the HEPA filter and causes a release of a portion of the waste that has accumulated on the filter. In addition, the failed filter is assumed to provide an unfiltered release pathway that continues to operate for up to one year. Bounding radiological and toxicological consequence calculations for the 241-AZ-702 ventilation system are provided in Addendum 1, "Tank 241-C-106 Sluicing Safety Analysis," Section 3.4.2.2.

A pressure differential of 2.5 kPa can fail HEPA filters. The high pressure events identified in the FSAR are applicable to the 241-AZ-702 ventilation system. These scenarios are discussed in Section 3.4.2.2.2.

The 241-AZ-702 ventilation system (or the 241-A-702 if it is returned to service) is used to support operation of the Waste Retrieval Sluicing System that is discussed in Addendum 1. The normal storage operation accident (i.e., no sluicing) discussed here and in Section 3.3.2.4.2 of the FSAR text, is bounded by the consequences shown in Addendum 1. Unlike sluicing, normal storage and transfer operations do not have the potential to greatly agitate the waste (both liquids and solids) and create an increased aerosol concentration in the headspace of Tank 241-AY-102. Addendum 1, Section 3.4.2.2, provides additional discussion regarding the accident and how it is impacted by sluicing activities.

3.4.2.2.1 High-Efficiency Particulate Air Filter Failure - Exposure to High Temperature Accident Scenario Assuming No Controls. The FSAR indicates that high temperatures associated with an external fire (occurring in close proximity to a HEPA filter system) or the failure of an in-line heater could degrade the ventilation system filters. If the integrity of the

filters was compromised, the inventory of the filters could be released, followed by an unfiltered release from the tank vapor space. Releases from the unfiltered pathway are assumed to continue for up to one year in the FSAR analysis. This one year unfiltered release is also assumed in the 241-AZ-702 ventilation system analysis. The radiological and toxicological consequences for this accident are bounded by those presented in Addendum 1, Section 3.4.2.2.

The estimated frequency for this accident scenario was determined to be anticipated (Table B-1, Event Number 40). The frequency of "anticipated" is based on the configuration of the ventilation system and the use of electric heaters.

Each of the two filter trains, containing two HEPAs and a HEGA filter, are housed separately, each train with its own heater. Only one train is used at a time, therefore only one is considered to be lost to fire. The HEME and the inlet HEPA are remotely located in the ventilation system and are not assumed to catch fire in this scenario.

3.4.2.2.1.1 Radiological Consequences. See Addendum 1, Section 3.4.2.2 for the radiological consequences of this accident.

3.4.2.2.1.2 Toxicological Consequences. See Addendum 1, Section 3.4.2.2 for the toxicological consequences of this accident.

3.4.2.2.1.3 HEPA Filter Failure - Exposure to High Temperature Accident Summary of Safety Class/Safety Significant SSCs and Technical Safety Requirements (TSRs). See Addendum 1, Section 3.4.2.2 for the safety SSCs and TSR controls that have been developed to address the risk associated with this accident.

3.4.2.2.2 High-Efficiency Particulate Air Filter Failure - Exposure to High Pressure. Accident Scenario Assuming No Controls - As described in the FSAR, a pressure differential of 2.5 kPa (0.36 psi) can cause HEPA filter failure. The accidents identified in the FSAR for the AWF tanks that could raise the tank pressure above 2.5 kPa (0.36 psi) include steam intrusions, Flammable Gas Deflagrations, organic solvent fire, and in-tank fuel fire/deflagrations. The 241-AZ-702 ventilation system hazard analysis (Appendix B) also identified excessive particulate loading in the filters and moisture on the filters as other potential initiators to the high pressure accident. The bounding analyses are presented in Addendum 1, Section 3.4.2.2. Unlike the HEPA filter failure from exposure to high temperature (discussed in Section 3.4.2.2.1), which assumed an unfiltered release for up to one year, the HEPA filter failure from high pressure involves high energy events which are not assumed to remain undetected. Therefore, a one year unfiltered release is not considered.

Radiological Consequences. The FSAR has evaluated the accidents that could cause a HEPA filter failure because of high pressure (i.e., steam intrusions, Flammable Gas Deflagrations, organic solvent fire, and in-tank fuel fire/deflagrations) in the AWF tanks (with the 241-A-702 ventilation system). In addition, the HazOp in Appendix B considered excessive filter moisture and high particulate loading. The results presented in Addendum 1, Section 3.4.2.2 are bounding for the 241-AZ-702 ventilation system.

High-Efficiency Particulate Air Filter Failure - Exposure to High Pressure Accident Comparison to Guidelines. The accident consequences for the 241-AZ-702 ventilation system are presented in Addendum 1, Section 3.4.2.2.

High-Efficiency Particulate Air Filter Failure - Exposure to High Pressure Accident Controls. See Addendum 1, Section 3.4.2.2 for the safety SSCs and TSR controls that have been developed to address the risk associated with this accident.

The only accident associated with HEPA filter failure due to high pressure which requires the imposition of other ventilation controls (beyond the HEPA filter control program) is the Flammable Gas Deflagration accident. The controls required for this accident are discussed in more detail in Section 3.4.2.14.

3.4.2.2.3 High-Efficiency Particulate Air Filter Failure - Controls. See Addendum 1, Section 3.4.2.2 for the safety SSCs and TSR controls that have been developed to address the risk associated with this accident.

3.4.2.3 Fire In Contaminated Area. There are no contaminated areas associated with the 241-AZ-702 ventilation system that are routinely accessed, such as valve pits, pump pits, and diversion boxes. In the scenario analyzed in the BIO, fuel from a crane gas tank is spilled into a contaminated (and open) valve pit, where it catches fire. The analysis without controls showed that controls are required to protect the onsite worker. To protect the onsite worker, an ignition control program has been established. The elements of this program are shown in FSAR, Table 3.3.2.4.3-3, "Technical Safety Requirement Controls for Fire in Contaminated Area." These controls are not directly applicable to the 241-AZ-702 ventilation system; however, they are applicable to the AWF in general.

3.4.2.4 Evaporator Dump. This accident involves a loss of electrical power to the evaporator, which results in a discharge of the contents of the evaporator to a DST. This scenario is not applicable to the AWF and therefore to the 241-AZ-702 ventilation system. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.5 Steam Intrusion from Interfacing Systems. This accident involves steam jets that are used to transfer waste into the Tank Farms. As a result of operator error, steam is routed to the headspace of a waste tank, which results in a pressure increase and HEPA filter failure. This scenario applies to the 241-AZ-702 ventilation system and is addressed in Section 3.4.2.2.2 of this document. The controls as listed in Addendum 1, Section 3.4.2.2.3 apply.

3.4.2.6 Leak from Railcar/Tank Trailer. This scenario evaluates the effects of a railcar breach, as the railcar is about to enter the 204-AR Waste Unloading Facility. This scenario is not applicable to the 241-AZ-702 ventilation system. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.7 Subsurface Leak Remaining Subsurface. Subsurface leaks that remain subsurface have been analyzed in the FSAR for existing transfer routes. A leak from a single-walled direct-buried pipe was selected as the bounding accident in the FSAR. This scenario was considered bounding because the leak

flows directly to the soil (i.e., there is no encasement) and the direct-buried pipe provides minimal soil shielding. This scenario is not applicable to the 241-AZ-702 ventilation system. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.8 Unplanned Excavation in Cribs, Ditches, and Ponds. This accident considers inadvertent excavation in a crib, ditch, or pond that contains a large quantity of contaminated soil. This accident does not involve the 241-AZ-702 ventilation system. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.9 Caustic Spray Leak. This accident involves a spray release of sodium hydroxide from a 1-in. Schedule 10 commercial steel pipe while the solution is being transferred to a waste tank. While this accident is associated with a waste tank, the scenario does not include the ventilation system of the tank, therefore this accident does not involve the 241-AZ-702 ventilation system. Therefore, no additional controls, beyond those listed in the FSAR, are required.

3.4.2.10 Sodium Fire. This accident is specific to the 2727-W Building and does not involve the 241-AZ-702 ventilation system.

3.4.2.11 Mixing of Incompatible Material - Toxic Vapor Generation. The scenario assumes a rapid uncontrolled addition of caustic to a DCRT which increases the pH level and ultimately results in the release of ammonia. The analysis applies to DCRTs, DSTs, and SSTs. The FSAR analysis results in no consequences and a single Defense-in-Depth control regarding the Industrial Hygiene Program, which ensures personnel safety during chemical additions to the waste tanks. The existing FSAR analysis is adequate for the 241-AZ-702 ventilation system and no additional controls, beyond those listed in the FSAR, are required.

3.4.2.12 Mixing of Incompatible Material - Tank Pressurization. This scenario assumes that an uncontrolled mixture of incompatible materials in a DCRT results in a tank pressurization and an airborne release. There is nothing unique to the ventilation system that introduces new and different accident scenarios for mixing incompatible materials. Since this occurs in a DCRT, this is not applicable to the 241-AZ-702 ventilation system. Therefore, the existing FSAR analysis is adequate for the 241-AZ-702 ventilation system and no additional controls, beyond those listed in the FSAR, are required.

3.4.2.13 Tank Failure Due to Excessive Loads. Postulated tank failure accidents, including tank dome failure, are analyzed in the FSAR, Section 3.4.2.1, "Tank Failure Due to Excessive Loads." Tank dome collapses could be initiated by excessive dome loading or from a combination of internal (e.g., pressure, vacuum, waste level, temperature) and external (e.g., soil, equipment, seismic) loads. The only potential accident initiator identified in the FSAR that is related to the 241-AZ-702 ventilation system is excessive vacuum caused by failures in the ventilation system with continued exhaust operation. Note that the potential for dome collapse caused by Flammable Gas Deflagrations is analyzed in Section 3.4.2.14.

The primary source of excessive vacuum would be from the main ventilation fans. The inlet breather subsystem for each tank includes pressure control valves to maintain tank pressure within the design limits and vacuum relief valves which protect against excessive negative pressure in the primary tank. A failure in the system that generated an excessive vacuum condition in the tank headspace (either fan over speed or inlet plugging) would actuate the vacuum relief valve. Subsequent failure of the vacuum relief valve could lead to excessive vacuum and tearing of the primary tank liner. However, this will not lead to a release of tank material (WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*).

The FSAR concludes there is no need for a safety limit on excessive vacuum. It references several recent analyses which discuss accidents that could result in excessive vacuum. The bounding accident resulting in the highest vacuum is a solvent fire which results in a negative pressure of -55.16 kPa (-8 psig). Details of the accident analysis are contained in Section 3.4.2.1 of the FSAR, WHC-SD-WM-TI-775, *Structural Assessment of Accident Loads*, and WHC-SD-TWR-RPT-002. The scenario is bounding because it results in a vacuum 4.4 times the maximum vacuum possible running the 241-AZ-702 system. The FSAR also considered fan over speed and inlet plugging which were not bounding. The maximum vacuum on the fan curve for 241-AZ-702 fans plus the recirculation fan is a gauge pressure of -12.3 kPa (-49.5 in. water gauge or -1.8 psig) (Section 2.5.1.2). In the analysis for the FSAR, the solvent fire results in tank failure but not in such a way as to provide a release to the environment. In addition, WHC-SD-WM-TI-775 suggests that some tank damage could occur at -6.9 kPa to -13.8 kPa (-1 to -2 psig), although there is no release due to this damage (WHC-SD-TWR-RPT-002). Protecting the tank is a programmatic issue; there is no safety issue since the worst case excessive vacuum does not result in onsite, offsite, or environmental consequences.

3.4.2.13.1 Controls. Because excessive vacuum results in no release, no controls are required for the 241-AZ-702 ventilation system for this accident. The other controls established in the FSAR are unrelated to ventilation and thus are unaffected by the presence of the 241-AZ-702 ventilation system (FSAR, Tables 3.4.2.1-5, "Summary of Technical Safety Requirement Controls for Tank Failure Due to Excessive Loads," and 3.4.2.1-6, "Summary of Defense-in-Depth Controls for Tank Failure Due to Excessive Loads and Tank Failure Due to Vacuum or Degradation").

3.4.2.14 Deflagration Accident. The deflagration accident for the aging waste tanks (with the 241-A-702 ventilation system) has been analyzed in the FSAR, Section 3.4.2.2, "Flammable Gas Deflagrations." This analysis (as will be shown below) is also bounding for the 241-AZ-702 ventilation system.

3.4.2.14.1 Deflagration Accident Scenario. Steady state flammable gas generation is expected from all of the AWF tanks. Steady state flammable gas generation is dependent on several parameters including heat load, waste temperature, total organic carbon (TOC) content, aluminum content, and nitrate/nitrite content. The exact influence these parameters have on flammable gas generation is unknown. However, it is estimated that, with current AWF conditions, a condition > 25% of the lower flammability limit (LFL) in the tank dome space can not occur in less than 24 days after the loss of active ventilation (HNF-SD-WM-CN-117, *Calculation of Hydrogen Release Rate*

at Steady State for Double-Shell Tanks). This calculation is not considered to be a "design basis analysis" because of the considerable uncertainty associated with it and because it uses non-bounding assumptions for tank and waste conditions. Rather it is the best available quantitative basis for the prediction that interruption of ventilation flow does not result in imminent danger of deflagration (assuming current tank contents).

Note that the ventilation system mitigates for steady-state flammable gas accumulation but does not mitigate for gas release events (i.e., waste intrusive activities or spontaneous release events). Waste intrusive activities are discontinued on loss of ventilation. Also, ventilation is not credited for gas release event (GRE) protection. The ventilation function addresses steady state release and accumulation.

No credit was taken in the FSAR analysis for any beneficial effects that flammable gas monitoring, ignition control practices, or ventilation could have to either prevent or mitigate an accident. An unmitigated, unprevented deflagration accident frequency was determined to be anticipated (Table B-1, Event Numbers 33 and 34).

3.4.2.14.2 Deflagration Accident Source Term. Because the accident scenario analyzed in the FSAR (for the 241-A-702 ventilation system) assumes no controls (i.e., no ventilation), the only source term change that will result from applying the same analysis to the 241-AZ-702 ventilation system is in the HEPA filter inventory. However, the analysis for the 241-A-702 ventilation system (documented in Attachment 5 of HNF-SD-WM-CN-099, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*) documents the total quantity of material released from the ventilation system to be 3.6×10^{-2} L, while the 241-AZ-702 system has a total release from the ventilation system of 2.3×10^{-3} L (HNF-SD-WM-CN-099). This shows that the total material released from the 241-AZ-702 system is bounded by the amount released from the 241-A-702 system. It should also be noted that the HEPA filter contribution to the total dose consequences is several orders of magnitude less than the other contributors for both radiological and toxicological consequences and does not impact the total consequences. Thus, the FSAR results for the accident without controls are still bounding for the 241-AZ-702 ventilation system. These results are shown in Section 3.4.2.14.3 below and the FSAR, Table 3.4.2.2-5, "Summary of Consequences and Frequencies of Flammable Gas Deflagration Without Controls."

3.4.2.14.3 Deflagration Accident Comparison to Guidelines. The radiological and toxicological risk guidelines (Table 3-8) are exceeded for the onsite receptor for the AWF tank headspace deflagration scenario. The radiological and toxicological risk guidelines for the offsite receptor, however, are met for the DST and AWF tank headspace deflagration scenarios assuming that burn pressures do not exceed the tank structural limits (i.e., lead to dome collapse). However, due to the technical uncertainties associated with flammable gas behavior, this assumption cannot be rigorously defended and cannot be relied upon to yield bounding results. Nevertheless, the FSAR results clearly imply a need to institute controls to prevent or mitigate hazards associated with flammable gas in the AWF tanks.

Requirements to Remain Within the Risk Evaluation Guidelines. The requirements and strategy to remain within the risk guidelines are summarized in the FSAR, Section 3.4.2.2, "Flammable Gas Deflagrations."

Experience indicates that other site ventilation systems have historically been adequate to sweep out the steady state generated gases. The 241-AZ-702 ventilation system has no operational history upon which to base the claim that it will also provide adequate ventilation. However, calculations (HNF-SD-WM-CN-117) show that, for best-estimate current conditions, no more than 0.057 m^3/min (2 scfm) is required to keep flammable gas concentrations below 25% of the LFL. Therefore, the nominal design flow rate of the 241-AZ-702 ventilation system is expected to be adequate. To confirm this, flammable gas monitoring will be used for a short time after full start up (steady state conditions attained) of the 241-AZ-702 ventilation system to confirm the system's ability to keep flammable gas concentrations below 25% of the LFL. The risk of this approach is low since the best-estimate calculations show a large margin between what is required and what is provided (2.83 m^3/min [100 scfm] nominal). A temporary monitoring program shall be established to benchmark the ability of the 241-AZ-702 ventilation system to sweep out flammable gas due to steady state generation. As a backup, the higher capacity 241-A-702 system will not be decommissioned until the monitoring is complete.

3.4.2.14.5 Deflagration Accident Summary of Safety-Class/ Safety-Significant Structures, Systems, and Components and Technical Safety Requirements Controls. Because of the technical uncertainties associated with the flammable gas safety issue, it is assumed that all installed equipment necessary to implement the flammable gas controls merit a Safety-Class designation. Additional analysis may provide refinement to this approach. The flammable gas controls are provided in the FSAR TSRs. The operation of the 241-AZ-702 ventilation system does not require any new flammable gas controls beyond those already established in the FSAR.

To apply the FSAR controls, a process is followed to specify the allowed safe conditions and control requirements to address the flammable gas hazards as described in the FG JCO (FSAR, Appendix K). The following is the description of the application of this process to the 241-AZ-702 ventilation system equipment.

Inlet Filter Assembly. The inlet filter assembly was found to meet requirements except for four elements. A review of the equipment layout drawings and characteristics of various components was conducted which identified four components which were not in compliance with the FG JCO requirements.

The control/electrical box houses potential sparking components (switches) but is not of explosion proof design, and is located within 18 diameters of the filter opening. The HEPA filter differential pressure switch is normally sparking, not of explosion proof design, and is located within 18 diameters of the filter opening. Heat trace wiring is not qualified to National Fire Protection Association (NFPA) Class I, Division 2, Group B requirements for temperature limited operation and provides temperature control for piping in proximity to the filter opening. The air stream electrical heater is located in the filter opening and vendor data shows that

the heater could exceed the 416 °C (781 °F) temperature limit for a dome intrusive region, which is an unacceptable design.

For these components, several alternatives were provided to meet requirements, with equivalency rulings based on administratively-controlled shutdown during globally waste disturbing activities for the control/ electrical box, HEPA filter differential pressure switch, and heat tracing. Administrative shutdown of unqualified components during time periods which require application of controls renders the applied condition of the equipment compliant. The air stream heater is required to meet Ignition Source Control Set 2 requirements at all times; therefore, the temperature of the heater surface would require control to limit temperature and be vapor tight or be de-energized or replaced since a fault would trip the ground fault circuit interrupter (GFCI). This is based on design of heat tracing that meets NFPA Class I, Division 2, Group B requirements.

For the heat tracing, metallic sheathing of the heat tracing with GFCI connection of the sheath was also found to provide an equipment equivalency. Addition of a grounded metallic sheath was found to provide equivalent safety by eliminating potential electrical sparking as a potential ignition source.

Recirculation Module. The recirculation module was found compliant except for the recirculation fan. The fan did not meet Air Movement Contractor Association (AMCA) 99, Standards Handbook, Type C requirements for application under Ignition Source Control Set 2 requirements. The FGEAB found that equivalent safety would be provided if an axial stop plate were included in the design to prevent fan blade mechanical sparking on the fan housing. This modification to the fan was found to be equivalent to the AMCA requirement to prevent axial restraint of the fan blades. The fan was found to have suitable radial shaft restraint to meet requirements.

Tie-Ins to Existing Equipment. Equipment tie-ins were found to meet requirements under applied controls and practices with the exception of the 20-in. riser tie-in. For the 20-in. tie-in, a reciprocating cutter application was proposed, which the FGEAB found to be a potential mechanical spark source. The FGEAB recommended that an alternative cutting technique be employed. Project W-030 personnel have identified a pipe cutting tool which was tested to satisfy the FGEAB that the maximum pipe temperature which could be reached during cutting is below 80% of autoignition and that hot particle releases, when cutting penetrates the pipe wall, would not provide a potential mechanical spark source. The tests provided pipe temperature data which was clearly bounded by 80% of the hydrogen autoignition temperature and showed that the shavings from cutting would not provide a hot particle spark inside the pipe (cuttings were continuous, rather than particle ejections).

Equipment Past First Mixing Point. Because this equipment is beyond the first mixing point, this equipment was identified to not require application of Ignition Source Controls.

3.4.2.15 Organic Solvent Fire. Some waste tanks contain separable organic solvent phases. If ignited, the burning organic can liberate sufficient energy to release hazardous material from the tank. The oxygen in the tank is the limiting parameter for this scenario. Tanks not yet vapor space sampled are assumed to contain organic solvents. The AWF tanks are considered

potential Organic Solvent containing tanks. The accident analysis presented in the FSAR, Section 3.4.2.4, "Organic Solvent Fire" is a parametric analysis that evaluates the worst case configurations for DST/AWF tanks. The change from the 241-A-702 to the 241-AZ-702 ventilation system does not change the worst case configuration, and the FSAR analysis remains bounding. Further discussion relative to source term differences between the analysis presented in the FSAR and that available with the 241-AZ-702 ventilation system is presented in Addendum 1, Section 3.4.1.

3.4.2.16 In-Tank Fuel Fire/Deflagration. This scenario postulates that a motor vehicle shears off one or more tank risers and ruptures the vehicle fuel tank. The change from the 241-A-702 to the 241-AZ-702 ventilation system does not change the worst case scenario analyzed in the FSAR, Section 3.4.2.5, "In-Tank Fuel Fire/Deflagrations," and the FSAR analysis remains bounding. Further discussion relative to source term differences between the analysis presented in the FSAR and that available with the 241-AZ-702 ventilation system is presented in Addendum 1, Section 3.4.1.

3.4.2.17 Organic Salt-Nitrate Reaction. Organic complexants were used during past Hanford operations and were discharged to the tank where they were mixed with sodium hydroxide, sodium nitrate, and other inorganic diluent already present in the tank. Organic complexants will react with these types of oxidizing materials. The reaction can be accelerated to a rapid combustion by heating to high temperatures by an initiator of sufficient energy. A combustion front would be generated by such a condition and would spread through the combustible waste releasing significant energy and gases. The dose due to the HEPA filter release is insignificant when compared to the results of the main reaction. This accident is applicable to the AWF per the FSAR, Section 3.4.2.6, "Organic Salt-Nitrate Reaction." Safety Limit 2.1.1, "Waste Temperature" of the TSRs and the controls for the Flammable Gas Deflagrations and Tank Bump scenarios as called for in the FSAR (Sections 3.4.2.2 and 3.4.2.11, "Tank Bump") remain unchanged as a result of the operation of the 241-AZ-702 ventilation system.

3.4.2.18 Surface Leak Resulting In Pool. Surface leaks that result in pools have been analyzed in the FSAR for transfer routes. A misrouting of waste to a valve pit was analyzed as the bounding case in the FSAR, Section 3.4.2.7, "Surface Leak Resulting In the Pool." This accident is not applicable to ventilation systems, therefore the FSAR analysis is bounding for the 241-AZ-702 ventilation system.

3.4.2.19 Subsurface Leak Resulting In Pool. Transfer line leaks at high flow rates that are in excess of the natural infiltration rate of the soil can result in surface pools of waste. These waste pools are a safety concern because they can cause significant onsite and offsite inhalation doses and produce significant shine and skyshine doses to the onsite receptor. However, this analysis is not applicable to the 241-AZ-702 ventilation system which services the vapor space of the AWF tanks.

3.4.2.20 Spray Leak in Structure or From Overground Transfer Line. Spray leaks have been analyzed in the FSAR for existing transfer routes. A breach of containment during a transfer could result in a pressurized spray release. A spray leak in a valve pit was analyzed as the bounding case in the FSAR. These spray releases are a safety concern because, depending on the waste

pressure and leak dimensions, they can be relatively efficient generators of respirable-sized aerosols. Spray leaks also apply to the DSTs and including the AWF. The FSAR (Section 3.4.2.9, "Spray Leak in Structure or From Waste Transfer Line") requires a Safety-Class exhaust stack continuous air monitor (CAM) interlock to the exhaust fan. This is required for the 241-AZ-702 ventilation system also.

3.4.2.21 Spray Leak From Underground Waste Transfer Lines. A construction excavation accident could conceivably breach a waste transfer line and cause a spray leak or a surface leak that results in a pool. However, this analysis is not applicable to the 241-AZ-702 ventilation system which services the vapor space of the AWF tanks.

3.4.2.22 Tank Bump Accident. A tank waste thermal rollover phenomenon, known as a Tank Bump, is a rapid steam pressurization of tank headspace. A Tank Bump is a safety concern because of the potential for a release of aerosolized waste to the environment. The Tank Bump accident has been analyzed in the FSAR, and as will be shown below, the FSAR results are bounding for the 241-AZ-702 ventilation system.

3.4.2.22.1 Analysis Strategy. For those tanks that pose a Tank Bump threat, the upper bound on heat load and radionuclide content is found in the Aging Waste Tanks. Tank 241-AZ-101 has nearly twice the heat load of any other AWF tank and therefore was evaluated in the FSAR as the bounding tank.

3.4.2.22.2 Tank Bump Accident Scenario Assuming No Controls. Since no controls are assumed and Tank 241-AZ-101 was evaluated as the bounding tank, the FSAR results do not need to be revisited for the 241-AZ-702 ventilation system. The results presented in the FSAR, Table 3.4.2.11-3, "Summary of Consequences and Frequencies of Tank Bump Without Controls," indicate that controls are required.

3.4.2.22.3 Tank Bump Accident Comparison to Guidelines. The FSAR contains the required comparison. The Tank Bump accident is considered unlikely.

3.4.2.22.4 Tank Bump Accident Controls. The Safety-Class and Safety-Significant SSCs selected in the FSAR Table 3.4.2.11-4, "Summary of Safety Structures, Systems, and Components for Tank Bump," include the tank waste temperature monitoring system and the tank waste level detection system (DSTs and AWF tanks). These safety SSCs do not involve ventilation and thus are unaffected by the 241-AZ-702 ventilation system.

The TSR controls presented in FSAR, Table 3.4.2.11-5, "Summary of Technical Safety Requirement Controls for Tank Bump," involve maintaining the temperature in the AWF tanks $\leq$ 91 °C (195 °F) for all waste levels or $\leq$ 91 °C (195 °F) in the top 4.6 m (15 ft) and $\leq$ 102 °C (215 °F) in the waste below 4.6 m (15 ft). In addition, waste transfer controls and controls on process instrumentation and measuring and test equipment (to ensure that instrumentation to monitor tank temperature is maintained) are imposed. Since no TSR controls were imposed on ventilation systems for the Tank Bump scenario, the 241-AZ-702 ventilation system has no impact on the TSR controls in the FSAR for this accident.

The Defense-in-Depth controls for Tank Bumps are shown in the FSAR, Table 3.4.2.11-6, "Defense-in-Depth Controls for Tank Bump," and include maintaining active ventilation. The 241-AZ-702 ventilation system will provide this capability.

Conclusion. The 241-AZ-702 ventilation system has no impact on the Tank Bump analysis as presented in the FSAR, nor does its operation require the establishment of additional controls beyond those selected in the FSAR.

3.4.2.23 Natural Phenomena. Natural phenomena analyzed in the FSAR include high winds, lightning, and earthquakes. The accidents discussed in the FSAR applicable to the 241-AZ-702 ventilation system are the seismically-induced gas release event and deflagration due to lightning. The seismically-induced GRE is bounded by the deflagration accident already discussed in the addendum. The lightning accident is bounded by the Flammable Gas Deflagration, the organic solvent fire, and the organic salt-nitrate reaction accidents. The Flammable Gas Deflagration and organic solvent fire are discussed in this addendum (Section 3.4.2.2.2). The organic salt-nitrate reaction accident is not applicable to the AWF (Section 3.4.2.17). The FSAR further indicates that no Safety-Class or Safety-Significant structures, systems, and components are associated with lightning and seismic protection. The existing FSAR analysis is adequate for the 241-AZ-702 ventilation system and no additional controls, beyond those listed in the FSAR and Addendum 1, Section 3.4.2.2, are required.

3.4.3 Beyond Evaluation Basis Accidents

An analysis of Beyond Evaluation Basis accidents events is documented in the Final Safety Analysis Report.

Table 3-1. Aging Waste Facility Hazards Identification.[a]

Energy Classification	Aging Waste Facility Hazards	
	Potentially Present Inside Tanks	Potentially Present Elsewhere In or Adjacent to Facility
Corrosive	Caustic, high temperature waste	Caustic
Explosive/pyrophoric	Hydrogen, ammonia, methane, nitrates	Hydrogen
Nuclear criticality	High fissile material concentration in waste	N/A
Flammable materials	Hydrogen, ammonia, methane	Rags, gasoline, lube oil, diesel fuel, grease, other
Thermal radiation	Radionuclides in tank	N/A
Chemical reactions	Uncontrolled chemical reactions	N/A
Friction	Bearings, fans, motors, other	Belts, bearings, fans, gears, motors
Electrical	Wiring, pumps, motors, electrical equipment	Battery banks, transformers, wiring, switchgear, underground wiring, cable runs, service outlets/fittings, pumps, motors, heaters, electrical equipment, high voltage, transmission lines
Kinetic-rotational	Motors, pumps	Motors, pumps, fans
Kinetic-linear	N/A	Cars, trucks, buses, obstructions, crane loads, pressure vessel blowdown, other
Mass, gravity, Height	Pits	Lifts and cranes, trucks, scaffold and ladders, pits, excavations
Pressure-volume	Stressed members, negative pressure collapse, positive pressure release	N/A
Thermal (except radiant)	N/A	Heaters

[a]The hazards identification represents the hazards that could potentially cause an uncontrolled release of radioactive or hazardous materials only. Hazards only resulting in personnel injury are not included.

N/A = not applicable.

Table 3-2. Tank Waste Liquids and Solids Analyte Concentrations.[a]

Composites concentrations (g/L)		
Analyte	**DST Solids**	**DST Liquids**
Ammonia (NH3)	6.6 E+00	7.1 E+00
Antimony (Sb)	9.2 E-01	6.4 E-03
Arsenic (As)	5.7 E+00	1.1 E-02
Barium (Ba)	5.9 E+00	3.3 E-02
Beryllium (Be)	2.4 E-01	3.8 E-03
Cadmium (Cd)	2.6 E+01	7.0 E-02
Calcium (Ca)	2.6 E+01	1.3 E+00
Cerium (Ce)	2.6 E+00	5.8 E-02
Chromium (Cr+3)	1.5 E+02	[b]
Cobalt (Co)	4.4 E+00	8.8 E-03
Cyanide (Cn)	4.7 E-01	9.1 E-02
Dysprosium (Dy)	[b]	
Lanthanum (La)	3.0 E+01	1.0 E+00
Mercury (Hg)	1.2 E-01	2.4 E-04
Neodymium (Nd)	7.0 E+00	5.6 E-03
Oxalate (C2O4)	2.8 E+02	[b]
Selenium (Se)	1.9 E+00	2.8 E-01
Sodium hydroxide (NaOH)	2.3 E+02	2.1 E+02
Sodium (Na) - NaOH[b]	3.5 E+02	2.1 E+02
Tellurium (Te)	9.3 E-01	2.7 E-03
Thallium (Tl)	1.5 E+01	3.7 E-02
TOC-oxalate[c]	7.5 E+01	4.0 E+01
Uranium (U)	4.4 E+01	1.1 E+01
Vanadium (V)	1.2 E-01	2.1 E-03

DST = double-shell tank.
TOC = Total organic carbon.

[a]The information in this table is from WHC-SD-WM-SARR-011, 1996, Toxic Chemical Considerations for Tank Farm Releases, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

[b] = The best available data indicates there is not significant concentrations of this analytes in this composite.

[c] = To avoid counting the same analyte twice, the oxalate concentration was subtracted from the TOC concentration and NaOH was subtracted from the Na concentration.

Table 3-3. Headspace Gas Composite Concentrations.[a]

	Worst Case Composite[b]	
Gas	Concentration (ppmv)	Concentration (mg/m^3)[cb]
Acetonitrile	13	21.8
Ammonia	61,300	40,000
Benzene	0.4	1.3
1,3 Butadiene	0.1	0.19
Butanol	58	164
Dodecane	45	296
2-Hexanone	0.8	2.7
Methylene chloride	2	22
Nitrous oxide	67,000	110,000
Propanenitrile	5	11
Tributyl phosphate	1	12
Tridecane	50	390

[a]The information in this table is from WHC-SD-WM-SARR-011, 1996, Toxic Chemical Considerations for Tank Farm Releases, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

[b]Based on worst case composites including slurry gas released.

[c]The conversion from ppmv to mg/m^3 assumes a temperature of 38 °C (100 °F) and a pressure of 740 torr (0.1 MPA).

Table 3-4. In-Tank Concentrations of the 11 Radionuclides Chosen for Inclusion in Accident Analysis.[a]

Isotope	Bq/L	ULD (Sv/L)	% dose	Bq/L	ULD (Sv/L)	% dose
	Aging Waste Facility Liquids			Aging Waste Facility Solids		
^{60}Co	7.71 E+05	4.56 E-02	0.0	4.9 E+08	2.9 E+01	0.0
^{90}Sr	5.60 E+09	3.62 E+02	25.4	2.9 E+12	1.9 E+05	10.8
^{90}Y	5.60 E+09	1.28 E+01	0.9	2.9 E+12	6.6 E+03	0.4
^{137}Cs	8.84 E+10	7.63 E+02	53.6	9.8 E+10	8.5 E+02	0.0
^{154}Eu	0.00	0.00	0.0	1.1 E+10	8.6 E+02	0.0
^{237}Np	9.20 E+04	1.34 E+01	0.9	9.9 E+08	1.4 E+05	8.4
^{238}Pu	2.75 E+03	2.92 E-01	0.0	6.7 E+07	7.1 E+03	0.4
^{239}Pu	1.20 E+06	1.39 E+02	9.8	4.4 E+08	5.1 E+04	3.0
^{241}Pu	3.39 E+05	7.56 E-01	0.1	1.7 E+09	3.7 E+03	0.2
^{241}Am	1.10 E+06	1.32 E+02	9.3	1.1 E+10	1.3 E+06	76.5
^{244}Cm	1.10 E+04	7.37 E-01	0.1	6.1 E+07	4.1 E+03	0.2
Total ULD		1.42 E+03	100.00		1.7 E+06	100.00

[a]WHC-SD-WM-SARR-037, 1996, Development of Radiological Concentrations Unit Liter Doses for TWRS FSAR Radiological Consequence Calculations, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table 3-5. Flammable Gas Generation Rates.

Type of Flammable Gas Generation	Quantity			
	AY-101	AY-102	AZ-101	AZ-102
Vapor space from steady state generation[a]	.21 L/day (7.25E-03 ft^3/day)	.52 L/day (1.83E-02 ft^3/day)	.57 L/day (2.01E-02 ft^3/day)	.48 L/day (1.71E-02 ft^3/day)
Retained in the sludge (potential GRE)[b]	67% of the LFL if totally released	No Quantity Identified	10% of the LFL if totally released	No Quantity Identified

[a]HNF-SD-WM-CN-117, 1997, Calculations of Hydrogen Release Rate at Steady State for Double-Shell Tanks, Rev. 0, Lockheed Martin Hanford Company, Richland, Washington.

[b]WHC-SD-WM-ER-526, 1997, Evaluation of Hanford Tanks for Trapped Gas, Rev. 1C, Lockheed Martin Hanford Company, Richland, Washington.

Table 3-6. Aging Waste Facility Energy Sources.

Energy	Location	Form and Quantity
Electrical (Ignition sources and high voltage)	• Dome space • Ventilation buildings • Ventilation system • External equipment • Pump • Pump pit/valve pit • Aboveground (near risers)	• Various electrical equipment • Ventilation fans • Monitoring and instrumentation • Material with potential electrostatic charge buildup
Mechanical (including spark sources)	• Dome space • Ventilation system • External equipment • Pump • Tank intrusive activities	• Tools with spark potential • Air motion caused by active ventilation • Ventilation fans, kinetic energy (recirculation and main) • Moving parts with kinetic energy (pumps, motors, etc.)
Mechanical (potential energy)	• Tank waste	• Potential energy stored in gas bubbles compressed by hydrostatic head • Potential energy stored as saturated liquid (Tank Bump potential)
Chemical	• Tank • Vehicles (on or near tanks) • Tank farm • Ventilation buildings	• Diesel and gasoline • Lubricants
Radiant	• Transfer lines • Tank waste	• Radionuclides in tank waste
External events	• Tank farms	• Lightning • Tornadoes/high winds • Heavy rains • Earthquakes/volcanoes • Range fires

Note: A more detailed listing of the energy sources evaluated in the hazards and operability study can be found in Appendix B, Table B-6.

Table 3-7. FSAR Accident Comparison Summary. (3 sheets)

No.	FSAR Accident	241-AZ-702 Section	FSAR Section	241-AZ-702 Comparison	TSR	Comment	Justification
1	Nuclear Criticality	3.4.2.1 and Section 6.3	3.3.2.4.1	Bounded by the FSAR	Nuclear Criticality Safety Program	N/A	There is no mechanism to increase the plutonium concentration in the ductwork sufficiently to cause a criticality.
2a	HEPA Filter Failure - High Temp. Unfiltered Release	3.4.2.2.1	3.3.2.4.2	Bounding consequence analysis provided in Addendum 1, Section 3.4.2.2	LCO 3.1.4A AC 5.18.2b AC 5.18.2c AC 5.18.2e	N/A	N/A
2b	HEPA Filter Failure - High Pressure	3.4.2.2.2	3.3.2.4.2	Bounding consequence analysis provided in Addendum 1, Section 3.4.2.2	AC 5.18.2b AC 5.18.2c AC 5.18.2e	FSAR 3.3.2.4.2 points to other accidents for actual consequences.	N/A
3	Fire in a Contaminated Area	3.4.2.3	3.3.2.4.3	Not applicable to 241-AZ-702 ventilation system in particular - no contaminated areas as described in FSAR.	Ignition Control Program	Generally applicable to AWF	No (open) contaminated areas in which to spill fuel.
4	Evaporator Dump	3.4.2.4	3.3.2.4.4	Not applicable	N/A	N/A	N/A
5	Steam Intrusion from Interfacing Systems	3.4.2.5	3.3.2.4.5	Bounded by the FSAR; see HEPA filter failure - due to high pressure	AC 5.18.2b AC 5.18.2c AC 5.18.2e	(see item 2 above)	(see item 2 above)
6	Leak from Railcar/ Tank Trailer	3.4.2.6	3.3.2.4.6	Not applicable	N/A	N/A	N/A
7	Subsurface Leak remaining Subsurface	3.4.2.7	3.3.2.4.7	Not applicable	N/A	N/A	N/A
8	Unplanned Excavation/ Drilling in Pond/ Ditch/Crib	3.4.2.8	3.3.2.4.8	Not applicable	N/A	N/A	N/A
9	Caustic Spray Leak	3.4.2.9	3.3.2.4.9	Not applicable to ventilation system analysis - controls required on farm	Caustic Transfer Controls applicable to AWF	N/A	N/A
10	Sodium Fire	3.4.2.10	3.3.2.4.10	Not applicable	N/A	Applicable only to 2727-W Bldg.	N/A

Table 3-7. FSAR Accident Comparison Summary. (3 sheets)

No.	FSAR Accident	241-AZ-702 Section	FSAR Section	241-AZ-702 Comparison	TSR	Comment	Justification
11	Mixing of Incompatible Material - Toxic vapor	3.4.2.11	3.3.2.4.11	Not applicable - associated with DCRTs	N/A	Associated with DCRTs	N/A
12	Mixing of Incompatible Material - Tank pressurization	3.4.2.12	3.3.2.4.12	Not applicable - associated with DCRTs	N/A	Associated with DCRTs	N/A
13a	Tank Failure Due to Excessive Loads	3.4.2.13	3.4.2.1	Not applicable to operation of the ventilation system.	Tank load control program	N/A	N/A
13b	Tank Failure due to vacuum or degradation	3.4.2.13	3.4.2.1	Bounded by the FSAR	Tank load control program	Tank damage which causes releases cannot occur at the capability of the fans	The fans cannot draw enough vacuum to cause releases either onsite or offsite.
14	Flammable Gas Deflagration	3.4.2.14	3.4.2.2	Bounded by the consequence accident in the FSAR.	LCO 3.2.1 AC 5.18.2b AC 5.18.2c AC 5.18.2e	No changes required to LCO; change needed to cover HEME and HEGA in admin. control (see item 2 above)	Basis for the measurement frequency of 25% of the LFL in the action statements is the CN-117 which governs the 241-AZ-702
15	Organic Solvent Fire	3.4.2.15	3.4.2.4	Bounded by the FSAR	AC 5.18.2b AC 5.18.2c AC 5.18.2e	See item 2 above.	See item 2 above.
16	In-Tank Fuel Fire/ Deflagration	3.4.2.16	3.4.2.5	Bounded by the FSAR	AC 5.18.2b AC 5.18.2c AC 5.18.2e	See item 2 above.	See item 2 above.
17	Organic Salt-Nitrate Reaction	3.4.2.17	3.4.2.6	Same as the FSAR.	SL 2.1.1, LCO 3.3.2, LCO 3.2.1, AC 5.18.2b AC 5.18.2c AC 5.18.2e	N/A	N/A
18	Surface Leak Resulting in Pool	3.4.2.18	3.4.2.7	Not applicable - related to transfer lines	N/A	N/A	N/A
19	Subsurface Leak Resulting in Pool	3.4.2.19	3.4.2.8	Not applicable - related to transfer lines	N/A	N/A	N/A
20	Spray Leak in Structure or From Overground Waste Transfer Lines	3.4.2.20	3.4.2.9	Applicable	Requires CAM interlock LCO 3.1.4A	N/A	N/A
21	Spray Leak from Underground Waste Transfer Lines	3.4.2.21	3.4.2.10	Not applicable - related to transfer lines.	N/A	N/A	N/A
22	Tank Bump	3.4.2.22	3.4.2.11	Same as the FSAR	LCO 3.3.2	N/A	N/A

Table 3-7. FSAR Accident Comparison Summary. (3 sheets)

No.	FSAR Accident	241-AZ-702 Section	FSAR Section	241-AZ-702 Comparison	TSR	Comment	Justification
23	Natural Phenomena - High wind - Lightning - Seismic	3.4.2.23	3.4.2.12	Bounded by the FSAR	Controls as listed for the seismically induced GREs and lightning strikes.	General applicability to the AWF	N/A

AC = Administrative Control.
AWF = Aging Waste Facility.
FSAR = HNF-SD-WM-SAR-067, 1999, Tank Waste Remediation System Final Safety Analysis Report, Rev. 0-A, Lockheed Martin Hanford Corporation, Richland, Washington.
CAM = continuous air monitor.
DCRT = double-contained receiver tank.
GRE = gas release event.
HEGA = high-efficiency gas adsorber.
HEME = high-efficiency mist eliminator.
HEPA = high-efficiency particulate air (filter).
LCO = Limiting Condition for Operation.
N/A = not applicable.
SL = Safety Limit.

Table 3-8. Radiological Risk Guidelines.[a]

Frequency Category	Frequency Range (yr^{-1})	Effective Dose Equivalent (rem)	
		Onsite	Offsite
Anticipated	$>10^{-2}$	.5	0.1
Unlikely	$10^{-4} < f \leq 10^{-2}$	5	0.5
Extremely unlikely	$10^{-6} < f \leq 10^{-4}$	10	4

[a]The information in this table is from WHC-CM-4-46, Safety Analysis Manual, Section 7.0, "Risk," Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Refer to Appendix G, "Sitewide Controlled Manual Cross-Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., Procedures (e.g., HNF-PRO-XXX).

Table 3-9. Toxicological Risk Evaluation Guidelines.[a]

Frequency Category	Frequency Range (yr^{-1})	Primary Concentration Guidelines	
		Onsite	Offsite
Anticipated	$>10^{-2}$	≤ ERPG-1	≤ PEL-TWA
Unlikely	$10^{-4} < f \leq 10^{-2}$	≤ ERPG-2	≤ ERPG-1
Extremely unlikely	$10^{-6} < f \leq 10^{-4}$	≤ ERPG-3	≤ ERPG-2

ERPG = Emergency Response Planning Guideline.
PEL-TWA = permissible exposure limit-time weighted average.

[a]The information in this table is from WHC-CM-4-46, Safety Analysis Manual, Section 7.0, "Risk," Rev. 4, Westinghouse Hanford Company, Richland, Washington.

Refer to Appendix G, "Sitewide Controlled Manual Cross-Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., Procedures (e.g., HNF-PRO-XXX).

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4.0 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

The safety classifications for the 241-AZ-702 ventilation system structures, systems, and components (SSCs) are presented in the following sections. Safety classifications for Tank Waste Remediation System (TWRS) facility SSCs are described in the HNF-SD-WM-SAR-067, *Tank Waste Remediation System Final Safety Analysis Report*, (FSAR), Chapter 4.0, "Safety Structures, Systems, and Components."

4.1 INTRODUCTION

The controls selected for each accident are described in Section 3.0, "Hazard and Accident Analyses." The selection process follows the SSC classification methodology described in WHC-CM-4-46[1], *Safety Analysis Manual*.

The SSCs included in this report are divided into two categories, Safety-Class SSCs and Safety-Significant SSCs. See the FSAR, Chapter 4.0, "Safety Structures, Systems and Components," for definitions of all the terms used to categorize SSCs.

4.2 REQUIREMENTS

DOE Orders and standards that provide requirements and guidance for safety classification of SSCs are as listed in the FSAR.

4.3 SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS

This section provides information about the Safety-Class SSCs identified in Section 3.0, "Hazard and Accident Analyses," of this addendum. Table 4-1 provides a categorization of those SSCs.

4.3.1 Safety-Class Structures, Systems, and Components

The following is a discussion of the Safety-Class considerations associated with the 241-AZ-702 ventilation system and the exhaust continuous air monitor (CAM) interlock.

[1]Refer to Appendix G, "Sitewide Controlled Manual Cross-Reference Table," of the FSAR for cross-walk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc., Procedures (e.g., HNF-PRO-XXX).

4.3.1.1 Safety Function. The deflagration accident described previously in Section 3.4.2.14, "Deflagration Accident" requires the provision of tank ventilation flow to be a Safety-Class function. Components that would be designated Safety-Class are those whose failure could block the flow path or deprive the flow of its motive force (e.g., ducting, valves, filters, fans, electrical distribution system). In addition, instrumentation critical to sensing flow are designated Safety-Class. See HNF-SD-WM-SEL-040.

The safety function is achieved by the 241-AZ-702 ventilation system SSCs which were originally designated to meet Safety-Significant criteria. The bases for this Safety-Significant designation were developed before the declaration of the Flammable Gas Unreviewed Safety Question (USQ) TF-96-0433. Therefore, the design, procurement and construction of the 241-AZ-702 ventilation system meets, as a minimum, applicable Safety-Significant criteria.

Another control is a result of the spray leak accident, described previously in Section 3.4.2.20, "Spray Leak in Structure or From Overground Transfer Line." This accident requires a continuous air monitor (CAM) interlock on the exhaust stack to shut down the exhaust fan should the exhaust high-efficiency particulate air (HEPA) filters breakthrough.

4.3.1.2 System Descriptions. The 241-AZ-702 ventilation system maintains adequate flow by continuous operation of the fans and provisions for switching to an alternate fan and filter bank during maintenance. Section 2.5 "Process Description" of this addendum provides a detailed description of the ventilation system.

The exhaust stack CAM interlock transfers the flow from one train to the other upon CAM alarm. This is slightly different than the interlock described in the FSAR, but is allowed under the compensatory measures for FSAR Implementation (Technical Safety Requirements [TSR] Limiting Condition for Operation [LCO] 3.1.4A, "Ventilation Stack Continuous Air Monitor [CAM] Interlock Systems").

4.3.1.3 Controls (Technical Safety Requirements). The additional control for the 241-AZ-702 ventilation system required to support the SSCs for the 241-AZ-702 ventilation system is in place within the TSRs which is summarized in the FSAR, Table 3.3.2.3.2-1, "Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents."

The Administrative Control (TSR AC 5.18, "HEPA Filter Controls") governing HEPA filter loading requires the addition of the 241-AZ-702 ventilation system high-efficiency mist eliminator (HEME) loading maximum of 800 mrem/hr and replacement of the high-efficiency gas adsorber (HEGA) filter before the upstream HEPA filter in the associated filter train has been replaced 20 times. Additionally, an efficiency requirement is placed on the HEPA filters upstream of the HEGA.

There are no changes required to LCO 3.1.4A, except to include its applicability to the 241-AZ-702 ventilation system.

4.4 SAFETY-SIGNIFICANT STRUCTURES, SYSTEMS, AND COMPONENTS

4.4.1 Safety-Significant Structures, Systems, and Components

There are no unique Safety-Significant SSCs designated for the 241-AZ-702 ventilation system.

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Table 4-1. Safety-Class SSCs for the 241-AZ-702 Ventilation System.

SSC	Accident(s)	Safety Functions
Ventilation System - Safety-Class[a] (by designation) - Safety-Significant (by design)	Deflagration	Maintain flammable gas concentrations in the tank dome spaces, due to steady-state releases, below 25% of the LFL.
CAM Interlock - Safety-Class for spray leak accident - Safety-Significant for HEPA filter failure accident	HEPA filter failure - high temperature Spray leak in structure or from overground waste transfer line	Mitigate radiological and toxicological releases to the environment.

CAM = continuous air monitor.
HEPA = high-efficiency particulate air (filter).
LFL = Lower Flammability Limit.

[a]The actual 241-AZ-702 ventilation system configuration, consistent with original design requirements, meets Safety-Significant design criteria. Allocation of design margins may demonstrate that certain Safety-Class requirements are met by the original design.

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5.0 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 INTRODUCTION

The existing operating envelope for the Tank Waste Remediation System (TWRS) is defined by the Technical Safety Requirements (TSRs) listed in Chapter 5.0, "Derivation of Technical Safety Requirements" of HNF-SD-WM-SAR-067, *Tank Waste Remediation System Final Safety Analysis Report*, (FSAR). These controls are implemented through HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, prepared using the guidance of U.S. Department of Energy (DOE) 5480.22, *Technical Safety Requirements*. The purpose of this section is to identify the TSRs that must be added to the FSAR to bring the W-030 ventilation upgrade within the TWRS safety envelope.

5.2 REQUIREMENTS

The DOE Orders required for establishing the safety basis for the 241-AZ-702 ventilation system are as listed in the main body of the FSAR.

5.3 TECHNICAL SAFETY REQUIREMENTS COVERAGE, AND DERIVATIONS

The accident analysis in Section 3.0, "Hazard and Accident Analyses," along with the designation of safety Structures, Systems, and Components (SSCs) and the associated TSRs in Section 4.0, "Safety Structures, Systems and Components," indicated that operation of the 241-AZ-702 ventilation system is bounded by the TWRS TSRs. However, an addition to the TSR Administrative Control (AC) 5.18, "HEPA Filter Controls" program is required to limit the inventories on high-efficiency particulate air (HEPA), high-efficiency gas adsorber (HEGA), and high-efficiency mist eliminator (HEME) filters and prefilters to protect the source term assumptions in the accident analyses. This control has been added to FSAR, Table 3.3.2.3.2-1, "Safety Structures, Systems, and Components and Technical Safety Requirement Controls and Defense-in-Depth Controls for Representative Accidents," to account for the reanalyzed accident scenarios and allows the FSAR to envelope operation of the 241-AZ-702 ventilation system. The FSAR, Table 3.3.2.3.2-1, correlates the reanalyzed accident scenarios with the necessary controls and includes the Safety-Class and Safety-Significant SSCs, the type of TSR control (i.e., Limiting Condition for Operation [LCO] or AC) and the specific location of the control within the TSR (e.g., LCO 3.2.1 "DST and AWF Ventilation System" or AC 5.18), and a summary of the key elements of the TSR derivation basis.

The Administrative Control (AC 5.18, "HEPA Filter Controls") governing HEPA filter loading requires the addition of the 241-AZ-702 ventilation system HEME loading maximum of 800 mrem/hr and replacement of the HEGA filter before the upstream HEPA filter in the associated filter train has been replaced 20 times. Additionally, an efficiency testing requirement is placed on the HEPA filters upstream of the HEGA.

Other TSRs required for the 241-AZ-702 ventilation system are not unique to the 241-AZ-702 ventilation system and are covered by TSRs previously identified in the FSAR.

5.4 DERIVATION OF FACILITY MODES

The operational modes for the TWRS facility are defined in the TSRs. Operation of the 241-AZ-702 ventilation system does not change any of these definitions of facility operating modes.

5.5 INTERFACE WITH TECHNICAL SAFETY REQUIREMENTS FROM OTHER FACILITIES

The TSRs for the 241-AZ-702 ventilation system are contained within the TSRs for the TWRS. Interfaces between the TWRS TSRs and the TSRs from other facilities are listed in FSAR Table 5-4, "Technical Safety Requirement Interfaces With Other Facilities."

6.0 PREVENTION OF INADVERTENT CRITICALITY

This section contains information relevant to prevention of inadvertent criticality as a result of operation of the 241-AZ-702 ventilation system. See Chapter 6.0, "Prevention of Inadvertent Criticality," of the *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, for further information on the TWRS specific criticality safety and protection program. The program ensures that sufficient controls are in place to reduce the likelihood of inadvertent nuclear criticality excursions as a result of the activities performed within the Tank Waste Remediation System (TWRS) facilities.

6.1 REQUIREMENTS

See the FSAR, Section 6.2, "Requirements," for requirements.

6.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 6.0 for facility implementation.

6.3 PROJECT IMPLEMENTATION

The WHC-SD-WM-TI-725, *Tank Farm Nuclear Criticality Review*, evaluated the possibility of a nuclear criticality occurring in tank farm facilities. Considering current plutonium inventories and operating conditions, it was concluded that a nuclear criticality accident was not credible in Hanford Site double-contained receiver tanks (DCRTs), double-shell tanks (DSTs), and single-shell tanks (SSTs). The discussion then presented an analysis of a hypothetical criticality accident resulting from the transfer of new plutonium inventory into the tank farms. No new conditions or configurations of plutonium are introduced into the tank farms by the 241-AZ-702 ventilation systems; and there is no change in the likelihood of a criticality for normal storage and operations at tank farms due to the implementation of this system.

The potential for criticality within the ventilation system itself has also been considered. The largest duct in the system has a 25.4 cm (10-in.) diameter. An infinitely long 25.4 cm diameter duct would need to be filled with waste material containing about 22 g Pu/liter (1.4 lb Pu/ft^3) in order to achieve criticality. All the waste in tanks exhibits plutonium concentrations substantially less than the subcritical limit of 2.6 g Pu/liter (0.16 lb Pu/ft^3). In fact the maximum concentration observed in tanks is about 0.35 g Pu/liter (0.022 lb Pu/ft^3) (although there was a single sample of 0.7 g Pu/liter [0.044 lb Pu/ft^3]). Most of the tanks exhibit concentrations substantially less. Thus any explosion or other excursion which might be postulated to force waste material into the ventilation system would not, by itself, result in a criticality concern.

From the foregoing discussion, it can be concluded that a mechanism capable of increasing plutonium concentration by a factor of 60-100 or more would necessarily have to function in order to achieve a condition of potential criticality. Plutonium buildup in ventilation systems such as that experienced at the Rocky Flats facility or at the Hanford Plutonium Finishing Plant (Z Plant) (PFP) involves either the transport of material which was highly concentrated to begin with, e.g., plutonium metal or concentrated oxide, or which was highly volatile, e.g., plutonium hexafluoride. Neither of these conditions pertain to the material in the Hanford tanks. The plutonium in high level neutralized waste is sorbed with the neutralized oxyhydroxides; thus it is neither easily airborne nor volatile.

Thermally driven increases in plutonium concentration can also be considered, i.e., those driven by fire in the tank. However, the aging waste facility (AWF) tanks have not been identified as organic nitrate tanks and thus the waste will not burn. Thus plutonium segregation and/or concentration due to combustion of organic nitrate is not a concern for operation of the 241-AZ-702 ventilation system.

To date none of these tanks have been identified as organic solvent containing tanks, although sampling has not yet been completed to verify that for the tanks of concern. Further, solvent fires primarily involve the solvent itself, and minimal impact on the sludge would be expected. Hence solvent fires are not expected to be a source of plutonium segregation and/or concentration for these tanks.

Finally, existing ventilation data was sought to determine if any plutonium segregation was indicated. There is comparatively little data available upstream of the high-efficiency particulate air (HEPA) filters. Some gamma spectrometry has been performed on the HEPA filters. This data usually indicates the presence of large amounts of ^{137}Cs, but gamma spectrometry cannot distinguish the weak gammas of plutonium in the presence of stronger gamma emitters. More complete analyses are performed downstream of the HEPAs and are reported in the annual *Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1995*, (DOE/RL-96-37). The ratios of common, non-volatile isotopes to plutonium for various tank farm stack samples can be compared to similar ratios for the source term reported in the BIO as a rough indicator of plutonium concentration by the ventilation process. The non-volatile isotope is taken as an indicator of the behavior of all the non-volatile, non-plutonium constituents of waste. If the ratios of a non-volatile isotope to plutonium in the ventilation system are similar to those found in the tank waste, this can be taken as an indicator that no concentration of plutonium is occurring in the ventilation process. The ^{90}Sr was chosen since it is relatively non-volatile and is present in most ventilation samples. The range of $^{90}Sr/^{239}Pu$ for the source term in the FSAR is 33 to 6600 (HNF-SD-WM-CN-108, *Calculation of Isotopic Ratios in Tank Farms Ventilation Systems*). The range of $^{90}Sr/^{239}Pu$ for the 1995 stack release data is 37 to 2200, a similar range of values. This rough comparison does not suggest any notable segregation or reconcentration of plutonium in the ventilation system.

Based on understanding of the relevant phenomena and the limited data discussed above, it is concluded that there is no potential for criticality in the 241-AZ-702 ventilation system.

7.0 RADIATION PROTECTION

This section identifies the requirements for radiation protection for Tank Waste Remediation System (TWRS) facilities and operations and the implementing program documents.

7.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 7.2, "Requirements," for requirements.

7.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 7.0, "Radiation Protection," for facility implementation.

7.3 PROJECT IMPLEMENTATION

The radiation dose and dose rate design limits are delineated in project functional design criteria, WHC-SD-600-FDC-001, *Functional Design Criteria for the Tank Farm Ventilation Upgrade, Project W-030*, and WHC-SD-W030-RD-001, *Supplemental Definition of Requirements for Tank Farm Ventilation Upgrade, Project W-030*. Design details required to comply with the criteria are verified in calculations completed by the architect-engineer/constructor. Programmatic elements of radiation protection are governed by existing Site and facility programs. Descriptions of radiation monitoring and instrumentation are given in the System Description of this document. No requirements above those identified in the programmatic documents were required for the 241-AZ-702 ventilation system.

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8.0 HAZARDOUS MATERIAL PROTECTION

This section identifies the requirements for hazardous material protection other than radiological hazards for Tank Waste Remediation System (TWRS) facilities and operations and the implementing program documents.

8.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 8.2, "Requirements," for requirements.

8.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 8.0, "Hazardous Material Protection," for facility implementation.

8.3 PROJECT IMPLEMENTATION

No project-specific requirements related to hazardous material protection were identified for the 241-AZ-702 ventilation system.

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9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

This section lists the requirement documents for the radioactive and hazardous waste management for the 241-AZ-702 ventilation system.

9.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 9.2, "Requirements," for requirements.

9.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 9.0, "Radioactive and Hazardous Waste Management," for facility implementation.

9.3 PROJECT IMPLEMENTATION

No additional requirements relating to radioactive and hazardous waste management were identified for the 241-AZ-702 ventilation system.

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10.0 INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

This section identifies the requirements for initial testing, in-service surveillance, and maintenance for Tank Waste Remediation System (TWRS) facilities and operations and their implementing program documents.

10.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 10.2, "Requirements," for requirements.

10.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 10.0, "Initial Testing, In-Service Surveillance, and Maintenance," for facility implementation.

10.3 PROJECT IMPLEMENTATION

10.3.1 Initial Testing

10.3.1.1 Testing Program. Organizational responsibilities for initial testing phases of the project are defined in WHC-SD-W030-SUP-001, *Startup Plan - Tank Farm Ventilation Upgrade Project W-030*. The initial testing program is described in WHC-SD-W030-SUP-003, *Startup Test Plan - Tank Farm Ventilation Upgrade W-030*.

Three phases of testing are performed during startup of the 241-AZ-702 ventilation system. These are the acceptance test procedures (ATPs), the pre-operational test procedures (POTPs), and the operational test procedures (OTPs). The ATPs and POTPs are performed before initial system operation while the OTPs are performed after system startup. Eight POTPs are performed; seven of the eight POTPs test individual sub-systems. The eighth POTP tests the overall system, checking for interactions between the sub-systems and for instabilities of total system operation. Completion of the POTPs establishes the stable operational settings of the system. The parameters evaluated in the test and their acceptance criteria are defined in WHC-SD-W030-SUP-003.

10.3.1.2 System Construction. System construction is performed under the current Authorization Basis and is not covered under this safety analysis document. Work packages are reviewed using the USQ process (HNF-IP-0842, *TWRS Administration*, Volume IV, Section 5.4) and the applicable Authorization Basis. A key component of the Authorization Basis against which construction was evaluated is Standing Order 97-01, *Compensatory Measures to Address Flammable Gas Hazards (East Tank Farms)*.

10.3.1.3 System Tie-In. The 241-AZ-702 ventilation system hot tie-in will be accomplished per the WHC-SD-W030-SUP-004, *Hot Tie-In Plan, Tank Farm Ventilation Upgrade Program*.

10.3.1.4 Temporary Flammable Gas Monitoring. A temporary monitoring program shall be established to benchmark the ability of the 241-AZ-702 ventilation system to sweep out flammable gas due to steady state generation. A plan has been prepared providing the details of the testing to demonstrate compliance with the following criterion (HNF-SD-W030-TC-001).

> Criterion: The 241-AZ-702 ventilation system shall be considered successful at maintaining tank flammable gas concentrations within acceptable levels if the flammable gas concentration is less than 25% of the LFL (FSAR, Section 10.4.1, "Provisions for Testing and Calibrations").

In order to demonstrate compliance with this criterion a mix of sampling, and online (Standard Hydrogen Monitoring System [SHMS] or gas chromatograph [GC]) or portable instruments (combustible gas meter [CGM] and Organic Vapor Meter [OVM]) may be used. At least two samples must be taken to validate each instrument used.

The data must be collected after the tank has had time to approach steady state conditions and shall be used to calculate a one-sided 95% upper confidence interval based on the precision and accuracy of the instrument used. As a backup, the higher capacity 241-AZ-702 system shall not be deactivated until the monitoring is complete and the above requirements have been met.

The flammable gas monitoring plan for the 241-AZ-702 ventilation system (Fowler 1997) discusses measurement of the flammable gas concentrations in the exhaust stream, temperatures of the waste and flow rates of the system to document the ability of the new system to mitigate flammable gas build up due to steady-state generation. The instruments, calibration requirements, collection frequencies and procedures to follow are defined in the plan. A discussion is included on how the data will be used to define the concentrations (e.g., modeling methods). The monitoring will occur after system startup.

10.3.2 In-Service Surveillance

Procedures for surveillance testing will be developed in accordance to U.S. Department of Energy (DOE) 5480.19, *Conduct of Operations Requirements for DOE Facilities.*

10.3.3 Maintenance

Procedures for maintenance will be developed in accordance to DOE 5480.19.

11.0 OPERATIONAL SAFETY

This section identifies requirements for conduct of operations, Aging Waste Facility (AWF) fire protection, and the implementing program documents directly resulting from the installation/operation of the 241-AZ-702 ventilation system.

11.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 11.2, "Requirements," for requirements.

11.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 11.0, "Operational Safety," for facility implementation.

11.3 PROJECT IMPLEMENTATION

A revision to HNF-SD-WM-FHA-020, *Fire Hazards Analysis for Tank Farms*, was performed for the 241-AZ-702 ventilation system. The conclusion from this analysis is as described below.

The risk of fire loss in the three-building facility is well managed through the placement of walls of fire rated construction and through the use of fire sprinkler systems for fire suppression throughout. Combustible material loadings are held to a minimum in each fire area and exposure dangers are mitigated by physical separation. The protection of this facility and its contents, as well as the safety of its occupants, appear to be more than adequately assured. Water supplies for this location do not have a second supply as required by U.S. Department of Energy (DOE) 6430.1A. A second water source will be provided by Project B-604 to meet this DOE 6430.1A requirement for the entire 200 East and West Areas.

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12.0 PROCEDURES AND TRAINING

This section lists the requirements for the procedures and training programs for the 241-AZ-702 ventilation system.

12.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 12.2, "Requirements," for requirements.

12.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 12.0, "Procedures and Training," for facility implementation.

12.3 PROJECT IMPLEMENTATION

Responsibility for training on the new systems before commencement of operations is defined in WHC-SD-W030-SUP-001. Training and procedure development are to be conducted per existing site and facility requirements. Procedures and training requirements for areas specifically related to the 241-AZ-702 ventilation system will be developed in accordance with U.S. Department of Energy (DOE) 5480.19 and the results of the accident analysis of this addendum (Section 3.0 "Hazard and Accident Analysis").

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13.0 HUMAN FACTORS

Human factors requirements are defined for this facility in the *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Chapter 13.0, "Human Factors." Specific requirements for the 241-AZ-702 ventilation system related to human factors above those specified in the reference are noted below.

This section lists the requirements for a human factors program to demonstrate that human factors are considered in facility design where human actions are relied upon for preventive or mitigative actions.

13.1 REQUIREMENTS

See the FSAR, Section 13.2, "Requirements," for requirements.

13.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 13.0, for facility implementation.

13.3 PROJECT IMPLEMENTATION

A human factors analysis for the instrument/control room and control systems was completed for the project. Results of this analysis were included in the design of the Project W-030 systems (WHC-SD-W030-ANAL-001, *Human Factors Analysis & Design Guidelines for the Tank Farm Ventilation Upgrade of AY-AZ Farms*). System design is summarized in the System Description section of this document. The human factors analysis provided location and sizes for workspace design such as monitors, keyboards, desk space area, floor space, and maintenance access. The analysis also provided for printer, monitor and label font sizes for optimal viewing and alarm size and color (and decibel level) for optimal response. Guidelines were provided for lighting, temperature and humidity control which were used in design.

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14.0 QUALITY ASSURANCE

This section lists the requirements for a quality assurance program to ensure the safety of personnel and the public, for environmental protection, and for the implementing program documents.

14.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 14.2, "Requirements," for requirements.

14.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 14.0, "Quality Assurance," for facility implementation.

14.3 PROJECT IMPLEMENTATION

Implementation of specific quality assurance requirements for the 241-AZ-702 ventilation system is controlled by WHC-SD-W030-QAPP-001, *Project Specific Quality Assurance Plan, W-030, Tank Farm Ventilation Upgrade*.

- Personnel performing work on the 241-AZ-702 ventilation system have been and will continue to be trained and qualified in accordance with the above-referenced quality assurance programs and DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for Nuclear Facilities*.

- Quality improvement processes described in the quality assurance programs are provided for the detection and correction of quality problems throughout the design and construction of this project.

- Documents and records associated with this project have been and will be independently reviewed for completeness and accuracy. A record index is available to classify all quality assurance records to aid in retrieval.

- Work processes associated with this project have been and will be strictly adhered to in accordance with this quality assurance program. Appropriate administrative procedures have been developed and approved to control key aspects in the design and construction of this project.

- Designs associated with this project have been or will be independently reviewed and approved. Completed construction will be accurately depicted by as-built drawings upon project completion.

- Procurement of Safety-Class and Safety-Significant items for this project are in compliance with this quality assurance program. Such items have been purchased from qualified suppliers where applicable and all stated requirements have been or will be met as verified through independent inspections, tests, and assessments. Certified Vendor Information has been or will be received and appropriately indexed and filed to support continuity of service for this project.

- Inspection and testing of items associated with this project will meet required standards as verified by properly trained and qualified personnel and records supplied on project turnover will attest to accuracy and completeness.

- Periodic management assessment of this project has been and/or will be conducted to ensure this project is compliant with this quality assurance plan and the objectives stated therein.

- Independent assessments will be planned, scheduled, and conducted to confirm that project deliverables and service quality are adequate to meet operational objectives.

15.0 EMERGENCY PREPAREDNESS PROGRAM

This section identifies the requirements for the emergency preparedness functions and response at the site of the 241-AZ-702 ventilation system.

15.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 15.2, "Requirements," for facility implementation.

15.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 15, "Emergency Preparedness Program," for facility implementation.

15.3 PROJECT IMPLEMENTATION

No additional project-specific requirements related to emergency preparedness were identified as unique (in addition to those identified in the FSAR) to the 241-AZ-702 ventilation system in Section 3.0, "Hazard and Accident Analyses"; Section 4.0, "Safety Structures, Systems, and Components"; and Section 5.0, "Derivation of Technical Safety Requirements," of this addendum.

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16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

This section describes provisions that facilitate future decontamination and decommissioning of the facilities with respect to the 241-AZ-702 ventilation system.

16.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 16.2, "Requirements," for requirements.

16.2 IMPLEMENTATION

See the FSAR, Chapter 16.0, "Provisions for Decontamination and Decommissioning," for requirements.

16.3 PROJECT IMPLEMENTATION

Decontamination and decommissioning was considered in the design of the 241-AZ-702 ventilation system (WHC-SD-W030-RD-001). It requires all equipment and surfaces exposed to, or containing, radioactive materials, to be designed to minimize cracks and crevices. Materials and surfaces were specified to minimize surface contamination and enhance washdown. Because of this, the 241-AZ-702 ventilation system provides modular components, lifting rings, and access ports for decontamination.

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17.0 MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

This section provides the requirements specific to this section and pertinent to the safety analysis, and the implementing program documents.

17.1 REQUIREMENTS

See *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, Section 17.2, "Requirements," for requirements.

17.2 FACILITY IMPLEMENTATION

See the FSAR, Chapter 17.0, "Management, Organization, and Institutional Safety Provisions," for facility implementation.

17.3 PROJECT IMPLEMENTATION

No additional management, organization, and institutional safety provisions, above those currently in place for the Aging Waste Facility (AWF) 241-A-702 ventilation system, were introduced or required by the 241-AZ-702 ventilation system.

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APPENDIX A

HAZARD BASIS

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Table A-1. Event Categories and Relationship to Hazard Energy and Material Sources.

Event Category	Event Category Description	Hazard Energy and Material Groups
E-1	Fire	Electrical Thermal Friction Pyrophoric material Spontaneous combustion Open flame Flammable Combustibles Chemicals
E-2	Explosion	Potential (pressure) Explosive materials Chemical reactions
E-3	Loss of Containment or Confinement	Radiological Material Hazardous Material
E-4	Direct Radiological Exposure	Ionizing radiation sources
E-5	Nuclear Criticality	Fissile material
E-6	External Hazards	Non-facility events Vehicles in motion Crane
E-7	Natural Phenomena	Natural Phenomena

Note: Material at risk can be found in the BIO, since the presence of the 241-AZ-702 ventilation system does not change the TWRS material at risk.

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APPENDIX B

HAZARD ANALYSIS SUMMARY

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APPENDIX B

HAZARD ANALYSIS SUMMARY

Note: This appendix is presented for information about the initial development of the accident analyses. It was performed before the development of the *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, and references the former Authorization Basis documents (i.e., Interim Operational Safety Requirements [IOSRs]) which are no longer applicable. The FSAR controls and Defense-in-Depth requirements take precedence. Because of this, disregard the entries in the Defense-in-Depth column. Also disregard the reference to AC 5.19 of the IOSRs in the entries associated with the Tank Bump accident which is analyzed in Section 3.4.2.22 of this addendum. Other references to IOSR administrative controls have corresponding administrative controls in the TSRs (i.e., IOSR AC 5.3 is TSR AC 5.7, IOSR AC 5.13 is TSR AC 5.18, IOSR AC 5.22 is TSR AC 5.16, IOSR AC 5.24 is TSR AC 5.19, and IOSR AC 5.29 is TSR AC 5.9, 5.10, and 5.11).

B1.0 HAZARD ANALYSIS SUMMARY

Table B-1 provides the summary for the Preliminary Hazard Analysis (PHA) and Hazards and Operability (HazOp) study that was performed for the Project W-030 ventilation system. A PHA technique was used to evaluate the hazards for the Project W-030 ventilation upgrade for the Aging Waste Facility (AWF). This technique consists of first identifying the hazards (e.g., radioactive sources, wastes, and chemicals) in terms of form, quantity, and location. Additional characterization identifies the mechanisms for their accidental releases. Tables B-6 and B-7 provide an energy source checklist and a summary of hazardous events used during the evaluation. Finally, the risks from accidents associated with these hazards are evaluated in a qualitative or semi-quantitative way, depending upon the accident scenario.

The hazard evaluations address consequences to the public, collocated workers, and immediate workers. Accidental releases can result from internal events, external events, or natural phenomena. Consequences of common industrial accidents are not included, unless they: 1) initiate a release of hazardous material, or 2) worsen the consequences of a hazardous material release. Industrial accidents which could cause only occupational injuries or illnesses are addressed by the Industrial Hygiene and Safety Program, which is a required element identified in the Administrative Controls section of the IOSRs.

A HazOp study was also performed to confirm and validate the results of the PHA. The hazard definition guide shown in Table B-2 describes the process variables and the guide words used to perform the HazOp. The HazOp emphasizes the processes involved with the ventilation system and not just the individual components. Also, a check list was used to capture and evaluate all high energy sources and natural hazards that impact the Project W-030 ventilation system. The results of the PHA and HazOp are recorded in Table B-1.

B2.0 METHODOLOGY

B.2.1 Hazard Identification

This hazards analysis describes the hazards identification and evaluation process performed for the Aging Waste Facility (AWF) Tank Farms and presents the comprehensive evaluation of potential process-related hazards, natural phenomena hazards, and external hazards. These hazards arise from the form, location, and quantities of nuclear chemical waste stored in the aging waste Underground storage tanks. Operations, maintenance, testing, and construction have been considered. The hazard identification and evaluation process provides a thorough and complete qualitative evaluation of the spectrum of potential accidents involving the hazards identified. This effort forms the basis for: 1) understanding facility worker protection and environmental features, and 2) selecting potential design basis accidents (DBAs) to be further developed and quantified in Section 3.4.2 "Design Basis Accidents."

The major classification of accident categories for the ventilation system were identified as loss of containment, loss of confinement, waste disposal, criticality, natural phenomena, fire and explosion, interface, maintenance and testing, and injury to personnel. Those hazards identified as credible by the review team were recorded in the Hazard Summary Table (Table B-1). Hazardous materials evaluated included radioactive material, toxic materials, corrosive materials, reactive materials, asphyxiants, explosives, and combustibles and flammables.

B.2.1.1 Loss of Containment/Confinement. Loss of containment as a hazard will be considered as breach of ventilation system barriers resulting in the release (non-airborne) of radioactive materials or hazardous chemicals.

B.2.1.2 Loss of Confinement. Loss of confinement as a hazard category will be considered as the breach of a ventilation system barrier resulting in the release of gaseous or airborne radioactive materials or hazardous chemicals.

B.2.1.3 Waste Disposal. Consideration of waste handling and disposal hazards will be limited to those hazards involving the waste that is generated under the ventilation function and incidental to the performance of the waste storage and treatment mission at the tank farms.

The scope of this hazard identification and analysis effort specifically will not include the hazards associated with the transportation, treatment and disposal of waste materials generated incidental to the performance of the waste storage mission.

A gaseous or airborne waste effluent stream results from filtered stack exhaust through active ventilation systems (primary, annulus, and portable exhausters) and filtered exhaust through tank ventilation inlet/outlet risers in passive ventilation systems. An additional airborne waste effluent stream may be associated with filtered exhaust through ventilation inlet risers in active ventilation systems during events that result in loss of negative pressure in the tank headspace.

B.2.1.4 Criticality. The hazard identification and analysis team assumed that insufficient fissile material carryover from the tank headspace to the ventilation system takes place that could result in a significant accumulation of fissile materials in the ventilation system (Section 6.3, "Project Implementation").

B.2.1.5 Natural Phenomena. The hazards associated with natural phenomena can be considered from two different perspectives based on the effects of the event. These are the direct effects to personnel (such as direct physical consequence) and those effects that result from a sequence of events leading to a release of hazardous material that is initiated by natural phenomena as the energy source.

B.2.1.6 Fire and Explosion. Hazards associated with fire and explosion considered in the context of the ventilation function were found to be represented by two classes: 1) those hazards that result in a direct physical effect to personnel caused by the fire or explosion, and 2) those hazards that result from the release of hazardous materials that may result from a sequence of events that are initiated by the fire or explosion.

Potential concerns related to initiation of fires or explosions internal to the ventilation system components are associated with either the carryover of crystallized flammable chemicals that may accumulate in ventilation system filters and components (active and passive ventilation systems) or exhaust of gases from the tank headspace through the ventilation system (active and passive).

B.2.1.7 Interfaces. The hazards associated with interfaces with utilities and other AWF tank equipment were considered.

B.2.1.8 Maintenance and Testing. The hazards associated with maintaining and testing the Project W-030 ventilation system were included in the PHA evaluation effort.

B.2.2 Hazard Evaluation

Using the PHA and HazOp evaluation techniques, a Hazard Analysis Summary table was constructed (Table B-1). Hazard Analysis Summary tables have been used to compile the results of the hazard identification and evaluation process for the AWF Project W-030 ventilation upgrade system. The hazard tables of Table B-1 are structured using columns to present information about the hazardous materials, energy sources, and general environmental and occupational hazards associated with tank farm operations. Each column in the hazard tables is described below.

- **Hazard.** Identifies the hazard evaluated for the given entry.
- **Event Number.** Identifies sequence for the hazards evaluated.
- **Event Category.** Provides an event category descriptor based on Table A-1.

- **Postulated Event Description.** Provides details on how the hazard can occur.

- **Significant Causes or Energy Sources.** Identifies the hazard or accident initiators.

- **Receptor.** Identifies the affected party.

  Note: This Hazard Analysis Summary Table includes the immediate onsite worker; the regulations do not evaluate this receptor and it is not included in the consequence analyses of Section 3.0, "Hazard and Accident Analyses," of this addendum.

- **Credited Prevention.** Identifies engineered or administrative features that would prevent or reduce the probability of the hazard/accident from occurring.

- **Event Frequency.** Discusses qualitative or semi-quantitative assessment of the frequency of occurrence of the hazard with and without preventative features. Values found in this column are based on Table B-3.

- **Credited Mitigation.** Identifies engineered or administrative features that would mitigate or reduce the consequences of the hazard/accident.

- **Consequences.** Discusses qualitative or semi-quantitative assessment of the consequences of the hazard with and without mitigative features. Values found in this column are based on Table B-4.

- **Risk Bin Number.** Assigns a risk number based on the frequency, the consequences, and the receptor. Values found in this column are based on Table B-5.

- **Defense-in-Depth Controls.** Lists the key preventative and mitigative features used to provide a Defense-in-Depth to minimize the occurrence or consequences of the identified hazard.

B.2.3 Hazard Evaluation Results. The hazard analysis results were recorded and transmitted in a letter report (Kelly 1996) which is included as an attachment to this section of the addendum. Attachment 1 to this report is the same as Tables A-1 in the previous section of this addendum and Tables B-3 through B-6 of this addendum. Attachment 2, "Hazard Summary Table," is found in Table B-1 of this section.

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
1	E-7	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Seismic event	Public	Engineered Features: - Double encase piping - Seismic design of system is SC-2 Administrative Features: - None identified	F2	F1	Engineered Features: - Double encased ducting Administrative Features: - None Identified	S0	S0	4	2	- Hardened building
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	8	5	- Same as for the public
				Rationale for frequency of event: Seismic event at the Hanford Site has a frequency of F2 Potential for contamination of the environment: E0, slight to negligible									
2	E-7	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Seismic event	Public	Engineered Features: - Double encased piping - Seismic design of system is SC-2 Administrative Features: - None identified	F2	F1	Engineered Features: - Double encased ducting Administrative Features: - Alarm response procedures	S0	S0	4	2	- Sloped ducting to drain to tank or sump - Pipe annulus liquid monitoring - Hardened building
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Rationale for frequency of event: Seismic event at the Hanford Site has a frequency of F2 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
3	E-7	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Tornado Tornado generated missiles High winds	Public	Engineered Features: - Building hardened to SC-2 winds (80 mph) - Lines buried 2.4 m (8 ft) deep - Double encased ducting Administrative Features: - Emergency response procedures - Tie down (AC)	F2	F1	Engineered Features: - Double encased ducting - Hardened building Administrative Features: - Emergency response procedures	S0	S0	4	2	- Cathodic protection
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Rationale for frequency of event: Tornado/high wind event at the Hanford Site has a frequency of F2 Potential for contamination of the environment: E0, slight to negligible									
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
4	E-7	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Tornado Tornado generated missiles High winds	Public	Engineered Features: - Building hardened to SC-2 winds (80 mph) - Lines buried 2.4 m (8 ft) deep - Double encased ducting Administrative Features: - Emergency response procedures - Tie down (AC)	F2	F1	Engineered Features: - Double encased ducting Administrative Features: - Emergency response procedures	S0	S0	4	2	- Cathodic protection
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	8	5	- Same as for the public
				Rationale for frequency of event: Tornado/high wind event at the Hanford Site has a frequency of F2 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
5	E-7	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Other externally generated missiles (e.g., compressed gas cylinders during maintenance or construction, falling light poles, etc.)	Public	Engineered Features: - Ducting is double encased - Ducting is buried - Hardened facility Administrative Features: - Emergency response procedure	F2	F1	Engineered Features: - Ducting is double encased Administrative Features: - Emergency response procedure	S0	S0	4	2	- All lines are sloped to tank or sump - Ducting is schedule 40 pipe - Ducting is SC-2
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	- Same as for the public
				Rationale for frequency of event: Compressed gas is used only during maintenance and other maintenance activities give a frequency of F2 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
6	E-7	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Other externally generated missiles (e.g., compressed gas cylinders during maintenance or construction, falling light poles, etc.)	Public	Engineered Features: - Ducting is double encased - Ducting is buried - Hardened facility - Ducting is schedule 40 pipe - Ducting is SC-2 Administrative Features: - Emergency response procedure	F2	F1	Engineered Features: - Ducting is double encased Administrative Features: - None identified	S0	S0	4	2	- Ducting is schedule 40 pipe - Ducting is SC-2
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	4	2	Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	8	5	Same as for the public
				Rationale for frequency of event: Compressed gas is used only during maintenance and other maintenance activities give a frequency of F2 Potential for contamination of the environment: E0, slight to negligible									
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
7	E-3	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Corrosion of ducting, weld cracks, etc.	Public	Engineered Features: - Cathodic protection - Stainless steel piping Administrative Features: - Initial weld inspections - Initial pressure testing	F3	F2	Engineered Features: - Double encased piping - Pipe annulus monitoring Administrative Features: - Alarm response procedure	S0	S0	7	4	- All lines are sloped back to tank or sump
				Co-Located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: Corrosion is anticipated to significantly degrade the piping (without prevention or mitigation) during the life of the facility; this makes it a frequency of F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
8	E-3	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Corrosion of ducting, weld cracks, etc.	Public	Engineered features: - Cathodic protection - Stainless steel piping Administrative Features: - Initial weld inspections	F3	F2	Engineered Features: - Pipe annulus monitoring Administrative Features: - None identified	S0	S0	7	4	- Double encased piping - Initial pressure testing
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: Corrosion is anticipated to significantly degrade the piping (without prevention or mitigation) during the life of the facility; this makes it a frequency of F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the process stream and exhaust stream													
9	E-3	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Fatigue failure resulting from thermal cycling, excessive vibration, etc.	Public	Engineered Features: - Vibration isolators at the fan/duct interface - Ducting is double encased - Stainless steel - Thrust blocks - Expansion loops - Controlled density fill around ducting - Ducting buried 2.4 m (8 ft) Administrative Features: - Heavy equipment permit required in tank farms (AC) - Survey made for paths of heavy equipment - Metal plates used when driving over existing lines	F3	F2	Engineered Features: - Double encased piping Administrative Features: - Alarm response procedures	S0	S0	7	4	- Pipe annulus liquid monitoring - Lines designed to 97 °C (206 °F) - All lines are sloped to tank or sump
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: Thermal cycling of the piping is anticipated to significantly degrade the piping (without prevention or mitigation) during the life of the facility; this makes it a frequency of F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the process stream and exhaust stream													
10	E-3	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Fatigue failure resulting from thermal cycling, excessive vibration, etc.	Public	Engineered Features: - Vibration isolators at the fan/duct interface - Ducting is double encased - Stainless steel - Thrust blocks - Expansion loops - Controlled density fill around ducting - Ducting buried 2.4 m (8 ft) Administrative Features: - Heavy equipment permit required in tank farms (AC) - Survey made for paths of heavy equipment - Metal plates used when driving over existing lines	F3	F2	Engineered Features: - Double encased piping Administrative Features: - Alarm response procedures	S0	S0	7	4	- Pipe annulus liquid monitoring - Lines designed to 97 °C (206 °F)
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: Thermal cycling of the piping is anticipated to significantly degrade the piping (without prevention or mitigation) during the life of the facility; this makes it a frequency of F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the process stream and exhaust stream													
11	E-3	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Internally generated missiles from recirculating fan blade failure.	Public	Engineered Features: - Centrifugal fans - Modules contain missiles (but not sealed) Administrative Features: - Maintenance	F3	F2	Engineered Features: - None Identified Administrative Features: - None Identified	S0	S0	7	4	- Periodic inspection would hear bearing noise - All lines are sloped to tank or sump
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	Same as for the public
				Rationale for frequency of event: Fan blade failure rate makes this event a frequency of F3 Potential for contamination of the environment: E0, slight to negligible									
12	E-3	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Internally generated missiles from main ventilation system exhaust fan blade failure.	Public	Engineered Features: - Centrifugal fans - Main ventilation system fan is located in a hardened room Administrative Features: - Maintenance	F3	F2	Engineered Features: - None Identified Administrative Features: - None Identified	S0	S0	7	4	- Periodic inspection would hear bearing noise
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: Fan blade failure rate makes this event a frequency of F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the process stream and exhaust stream													
13	E-6	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Ventilation system overburden (external loading)	Public	Engineered Features: - Control density fill - Double encased ducting Administrative Features: - Excavation permit required (AC 5.24) - Dome loading limited (AC 5.22) - Shift manager controls vehicle access/route for heavy equipment	F3	F2	Engineered Features: - Double encased ducting Administrative Features: - None Identified	S0	S0	7	4	- Ducting buried 8 ft deep - All lines are sloped to tank or sump
		Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.		Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: The frequency of heavy equipment moving within tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
14	E-6		Ventilation system overburden (external loading)	Public	Engineered Features: - Control density fill - Double encased ducting Administrative Features: - Excavation permit required (AC 5.24) - Dome loading limited (AC 5.22) - Shift manager controls vehicle access/route for heavy equipment	F3	F2	Engineered Features: - Double encased ducting Administrative Features: - None Identified	S0	S0	7	4	- Ducting buried 2.4 m (8 ft) deep
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: The frequency of heavy equipment moving within tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									
Hazard – Radiological and toxicological material in the process stream and exhaust stream													
15	E-6	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	External dropped equipment	Public	Engineered Features: - Hardened aboveground - Double encased Administrative Features: - Major lifts require a USQ screening - AC/procedure on all lifts	F3	F2	Engineered Features: Administrative Features:	S0	S0	7	4	- Ducting buried 2.4 m (8 ft) - Double encased lines - All lines are sloped to tank or sump
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: The frequency of crane operations and heavy lifts within tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
16	E-6	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	External dropped equipment	Public	Engineered Features: - Hardened aboveground - Double encased Administrative Features: - Major lifts require a USQ screening - AC/procedures on all lifts	F3	F2	Engineered Features: - None Identified Administrative Features: - None Identified	S0	S0	7	4	- Ducting buried 2.4 m (8 ft)
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: The frequency of crane operations and heavy lifts within tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
17	E-6	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Excavation operations	Public	Engineered Features: None Identified Administrative Features: - AC 5.24, Excavation permit program - HNF-IP-0842[1] manual requires hand digging - HNF-IP-0842[1] manual requires scanning the area before digging - RCT and PIC present during activity and	F3	F2	Engineered Features: - None Identified Administrative Features: - None Identified	S0	S0	7	4	- Ducting buried 2.4 m (8 ft) - Yellow tape marker has been placed 0.6 m (2 ft) above ducting - All lines are sloped to tank or sump - Ducting is located inside fence
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: The frequency of excavations in tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
18	E-6	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Excavation operations	Public	Engineered Features: None Identified Administrative Features: - AC 5.24, Excavation permit program - HNF-IP-0842[1] manual requires hand digging - HNF-IP-0842[1] manual requires scanning the area before digging - RCT and PIC present during activity and	F3	F2	Engineered Features: - None Identified Administrative Features: - None Identified	S0	S0	7	4	- Ducting buried 2.4 m (8 ft) - Yellow tape marker has been place 0.6 m (2 ft) above ducting
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: The frequency of excavations in tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									
19	E-6	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Ground creep and movement	Public	Engineered Features: - Controlled density fill - Expansion loops Administrative Features: - None identified.	F3	F2	Engineered Features: - None identified. Administrative Features: - None identified.	S0	S0	7	4	- All lines are sloped to tank or sump - Double encased ducting
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: The frequency of ground movement or ground creep makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
20	E-6	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Ground creep and movement	Public	Engineered Features: - Controlled density fill - Expansion loops Administrative Features: - None identified	F3	F2	Engineered Features: - None identified. Administrative Features: - None identified.	S0	S0	7	4	- Double encased ducting
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: The frequency of ground movement or ground creep makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
21	E-6	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Vehicular collision with above grade ventilation system components	Public	Engineered Features: - Hardened facility - Recirculation modules Administrative Features: - Spotter required for vehicles backing up within tank farms	F3	F2	Engineered Features: - None identified. Administrative Features: - None identified.	S0	S0	7	4	- All lines are sloped to tank or sump - Components are not readily vulnerable
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: The frequency of vehicular operation within tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
22	E-6	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Vehicular collision with above grade ventilation system components	Public	Engineered Features: - Hardened facility - Recirculation modules Administrative Features: - Spotter required for vehicles backing up within tank farms	F3	F2	Engineered Features: - None Identified Administrative Features: - None Identified	S0	S0	7	4	- Components are not readily vulnerable
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	8	- Same as for the public
				Rationale for frequency of event: The frequency of vehicular operation within tank farms makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
23	E-6	Process condensate release to the soil due to ducting failure, drain line failure, seal pot failure, etc.	Freezing and thawing of ventilation system components that contain liquid	Public	Engineered Features: - Components have drains - Seal loops below frost line Administrative Features: - Freeze protection/ winterization procedure	F3	F3	Engineered Features: Administrative Features: - Freeze protection plan for AWF	S0	S0	7	4	- Sloped ducting back to sump/tank - Double encased - Electric heaters - Can by-pass condenser and/or HEME - Airflow from condenser limits exit temperature to 1 °C (34 °F)
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for public
				Rationale for frequency of event: The frequency of freezing weather conditions on the Hanford Site makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the ventilation process stream and exhaust stream													
24	E-6	Process vapor release to the atmosphere due to ducting failure, drain line failure, seal pot failure, etc.	Freezing and thawing of ventilation systems that contain liquid	Public	Engineered Features: - Components have drains - Seal loops below frost line Administrative Features: - Freeze protection/ winterization procedure - Freeze protection plan for AWF	F3	F3	Engineered Features: None Identified Administrative Features: - Freeze protection plan for AWF	S0	S0	7	7	- Double encased ducting - Electric heaters - Can by-pass condenser and/or HEME - Airflow exit temperature limited to 1 °C (34 °F)
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	7	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	11	- Same as for the public
				Rationale for frequency of event: The frequency of freezing weather conditions on the Hanford Site makes this event an F3 Potential for contamination of the environment: E0, slight to negligible									
Hazard – Radiological and toxicological in the tank													
25	E-3	Release of radiological material due to Tank Bump	Loss of tank cooling due to failure of the tank recirculatio n system fan	Public	Engineered Features: - Exhaust system fans - Air lift circulators - Main ventilation system has backup Administrative Features: - Shut off heat generating equipment (mixer pumps, etc.) - Temperature monitoring	F3	F2	Engineered Features: - None identified Administrative Features: - AC 5.19, Tank heat load limit	S3	S3	16	15	- Annulus ventilation system available - Ancillary exhaust connectors available - Cooling provided by main ventilation system
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: The frequency of fan failures makes this event an F3 Potential for contamination of the environment: E3									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the tank													
26	E-3	Release of radiological material due to Tank Bump	Loss of ventilation due to failure of one of the main ventilation system fans	Public	Engineered Features: - Redundant ventilation trains Administrative Features: - Time to repair	F3	F2	Engineered Features: Administrative Features: - AC 5.19, Tank heat load limit	S3	S3	16	15	- Electrical backup - Redundant fans - Ancillary exhaust connectors - Main ventilation systems (primary and backup) are separately located - Manual settings of system can be made - ALC operation available
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: The frequency of fan failures makes this event an F3 Potential for contamination of the environment: E3									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard - Radiological and toxicological material in the tank													
27	E-3	Release of radiological material due to Tank Bump	Loss of ventilation due to failure of both of the main ventilation system fans	Public	Engineered Features: - Scenario requires two independent failures (redundant ventilation trains) Administrative Features: - Temperature monitoring	F2	F1	Engineered Features: - None Identified Administrative Features: - AC 5.19, Tank heat load limit	S3	S3	15	13	- Standby diesel generator provides electrical power - Main ventilation systems (primary and backup) are separately located - Ancillary ventilation connector - Days or weeks available to respond before Tank Bump occurs - ALC operation available
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Rationale for frequency of event: The frequency of two fan failures makes this event an F2 Potential for contamination of the environment: E3									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the tank													
28	E-3	Release of radiological material due to Tank Bump	Loss of ventilation due to loss of AC power	Public	Engineered Features: - Standby diesel generator Administrative Features: - None identified	F3	F2	Engineered Features: - None identified Administrative Features: - AC 5.19, Tank heat load limit	S3	S3	16	15	- Standby diesel generator provides electrical power - Main ventilation systems (primary and backup) are separately located - Ancillary ventilation connector - Days or weeks available to respond before Tank Bump occurs - ALC operation available
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: The frequency of loss of AC power has a frequency of F3 Potential for contamination of the environment: E3									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the tank													
29	E-3	Release of radiological material due to Tank Bump	Loss of ventilation due to blockage of the tank inlet breather	Public	Engineered Features: - Pressure monitoring system Administrative Features: - Temperature monitoring - AC for pressure drop across inlet breather (OSD limit) - Temperature monitoring - Flow monitoring (for low flow) - Alarm response procedure)	F3	F2	Engineered Features: - None Identified Administrative Features: - AC 5.19, Tank heat load limits	S3	S3	16	15	- Air lift circulators available - Vacuum relief valve is set at -1.5 kPa (6 in. w.g.) - Recirculation system can maintain waste temperature - Heaters protect filters from freezing
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: Total blockage of the inlet breather (ice, tumbleweed, plastic bag, particulate build-up, or other means) is expected to occur during the life of the facility; this makes the event frequency an F3 Potential for contamination of the environment: E3									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
30	E-3	Release of radiological material due to Tank Bump	Loss of ventilation due to blockage of the exhaust system HEME	Public	Engineered Features: - Seal pot has level alarm - HEME can be bypassed Administrative Features: - Pressure drop tested periodically across HEME	F3	F2	Engineered Features: - None identified Administrative Features: - AC 5.19, Tank heat load limit	S3	S3	16	15	- HEME has capability of being replaced (modular) - Temperature monitoring of waste - Water spray prevent HEME filter from drying out - ALC operation available
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: Total blockage of the HEME (particulate build-up) and without prevention or mitigation is expected to occur during the life of the facility; this makes the event frequency an F3 Potential for contamination of the environment: E3									
31	E-3	Release of radiological material due to Tank Bump	Loss of ventilation due to blockage of the exhaust system HEPA/HEGA filters	Public	Engineered Features: - Redundant ventilation train - High pressure drop across filters switches systems Administrative Features: - High pressure drop across HEPA/HEGA - Temperature monitoring - Alarm response procedures	F3	F2	Engineered Features: - None Identified Administrative Features: - AC 5.19, Tank heat load limit	S3	S3	16	15	- Temperature monitoring of waste - 200 mrem/h maximum filter loading (800 mrem/h for HEME) - ALC operation available
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: Total blockage of the HEPA/HEGA (particulate build-up) and without prevention or mitigation is expected to occur during the life of the facility; this makes the event frequency an F3 Potential for contamination of the environment: E3									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the tank													
32	E-3	Release of radiological material due to Tank Bump	Loss of ventilation due to failure of the seal pot allowing water to back up to HEME and/or exhaust system condenser	Public	Engineered Features: - Liquid level probes (high and low levels) Administrative Features: - Alarm response procedures	F3	F2	Engineered Features: - None identified Administrative Features: - AC 5.19 Tank heat load limit	S3	S3	16	15	- Temperature monitoring - Time available for maintenance response - ALC operation available
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: Total blockage of the seal loop (without prevention or mitigation) is expected to occur during the life of the facility; this makes the event frequency an F3 Potential for contamination of the environment: E3									
Hazard – Radiological and toxicological material in the tank													
33	E-1	Release of radiological material due to dome failure caused by flammable gas headspace deflagration	Accumulation of flammable gas from steady state generation and ignition source	Public	Engineered Features: - Operating ventilation system (airflow through the tanks) prevents flammable gas accumulation - Flow monitoring is Safety-Class Administrative Features: - AC 5.29, Flammable gas controls	F3	F2	Engineered Features: - Operating ventilation system (airflow through the tanks) mitigates flammable gas accumulation Administrative Features: - None Identified	S3	S3	16	15	- None identified
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: Radioactive waste generates flammable gases in all AWF tanks; without prevention or mitigation, flammable conditions within the tank are expected to occur in days, weeks, or months depending on initial tank conditions; an ignition source is assumed to be present; this makes the event frequency an F3 Potential for contamination of the environment: E3									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the tank													
34	E-1	Release of radiological material due to dome failure caused by flammable gas headspace deflagration	Accumulation of flammable gas resulting from a GRE and ignition source	Public	Engineered Features: - Flow monitoring is Safety-Class - Lock out recirculation system for suspect tank(s) Administrative Features: - AC 5.29, Flammable gas controls	F3	F2	Engineered Features: - Operation of ventilation will purge tank of flammable gases Administrative Features: - None Identified	S3	S3	16	15	- ALC operation available
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	16	15	- Same as for the public
				Rationale for frequency of event: Tanks identified as GRE potential tanks are, by definition, those tanks which could have a release that exceeds 25% of the LFL; an accumulation of flammable mixtures is anticipated in these tanks during the life of the facility; an ignition source is assumed to be present; this makes the event frequency an F3 Potential for contamination of the environment: E3								
Hazard – Radiological and toxicological material in the tank													
35	E-7	Release of radiological material due to dome failure or collapse caused by excessive vacuum	Blocked inlet breather. Overspeeding exhaust fan. Excessively open exhaust valve.	Public	Engineered Features: - Vacuum relief valve Administrative Features: - Pressure drop across inlet breather - Vacuum monitoring - Flow monitoring	F2	F1	Engineered Features: - None Identified Administrative Features: - Alarm response procedure	S3	S3	15	13	- Inlet heater protect against ice on filters - Flow monitoring
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Rationale for frequency of event: Total blockage of the inlet breather (ice, tumbleweed, plastic bag, particulate build-up, or other means) is expected to occur during the life of the facility and has a frequency an F3; this event also requires the simultaneous failure of the pressure relief valve; these to failures make the frequency an F2 Potential for contamination of the environment: E3								

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Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the tank													
36	E-6	Release of radiological material due to dome failure or collapse caused by excessive vacuum	Ventilation imbalance	Public	Engineered Features: - Flow monitoring Administrative Features: - Pressure monitoring - Alarm response procedure	F2	F1	Engineered Features: - Tank vacuum relief valve Administrative Features: - Alarm response procedure	S3	S3	15	13	- Valve settings can be manually set
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Rationale for frequency of event: Failure of the ventilation system to create a dome failure is unlikely because of the presence of the inlet system and pressure relief valves (these would also have to fail) Potential for contamination of the environment: E3									
37	E-6	Release of radiological material due to dome collapse caused by excessive pressure	Excessive air supply to air lift circulators	Public	Engineered Features: Administrative Features: - Interlock to shut off ALC on high pressure - High pressure alarm - Alarm response procedure	F2	F1	Engineered Features: - Manifolded to other AWF tanks and main ventilation system - System is to be operable and operating Administrative Features: - Alarm response procedure	S3	S3	15	13	- Pressure monitoring
				Co-located Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	15	13	- Same as for the public
				Rationale for frequency of event: Normal operation of the ALC results in 0.04 m^3/s (80 cfm) being introduced into the tank; the tank is manifolded to the other three tanks; the inlet filter system is rated for 0.24 m^3/s (500 cfm); the frequency of the given event is deemed to be F2 Potential for contamination of the environment: E3									

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Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the process stream													
38	E-6	Release of radiological material due to a leak in the recirculation ventilation cooling system or the exhaust ventilation cooling system	Corrosion of shell or tubes	Public	Engineered Features: - Failure requires failure of both the propylene glycol system and cooling tower (two failures) - Cooling fluid is at a higher pressure than the process gas (ventilation airstream) Administrative Features: - None identified)	F1	F1	Engineered Features: - None identified Administrative Features: - None identified	S0	S0	7	4	- System components are modular
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	7	4	- Same as for the public
				Rationale for frequency of event: Corrosion of both the shell and the tubes of the condenser put the frequency in the F1 range Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the exhaust stream and built up on the HEPA filters													
39	E-6	Release of radiological material due to HEPA filter AZ-K1-4-1A blow out	High dP due to excessive HEPA filter loading, excessive system moisture carryover, high tank pressure, etc.	Public	Engineered Features: - Heater - Redundant HEPA filters Administrative Features: - Pressure drop across HEPA filter tested annually	F1	F1	Engineered Features: - Redundant HEPA filters Administrative Features: - Filters to be replaced if they fail dP testing - Filters to be replaced if they fail radioactive load surveillance	S1	S1	5	5	- Limits on radioactive loading on filters (200 mrem/h, 800 mrem/h for HEME) - Recirculation system, condenser, and HEME remove moisture and particulate loading from airstream - Redundant ventilation trains
				Co-located Worker	- Same as for the public			- Same as for the public	S1	S1	5	5	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	5	5	- Same as for the public
				Rationale for frequency of event: Event requires the failure of two HEPA filters in series; this makes the event frequency in the F1 range Potential for contamination of the environment: E1									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the exhaust stream and built up on the HEPA filters													
40	E-1	Release of radiological material due to HEPA filter failure	HEPA filter failure caused by: - External fire in the vicinity of the HEPA filters - Fire in the ventilati on system caused by flammable gas buildup and ignition - Fire from electri-cal failure of the heaters in the common exhaust system, etc. - Damage to HEPA filters from an external event, dropping of a heavy load, etc.	Public	Engineered Features: - Backflow prevention on fan housing - Firewall between systems - Temperature monitoring isolates upon high temperature Administrative Features: - None identified	F1	F1	Engineered Features: - None identified Administrative Features: - Limits on radioactive loading	S1	S1	5	5	- Maximum filter loading is limited to 200 mrem/h contact (800 mrem/h for HEME)
				Co-located Worker	- Same as for the public			- Same as for the public	S1	S1	5	5	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	5	5	- Same as for the public
				Rationale for frequency of event: Event requires the fire (located at or near the HEPA filters) and the ignition of the HEPA filters; this puts the event frequency in the F1 range Potential for contamination of the environment: E1									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material in the exhaust stream													
41	E-6	Release of radiological material due to reduced efficiency of the HEPA filters	- HEPA filter seal failure - Defective HEPA filter - Deteriorated HEPA filter	Public	Engineered Features: - Requires double failure of HEPA filters for loss of containment Administrative Features: - Filter leak tests - Delta pressure drop testing of the filters annually - Filter leak test before and after installation and	F1	F1	Engineered Features: - None Identified Administrative Features: - None Identified	S0	S0	2	2	- Maximum filter loading is limited to 200 mrem/h contact (800 mrem/h for HEME) - Exhaust stack radiation monitor and alarm - Pressure monitoring - Exhaust stack height
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	2	2	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S0	S0	2	2	- Same as for the public
				Rationale for frequency of event: Event requires the failure of two HEPA filters in series; this makes the event frequency in the F1 range Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Radiological and toxicological material on the HEPA filters													
42	E-7	Occupational radiation exposure	HEPA filter radioactive particle accumulation	Public	Engineered Features: - HEPA filters are SC-2 Administrative Features: - AC 5.13, Radiation protection program	F3	F3	Engineered Features: - None identified Administrative Features: - Filters to be replaced if they fail dP testing - Filters to be replaced if they fail radioactive load surveillance	S0	S0	7	7	- Recirculation system washes out particulates of airstream and returns condensate to AWF tank - HEME washes out particulates of airstream and returns condensate to catch tank - Maximum radiological loading on filters limited to 200 mrem/h and 800 mrem/h on HEME
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	7	7	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S1	S1	11	11	- Same as for the public
				Rationale for frequency of event: HEPA filter are designed to trap particulates; this makes the event frequency anticipated or in the F3 Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard - Radiological and toxicological material in the ventilation ducting													
43	E-5	Release of radiological material and exposure to radiation	Criticality caused by buildup of radioactive material in the ducting	Public	Engineered Features: - Geometry of ventilation system not conducive to criticality Administrative Features: - AC 5.3, Criticality prevention program	F0	F0	Engineered Features: - None identified Administrative Features: - None identified	S0	S0	1	1	- None Identified
				Co-located Worker	- Same as for the public			- Same as for the public	S0	S0	1	1	- Same as for the public
				Immediate Worker	- Same as for the public			- Same as for the public	S3	S3	10	10	- Same as for the public
				Rationale for frequency of event: Event requires the failure of two HEPA filters in series; this makes the event frequency in the F1 range Potential for contamination of the environment: E0, slight to negligible									

Table B-1. Hazards Analysis Summary. (30 sheets)

Event No.	Event Category	Postulated Event Description	Significant Causes or Energy Sources	Receptor	Credited Prevention (Attributes that Lower Frequency)	Event Frequency		Credited Mitigation (Attributes that Lower Consequences)	Consequences		Risk Bin Number		Defense-in-Depth Controls
						Without Prevent	With Prevent		Without Mitigat	With Mitigat	Without Prevent Mitigat	With Prevent Mitigat	
Hazard – Leaking Ethylene Glycol into AWF tank													
44	N/A	Coolant leakage from recirculation cooling unit leaks into tank	Corrosion or mechanical failure	Public	Engineered Features: - Coolant lines are made of stainless Administrative Features: - None identified	A	A	Engineered Features: - None Identified Administrative Features: - None Identified	N	N	12	12	
				Co-located Worker	- Same as for the public				N	N	12	12	
				Immediate Worker	- Same as for the public				N	N	12	12	
				Potential for contamination of the environment: E0, slight to negligible									

AC = Administrative Control.
ALC = airlift circulators.
AWF = Aging Waste Facility.
GRE = gas release event.
HEGA = high-efficiency gas adsorber.
HEME = high-efficiency mist eliminator.
HEPA = high-efficiency particulate air (filters).
OSD = Operating Specifications Document.
RCT = radiological control technician.
PIC = person-in-charge.
USQ = Unreviewed Safety Question.

Note: [1]HNF-IP-0842, 1997, TWRS Administration, Lockheed Martin Hanford Corporation, Richland, Washington.

Table B-2. HazOp Definition Guide.

Guide Words / Process Variables	No, Not, Non	Less, Low, Short	More, High, Long	Part of	As Well As, Also	Other Than	Reverse
Flow	No Flow	Low Rate, Low Total	High Rate, High Total	Missing Ingredient	Misdirection, Impurities	Wrong Material	Backflow
Pressure	Open to Atmosphere	Low Pressure	High Pressure				Vacuum
Temperature	Freezing	Low Temperature	High Temperature				Auto-refrigeration
Level	Empty	Low Level	High Level	Low Interface			
Agitation	No Mixing	Poor Mixing	Excessive Mixing	Mixing Interruption	Mixing Interruption		Phase Separation
Reaction	No Reaction	Slow Reaction	Runaway Reaction	Partial Reaction	Partial Reaction	Wrong Reaction	Decomposition
Time Procedure	Skipped or Missing Step	Too short, Too Little	Too Long, Too Much	Action(s) Skipped	Extra Action(s) (Short cuts)	Wrong Action	Out of Order, Opposite
Speed	Stopped	Too Slow	Too Fast	Out of Synch		Web or belt Break	Backward
Special	Utility Failure	External Leak	External Rupture	Tube Leak	Tube Rupture	Startup, Shut down, Maintenance	

Table B-3. Frequency Evaluation Levels.

Acronym	Description	Frequency Level (per yr $^{-1}$)
A (F3)	Anticipated, Expected	$>10^{-2}$
U (F2)	Unlikely	$10^{-4}<f\leq 10^{-2}$
EU (F1)	Extremely Unlikely	$10^{-6}<f\leq 10^{-4}$
BEU (F0)	Beyond Extremely Unlikely	$\leq 10^{-6}$

Note: The information in this table is from WHC-CM-4-46, Safety Analysis Manual, Section 7.0, "Risk," Rev. 3, Westinghouse Hanford Company, Richland, Washington.

Table B-4. Radiological and Chemical Consequence Evaluation Levels for Hazard Receptors.

Consequence Level (Abbreviation) ↓	Consequences to the Public, Workers, or Environment
High (H) or S3	May cause deaths onsite; loss of the facility or operation; major injuries or illness offsite; radiation exposure to offsite individuals in excess of annual limits; or severe impact on the environment.
Moderate (M) or S2	May cause severe injuries or severe occupational illness onsite; radiation exposure to onsite individuals in excess of annual limits; major damage to a facility or operation; minor illness or injury offsite; exposure of offsite individuals to radiation below annual limits; or major impact on the environment.
Low (L) or S1	May cause minor injuries or minor occupational illness onsite; exposure of onsite individuals to radiation below annual limits; negligible impact offsite; or minor impact on the environment.
Negligible (N) or S0	Will not result in injury; occupational illness; exposure onsite or offsite; or result in significant impact on the environment.

Note: The information in this table is from WHC-CM-4-46, Safety Analysis Manual, Section 7.0, "Risk," Rev. 3, and WHC-SD-WM-SARR-011, 1995, Toxic Chemical Considerations for Tank Farm Releases, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table B-5. Risk Binning Matrix.

Frequency → Radiological or Toxicological Consequence ↓	Beyond Extremely Unlikely (F0) ($\leq 10^{-6}$/yr)	Extremely Unlikely (F1) ($10^{-6} < f \leq 10^{-4}$/yr)	Unlikely (F2) ($10^{-4} < f \leq 10^{-2}$/yr)	Anticipated (F3) ($> 10^{-2}$/yr)
High (S3)	10	7	4	1
Moderate (S2)		8	5	2
Low (S1)		9	6	3
Negligible (S0)	11	12		

Key:

→ Risk Bins 1,2,3,4,5,7: Accident Analysis required; may require safety structures, systems, and components (SSC); may require interim operation safety requirements

→ Risk Bins 6,8,9: may require administrative or OSD level controls

Table B-6. Energy Source Checklist from DOE.[a] (4 sheets)

Type of Hazard	Form of Hazard	Comment
Electrical	Battery banks	Uninterruptible Power Source, 208 V rectified, sealed lead-acid battery, because of seal not a source for toxic and loss of it covered in PHA as power loss.
	Diesel units	Battery Charger for batteries for diesel - 125 KW output, in a vented building; no buildup of hydrogen. Covered in PHA as total loss of power
	High lines	None
	Transformers	Yes, one 300 KW in yard (1380 V and down to 120 V), outside fence and not covered in PHA
	Wiring	241-AY-101,-102, 241-AZ-101,-102 in trays, not covered in W-030 PHA, but covered in TWRS PHA
	Switchgear	Outside the tank farms and fence, except diesel switchgear in closed building
	Underground wiring	None for W-030 PHA, but in 241-AY-101,-102 and 241-AZ-101,-102 TWRS PHA
	Cable runs	Instruments - 120 V
	Service outlets and fittings	Yes, welding receptacles in tank farms covered in TWRS PHA
	Pumps	Yes, pumps wired per codes for W-030 additions; other pumps 241-AY-101,-102, 241-AZ-101,-102 covered in TWRS PHA
	Motors	Covered by pumps
	Heaters	Fire covered in W-030 PHA, wired per code, 480 V/code
	Power tools	None
	Small equipment	Instrumentation 120 V or lower.
	Electrical equipment	241-AY-101,-102, 241-AZ-101,-102 covered in TWRS PHA
	Hot plates	None
	High voltage	Yes, covered for sources of W-030 equipment
	Locomotive, electrical	None
	Transmission lines	None
	Other	Switchgear for diesel
Nuclear Criticality	Vaults/pits	None
	Temporary storage areas	None
	Receiving areas	None
	Shipping areas	None
	Casks	None
	Burial grounds	None
	Storage tanks	241-AY-101,-102, 241-AZ-101,-102 and pits
	Canals and basins	None
	Reactor in-tank storage areas	None
	Dollies	None
	Trucks	None
	Hand carry	None
	Cranes	None
	Lifts	None
	Shops	None
	Hot cells	None
	Assembly areas	None
	Inspection areas	None
	Laboratories	None
	Pilot plants	None
Nuclear (in-reactor)	Reactors	None
	Critical facilities	None
	Subcritical facilities	None

Table B-6. Energy Source Checklist from DOE.* (4 sheets)

Type of Hazard	Form of Hazard	Comment
Kinetic/linear (in plant)	Fork lifts	None
	Carts	None
	Dollies	None
	Railroad	None
	Surfaces	None
	Obstructions (collision with)	Stack, covered in W-030 PHA
	Shears	None
	Presses	None
	Crane loads in motion	Tie-ins, riser damage if shield plug drops
	Pressure vessel blowdown	None
	Power assisted driving tools	Construction, pipe wrench, little or no damage
	Cars	Stack inlet stations - maintenance, impossible to get to
	Trucks	Stack inlet stations - maintenance, impossible to get to
	Buses	None
	Heavy equipment	Cranes, guzzler trucks
	Centrifuges	None
	Motors	With pumps
	Pumps	241-AY, AZ-101,102, outside of farm
	Cooling tower fans	Outside fence
	Cafeteria equipment	None
	Laundry equipment	None
	Gears/compressors	None/motor operated valves
	Shop equipment (grinders, saws, brushes, etc.)	Construction
	Fans	Chiller fans, protected from doing damage
PV-KD (pressure, tension)	Boilers/chillers	None/2 by 2 stage refrigeration Compressor, covered in W-030 PHA
	Heated surge tanks	None
	Autoclaves	None
	Test loops and facilities	None
	Gas bottles	Construction
	Pressure vessels	None
	Negative pressure, collapse	241-AY, 241-AZ-101,-102/air inlets and relief valves mitigate
	Stressed members	None
	Steam Headers and lines	None
MGH (falls and drops)	Human effort	Maintenance
	Vent cells	Maintenance/short time
	Bucket and ladders	None
	Trucks	Maintenance
	Hoists and elevators	None
	Jacks	None
	Scaffold and ladder	Maintenance
	Excavations	Construction - tie-ins, per codes
	Pits	None
	Elevated doors	None
	Raw water lines	None
	Canals	None
	Vessels	None
	Lifts	Construction maintenance
	Cranes	Construction maintenance, carbon filters weigh only 150 pounds

Table B-6. Energy Source Checklist from DOE.[a] (4 sheets)

Type of Hazard	Form of Hazard	Comment
MGH (falls and drops) (Cont'd)	Packing materials	None
	Rags	None
	Gasoline	None
	Paint solvent	None
	Diesel fuel	Inside building 701-AZ (FHA), fill per codes
	Hydrogen	241-AY, 241-AZ-101,-102/Battery charger - building ventilated
	Organics	None
	Nitric acid	None
	Gases	241-AY, 241-AZ-101,-102
		None
Corrosive	Acids	Batteries/UPS, vented/sealed
	Caustic	241-AY-101,-102, 241-AZ-101,-102
	Natural chemicals	241-AY-101,-102, 241-AZ-101,-102
	Decon solution	None
	High temperature waste	241-AY-101,-102, 241-AZ-101,-102/241-AZ-102[b], covered in Tank Bump and flow in W-030 PHA
	Plug storage	None
Radioactivity	Storage areas	None
	Storage buildings	None
	Radioactive sources	241-AY-101,-102, 241-AZ-101,-102, covered in Tank Bump and filter blowout in W-030 PHA
	Building	Tank ventilation
	Filters	Covered in W-030 PHA
	Condenser cell	Yes
Radioactivity (Cont'd)	Electric furnace	None
	Blacklight (e.g., magniflux)	None
	Laser	None
	Medical x-ray	None
	Radiography equipment and sources	None
	Electron beam	None
	Equipment noise	Some noise will be generated by the heating, ventilating, and air-conditioning system and the chiller system. However, rotating equipment, diesel generator designed for minimum noise
	Ultrasonic cleaners	None
Thermal radiation	Furnaces	None
	Boilers	None
	Steam lines	None
	Lab and pilot plant equipment	None
	Sun	Sun is often present on the Hanford Site, but does not effect Project W-030
Thermal (except radiant)	Convection	Cooling towers
	Heavy metal weld preheat	None
	Exposed steam pipes	None
	Electric heaters	Ventilation inlet and main system - Maintenance, covered in W-030 PHA
	Fire boxes	None
	Lead melting pot	None
	Electrical wiring and equipment	Wired per code and does not present a thermal energy - covered above as equipment

Table B-6. Energy Source Checklist from DOE.[a] (4 sheets)

Type of Hazard	Form of Hazard	Comment
Explosive pyrophoric	Caps	None
	Primer cord	None
	Dynamite	None
	Power metallurgy	None
	Dusts	None
	Hydrogen (including battery banks and water decomposition)	241-AY-101,-102, 241-AZ-101,-102. Diesel building battery charger (ventilated)
Explosive pyrophoric	Peroxides - superoxides	None
	Acetone	None
	Fluorides	None
	Carbon monoxide	None
	Lead	None
	Ammonia and compounds	Possible waste in tanks: Part of toxicological constituents of SARR-011
Other	Dusts and particulates	Environmental dusts could be present, but not considered in PHA
	Pesticides-herbicides-insecticides	Spray each spring for pesticides and herbicides-minimal affect and not covered in PHA
	Bacteria	None
	Beryllium and compounds	None
	Chlorine and compounds	None
	Sandblast	None
	Metal plating	None
	Asphyxiation-drowning	None

FHA = Fire Hazards Analysis.
PHA = Preliminary Hazard Analysis.
TWRS = Tank Waste Remediation System.

[a]DOE-45/19, 1979, Job Safety Analysis, SSDC-19, U.S. Department of Energy, Washington, D.C.

[b]WHC-SD-WM-SARR-011, 1995, Toxic Chemical Considerations for Tank Farm Releases, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table B-7. Summary of Hazardous Events.

Hazardous Event	Definition of Event
Loss of containment	For the hazard identification task, loss of containment was considered as the breach of a barrier resulting in the release of hazardous liquid material (radioactive and/or toxic chemical).
Loss of confinement	For the hazard identification task, loss of confinement was considered as the breach of a barrier resulting in the release of hazardous gaseous or airborne material (radioactive and/or toxic chemical).
Waste disposal	Consistent with the requirements of DOE 5480.23 (DOE 1992) consideration of hazards associated with waste disposal and handling were limited to those hazards involving the waste that is generated incidental to the performance of functions related to the waste storage and treatment mission at tank farms.
Criticality	The hazards associated with criticality were identified considering two different perspectives based upon the effects of the event. These were the direct effects to personnel (such as direct radiation exposure) and the effects that result from a sequence initiated by criticality as an energy source that may lead to a release of hazardous material.
Natural phenomena	The hazards associated with natural phenomena were identified considering two different perspectives based upon the effects of the event. These were the direct effects to personnel (such as physical injury and the effects that result from a sequence initiated by natural phenomena such as an energy source that may lead to a release of hazardous material.
Fire and deflagration	The hazards associated with fires and explosions were identified considering two different perspectives based upon the effects of the event. These were the direct effects to personnel (such as physical injury) and the effects that result from a sequence initiated by a fire or deflagration of an energy source that may lead to a release of hazardous material.
Interfaces	This category was used to identify hazards that may be associated with interfaces between the major functional segment under consideration and operations/activities related to the other major functional segments. Hazards that did not fit within the context of the other hazard categories were included under interfaces.
Extrinsic hazards	Hazards associated with facilities or activities outside of tank farms. No impact to existing extrinsic hazards was identified in this assessment and therefore no further action was taken.
Testing, surveillance, and maintenance	This category was used to identify hazards that are uniquely associated with the testing, surveillance, and maintenance activities associated with the major functional segment under consideration. The hazards considered were related to both personnel exposure to hazardous materials (radioactive and toxic chemical) and potential personnel injury.
Industrial	Injury to operating personnel – This category was used to identify the general occupational hazards (radiological, hazardous chemical and general industrial) associated with the major functional segment under consideration.

DOE 5480.23, 1992, Nuclear Safety Analysis Reports, Change 1, U.S. Department of Energy, Washington, D.C.

ATTACHMENT B-1

LETTER REPORT TRANSMITTAL LETTER

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Westinghouse Hanford Company | **Internal Memo**

From: Consequence Analysis
Phone: 376-9219 A3-34
Date: September 27, 1996
Subject: VALIDATION OF THE W-030 PROJECT PHA

8M400-JEK-96015

To: R. L. Guthrie A3-37

cc: S. M. Stahl A3-37
JEK File/LB

Reference: WHC-CM-6-32, Section WP-4.6, Rev. 1, Hazard Analysis, Safety Analysis and Nuclear Engineering Work Procedures

Monday and Tuesday, September 23 and 24, 1996 we met to verify the existing PHA for the W-030 Project. Those that met at these meetings included the following:

Frank T. Clifton
Richard L. Guthrie
Morgan D. Harding
Mark G. Hunn
John E.kelly
Scott R. Pierce
Paul D. Rice
Gary R. Tardiff

Brief resumes for these gentlemen appear attached to this report. Initially, we developed a DOE-RL approved Energy Source Checklist. We went through the list and determined what energy sources are affected by the W-030 Project. Included are those energy sources either not part of the project or the reasoning for not developing them further in the W-030 PHA. This checklist is attached. We also verified which of these events should be included in the W-030 PHA. We went through each Event Category, Postulated Event Description, Significant Causes of Energy Source including any new events in the PHA and affirmed that the information was correct. Next, the accident frequency and mitigation feature was verified for each event. Some of the Engineering attributes that lower the frequency were found to be incorrect and were removed. We then verified what was used to reduce the frequency and made sure that these items were not included in the Defense in Depth Column. Table F-5 of reference 1 was used for the frequency ranges. Where necessary, the consequences were updated using Table F-3 of reference 1. Finally, the Risk Bin Numbers were updated to the latest Risk Matrix Bin Numbers found in Table F-6 of reference 1.

HAZARD ANALYSIS PARTICIPANTS

The following contains the names and experience of the Hazard Analysis Participants for the W-030 project SARR.

Frank T. Clifton - Westinghouse Hanford Company - Principal Engineer

Mr. Clifton is a Mechanical Engineer assigned to TWRS Engineering and to the W-030 Project. He has 25 years in the nuclear industry including 20 years at Hanford; assigned to a variety of major projects, with primary responsibilities related to the design of nuclear ventilation systems.

Richard L. Guthrie - Westinghouse Hanford Company - Principal Engineer

Mr. Guthrie has over 19 years experience in Mechanical Engineering. Three and one half of those years have been spent at Hanford. Richard is a Registered Professional Engineer in Mechanical Engineering and a Certified Safety Professional in System Safety Aspects. He has performed PHAs and FTAs with companies like Loral Space Information Systems, Morton Thiokol, General Dynamics, and the Superconducting Super Collider. His TWRS experience includes numerous unreviewed safety evaluations and a HAZOP for the light duty utility arm. Richard is currently working in the TWRS SAR Engineering Group of the Safety Analysis and Nuclear Engineering Division.

Morgan D. Harding - Westinghouse Hanford Company

Mr. Harding has 11 years experience in the nuclear industry. The past six of those years have been in tank farms. Prior to that he was at N-Reactor. He has for the past 4 years been part of the TWRS management team managing planners for the Operations support group and Major Maintenance. Managed east tank farms Operations Field Support Group. His latest management position as Operations interface to construction forces, has given him over 2 years in the field working with the construction forces that have built and installed equipment for projects such as W-030 Aging Waste Ventilation System, W-320 106-C Sluicing System, W-151 101-AZ Retrieval Project, and the 107-AN Mixer Pump and Caustic Injection system. All of the above experience and knowledge of tank systems has brought him to the W-030 Project team as the operations representative for system start-up. This was to include development and implementation of procedures, training programs, system acceptance, etc.

Mark G. Hunn - Contract Engineer (Self) - Mechanical Engineer

Eighteen years experience in the armed forces and nuclear industries as a technical manager, project engineer, and field

crew supervisor. Background includes work on safety documentation, environmental cleanup and decontamination projects, supervision of operational nuclear reactors, and major system maintenance.

John E. Kelly - Westinghouse Hanford Company - Fellow Engineer

Mr. Kelly has 30 years experience in system safety reliability engineering with 6 years experience at Hanford including the N-Reactor PRA. He is a internationally recognized expert in system safety analysis and probabilistic safety assessments and a licensed Safety Engineer in the state of California. His experience in the DOE complex includes hazard and risk analysis work for the Savannah River Site, Sandia National Laboratories, Lawrence Livermore National Laboratory, and taught classes at Brookhaven and Argonne National Laboratories.

Scott. R. Pierce - Westinghouse Hanford Company - Cognizant Engineer W-030 Project

- Provided technical oversight for startup and future operation of the 5 million dollar ventilation facility.
- Coordinate preparation of 18 Operating Procedure, 50 Maintenance Procedures, 22 Alarm Response Procedures, and 8 Emergency Response Procedures.
- Provided technical input to planning and performing the system's 11 Acceptance Tests, 8 Pre-Operational Tests, and 2 Post-Operating Tests.
- Determined process and alarm set points for system operation.
- Developed operator surveillance of new facility.
- Participated on Formal Design Review team for Westinghouse's acceptance of system design.
- Held position on Project W-030 Test Review Board.

Paul D. Rice - ICF Kaiser Hanford - Senior Principal Engineer

Mr. Rice has been a Registered Mechanical Engineer since 1971, and has been employed at Hanford since 1970. He has been the lead HVAC design engineer for the W-030 project since its beginning, and was directly involved in the development and testing of the 1/7 scale process ventilation prototype. Mr. Rice has twenty eight years of diverse experience in the field of Mechanical Engineering, with particular emphasis on energy conservation, HVAC, and on mechanisms. Experience related to HVAC has included analysis, design, and field inspection of systems for nuclear processing facilities, research laboratories, and office buildings. Mechanisms experience includes preliminary design for reactor maintenance systems and special equipment. Other engineering experience has included aircraft HVAC systems, wind tunnel model design, and artificial kidney machine design.

Gary R. Tardiff - Westinghouse Hanford Company - Principal Engineer

Mr. Tardiff has 15 years experience at Hanford with 12 years at PUREX and 3 years at Tank Farms. Gary currently works in the East Tank Farm Engineering as a Project Cognizant Engineer. Previous work experience includes two years experience for E.I. Dupont de Nemours doing design, cost estimating, and development of pilot scale equipment, he also worked on production of experimental fluorocarbons for marketing and toxicological purposes. He worked for W.R. Grace for five years in production and process development of chelating agents for product yield increase and purification. He has a Bachelor of Science degree in Chemical Engineering and has participated in several HAZOPS including Project W-151, 204-AR Facility, Project W-030 and TWRS FSAR HAZOPs.

In the process of performing the PHA for the W-030 Project, we used the Energy Source Checklist from DOE. In the comment section of this table, we concluded whether the energy source was covered in the was unique to the W-030 Project and should be covered by the W-030 Project PHA, or whether this energy source does not affect the ventilation project and therefore coverage in the TWRS FSAR PHA and HAZOP analyses. This is also shown in the comment section. The checklist is attached.

John Kelly
Fellow Engineer

gjr

Concurrence: [original signed by] Date[09/27/97]
D. S. Leach, Manager
Consequence Analysis

Attachment B-1. Letter Report

Transmittal Letter (Kelly 1996)
(4 pages)

APPENDIX C

HAZARD EVALUATION RESULT

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APPENDIX C

HAZARD EVALUATION RESULT

See Appendix B, Section B.2.3, "Hazard Evaluation Results," of this addendum.

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APPENDIX D

CONTROL ALLOCATION TABLES

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APPENDIX D

CONTROL ALLOCATION TABLES

See Appendix B, Table B-1 "Hazard Analysis Summary," of this addendum.

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MIXER PUMP TEST (241-AZ-101) SAFETY ANALYSIS

ADDENDUM 4

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EXECUTIVE SUMMARY

ES.1 FACILITY BACKGROUND AND MISSION

The purpose of this document is to describe and analyze the mixer pump test for Aging Waste Facility (AWF) Tank 241-AZ-101 and to address the "yes/maybe" responses marked for evaluation questions identified in Unreviewed Safety Question (USQ) Evaluation TF-94-0266. The scope of this document is limited to the performance of the mixer pump test for Tank 241-AZ-101. Unreviewed Safety Question Determination (USQD) TF-96-0018 verified that the installation of two mixer pumps into Tank 241-AZ-101 was within the current Tank Waste Remediation System (TWRS) Authorization Basis. USQDs TF-96-0461, TF-96-0448, and TF-96-0805 verified that the installation of the in-tank video camera, thermocouples, and Ultrasonic Interface Level Analyzer (URSILLA), respectively, were within the current TWRS Authorization Basis. USQD TF-96-1041 verified that the checkout testing of the installed equipment was within the current TWRS Authorization Basis. Installation of the pumps and equipment has been completed. This document provides an evaluation of safety considerations associated with operation of the mixer pumps for the mixer pump test. This document augments the existing AWF authorization basis as defined in the TWRS Final Safety Analysis Report (FSAR), and as such, will use the TWRS Technical Safety Requirements (TSRs) to adequately control the mixer pump test. The hazard and accident analysis is limited to the scope and impact of the mixer pump test, and therefore, does not address hazards already addressed by the current AWF authorization basis. It is important to note this Addendum was previously attached to the Basis for Interim Operation (BIO) and has been modified where necessary to assure compatibility with the FSAR. It is important to note that the hazards information presented in Appendices 3A and 3B has been updated as necessary and incorporated into the FSAR hazards analysis database. Appendices 3A and 3B are retained in this Addendum for information only and should not be used in the Unreviewed Safety Question process.

The mixer pump test has been evaluated to cover the use of either the existing ventilation system or the ventilation system upgrade provided by Project W-030. Analysis of Project W-030 is outside of the scope of this document and is addressed in FSAR Addendum 3.

The test will use two high-capacity mixer pumps in various configurations and modes to demonstrate solids mobilization of waste in Tank 241-AZ-101. The information and experience gained during the test will provide data for comparison with sludge mobilization prediction models; provide data to estimate the number, location, and cycle times of the mixer pumps; and provide indication of the effects of mixer pump operation on the AWF tank systems and components. The slurry produced will be evaluated for future pretreatment processing. This process test does not transfer waste from the tank; the waste is mixed and confined within the existing system. At the completion of the mixer pump test, the mixer pumps will be stopped and normal tank operations, maintenance, and surveillance will continue. Periodic rotation of the mixer pumps and motor shafts, along with bearing greasing, is required to maintain the pumps following the mixer pump test.

ES.2 FACILITY OVERVIEW

An overview of the AWF, including a description of the facility mission and stage of life-cycle, is provided in Chapter 2 of the FSAR and in Chapter 2 of this addendum. General TWRS and Hanford Site information is provided via reference to the TWRS FSAR. Likewise, specific information pertaining to the AWF tanks is provided via reference to the TWRS FSAR. Aspects of the mixer pump test and facility test configuration relevant to this safety evaluation are documented in Chapter 2 of this addendum.

ES.3 FACILITY HAZARD CLASSIFICATION

TWRS facilities, including the AWF, have been designated as Hazard Category 2 facilities (Table 3.3.2.2-3, "Final Hazard Category for Tank Waste Remediation System Facilities," of the TWRS FSAR). The mixer pump test does not impact the Hazard Classification assumptions of Tank 241-AZ-101 (no change to the inventory or amount of the material at risk). Thus, Tank 241-AZ-101 remains classified as Hazard Category 2.

ES.4 SAFETY ANALYSIS OVERVIEW

Hazards associated with operation were evaluated using process hazard analysis and Hazards and Operability (HazOp) evaluation techniques. From the results of the hazard analysis, six postulated events were identified as representative of the significant hazards. These events are: (1) a ventilation system high-efficiency particulate air (HEPA) filter failure, (2) backflow through open tank riser, (3) leakage via failed vent ducting, (4) a breach of the tank due to internal or external mechanisms, (5) a nuclear criticality induced by mixer pump operation, and (6) a seismic event. These postulated events were evaluated, based on specific causes and conditions associated with the mixer pump test as described in Section 3.3.2.4 of this addendum. This evaluation resulted in the identification of four design basis accidents that are analyzed in Section 3.4.2 of this addendum. These accidents are: (1) unfiltered release of radionuclides and toxic aerosols from the tank, (2) tank bump, (3) breach of containment, and (4) overpressurization caused by criticality. The various causes and conditions associated with each of these accident scenarios are identified in Table 3-5 of this addendum. A summary of the accident consequences and a comparison to the risk evaluation guidelines are provided in Table ES-1 of this addendum. A summary of the preventive and mitigative features is provided in Table ES-2 of this addendum.

ES.5 ORGANIZATIONS

Prior to October 1, 1996, Westinghouse Hanford Company and ICF Kaiser Hanford were responsible for design, construction, and testing associated with the mixer pump test. Westinghouse Hanford Company was also responsible for operations, project management, and safety analysis. Since October 1, 1996, Fluor Daniel Hanford, Inc., has acted as management contractor and is ultimately responsible for contract performance, which includes protecting the

public, workers, and environment from anticipated hazards associated with Hanford Site operations, and for being the focal point for interaction with the U.S. Department of Energy (DOE) and the stakeholders. Fluor Daniel Northwest, Inc., has been responsible for design, construction, and testing; Lockheed Martin Hanford Corporation has been responsible for operations and for the nuclear safety analysis and licensing process; Numatec Hanford Corporation has been responsible for project management.

ES.6 SAFETY ANALYSIS CONCLUSIONS

It is concluded that the mixer pump test can be safely conducted using currently-approved TSRs in conjunction with Air Lift Circulator TSR controls, converted from Heubach 1996 as identified in Wagoner 1997, thus ensuring protection of the workers and the public.

ES.7 DOCUMENT ORGANIZATION

This document is organized in the format of DOE-STD-3009-94. General information pertaining to TWRS or the entire Hanford Site and specific information pertaining to the AWF tanks, but not directly relevant to the mixer pump test, are provided via reference to the TWRS FSAR.

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Table ES-1. Summary of Accident Consequences.

Design Basis Accident Scenario	Mixer pump test Design Basis Accident consequences				Risk evaluation guidelines
			without prevention/ mitigation	with prevention/ mitigation*	
Unfiltered release of radionuclides or toxic aerosols (Section 3.4.2.1)					
HEPA filter failure due to high temperature (Section 3.4.2.1.3) Frequency: U	Radiological (rem) (bounding values from 241-A-702 vent system)	Offsite	**	1.8 E-3	0.5
		Onsite	**	2.2	5
	Toxicological (SOF) (bounding values from 241-AZ-702 vent system)	Offsite	**	2.5 E-4	1 (ERPG-1)
		Onsite	**	2.8 E-2	1 (ERPG-2)
Reverse flow through tank due to tank dome collapse and breach of confinement (Section 3.4.2.3.6) Frequency: BEU (see Breach of Containment)	This event is determined to be beyond extremely unlikely for mixer pump test.	Offsite and Onsite	None	N/A	N/A
Tank Bump (Section 3.4.2.2) Frequency: U	Radiological (rem)	Offsite	.22	None	0.5
		Onsite	250	None	5
	Toxicological (SOF)	Offsite	0.73	None	1 (ERPG-1)
		Onsite	4.9E+03	None	1 (ERPG-2)
Breach of containment (Section 3.4.2.3)					
Flammable Gas Deflagration (Section 3.4.2.3.1) Frequency: Accident prevented through TSR AC 5.9., 5.10., 5.11. Technical uncertainty prevents quantification. Natural phenomena frequencies probably drive this to EU.	Radiological (rem)	Offsite	4.5 E-1	None	0.1
		Onsite	5.29 E+2	None	0.5
	Toxicological (SOF)	Offsite	9.6 E-1	None	1 (ERPG-1)
		Onsite	8.4 E+2	None	(ERPG-2)
Tank Dome Collapse (Section 3.4.2.3.6) Frequency: BEU	This event determined to be BEU for mixer pump test structural loadings.	Offsite and Onsite	None	N/A	N/A
Seismic during pumps operation (Section 3.4.2.3.7) Frequency: BEU	Analysis shows that pump support and riser configuration acceptable for applied design requirements.	Offsite and Onsite	None	N/A	N/A
Material degradation due to high temperature (Section 3.4.2.3.5) Erosion (Section 3.4.2.3.4) Missiles from the pumps (Section 3.4.2.3.3) Frequencies: BEU	Analyses show that these events are prevented and not credible.	Offsite and Onsite	None	N/A	N/A
Criticality (Section 3.4.2.4) Frequency: BEU	This event determined to be BEU for mixer pump test.	Offsite and Onsite	None	N/A (no preventive or mitigative features identified)	N/A

*Mitigation actions reduce numerical consequences. Prevention actions denoted by column entry of "None", since consequences are prevented. See Table ES-2 on the following page for specific Mitigation/Prevention actions.

**See Section 3.4.2.1.2.1 for discussion of unmitigated consequences.

(Note: Section numbers are sections in this addendum.)

A = anticipated (1/yr - 10^{-2}/yr)
BEU = beyond extremely unlikely ($\leq 10^{-6}$/yr)
EU = extremely unlikely (10^{-4}/yr - 10^{-6}/yr)
U = unlikely (10^{-2}/yr - 10^{-4}/yr)
N/A = not applicable
SOF = sum-of-fractions

Table ES-2. Summary of Preventive/Mitigative Actions.

Accident Scenario	Preventive or Mitigative Actions during mixer pump test	Applicable Control or Other Document
Unfiltered release of radionuclides and toxic aerosols from the tank (Section 3.4.2.1)	• Limiting the maximum activity on each filter to a level that gives an equivalent dose rate of 200 mrem/h on contact controls the amount of particulates that could be expelled. Also ensuring the primary ventilation stack CAM is operable to shut down the ventilation system in 10 minutes.	TSR AC 5.18 TSR LCO 3.1.4
Tank Bump (Section 3.4.2.2)	• Localized high temperatures may be caused by mixer pump operation. The mixer pumps will be turned off if the top 15 feet of waste reaches 195 °F or the waste below 15 feet reaches 215 °F. ALCs will be operated to provide more uniform temperature distributions per limits described below. • Upon loss of the primary ventilation system the mixer pump(s) will be turned off to control gas and heat buildup in the tank. • During normal operation of the pump(s) and at the end of the test while the pumps are turned off, the waste temperature will be monitored and the air lift circulators operated as soon as the temperature reaches 230 °F for waste below 20 feet and 190 °F for the average waste solution.	TSR LCO 3.3.2, 3.3.4 TSR LCO 3.2.1 TSR LCO 3.3.4
Breach of Containment (Section 3.4.2.3)	• High temperature (3.4.2.3.5): - Primary tank exhaust ventilation system shall be operable. • Flammable gas deflagration (3.4.2.3.1): - Implementation of Ignition Source Controls as well as monitoring for flammable gas are preventive measures against deflagration, breach of the tank, and breach of ventilation confinement in the event that an episodic gas release exceeds 100% of the lower flammability limit. - LCO 3.2.1 requires ventilation operability to prevent flammable gas accumulations. The vent system operation also prevents tank pressurization and an unfiltered release. • Tank dome collapse due to overload (3.4.2.3.6): - This event is deemed beyond extremely unlikely for the mixer pump test based on analysis of dead load, live load, jet impingement, and seismic loads. All components of the support system were found adequate to support the mixer pumps for both service and extreme conditions. • Seismic (3.4.2.3.7): - Structural analysis of seismic loads shows that the pump support and riser configuration are acceptable for the applied design requirements.	TSR LCO 3.2.1, 3.3.2 TSR AC 5.9, 5.10, 5.11 TSR LCO 3.2.1 TSR AC 5.16 Moody 1996
Criticality (Section 3.4.2.4)	• A Criticality Safety Evaluation Report prepared for Project W-151 identified no scenario associated with the mixer pump test that could credibly lead to criticality.	TSR AC 5.7

(Note: Section numbers are sections in this addendum.)

AC = Administrative Control
AWF = Aging Waste Facility
LCO = Limiting Condition for Operation
TSR = Technical Safety Requirement (TWRS)

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LIST OF TERMS

AC	Administrative Control
ALC	air lift circulator
AWF	Aging Waste Facility
BDBA	beyond design basis accident
BIO	Basis for Interim Operation
CEDE	committed effective dose equivalent
CFM	cubic feet per minute
CSER	criticality safety evaluation report
D&D	decontamination and decommissioning
DBA	design basis accident
DOE	U.S. Department of Energy
DST	double-shell tank
EIS	Environmental Impact Statement
ERPG	Emergency Response Planning Guideline
ES	Executive Summary
EU	extremely unlikely
FDC	Functional Design Criteria
FGEAB	Flammable Gas Equipment Advisory Board
FSAR	Final Safety Analysis Report
GRE	gas release event
HazOp	hazards and operability study
HASP	Health and Safety Plan
HEGA	high-efficiency gas absorber
HEME	high-efficiency mist eliminator
HEPA	high-efficiency particulate air (filter)
IOSR	Interim Operational Safety Requirement
LFL	Lower Flammability Limit
LCO	Limiting Condition for Operation
NCAW	Neutralized Current Acid Waste
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PF	partition fraction
PNNL	Pacific Northwest National Laboratory
RCRA	Resource Conservation and Recovery Act
RF	Respirable Fraction
RL	U.S. Department of Energy, Richland Operations Office
SC	Safety-Class
SDC	Standard Design Criteria
SHMS	Standard Hydrogen Monitoring System
SOF	sum-of-fractions
SSC	structure, system, and component
STOMP	Subsurface Transport Over Multiple Phases
TEDE	total effective dose equivalent
TEMPEST	Transient Energy Momentum and Pressure Equations Solutions in Three Dimensions
TOC	total organic carbon
TSD	treatment, storage and disposal
TSR	Technical Safety Requirement
TWA	time weighted average
TWRS	Tank Waste Remediation System
ULD	unit liter dose

LIST OF TERMS (Cont'd)

USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination
URSILLA	Ultrasonic Interface Level Analyzer

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1.0 SITE CHARACTERISTICS

1.1 INTRODUCTION

The objective of this chapter is to describe any changes to the site characteristics of the Hanford Site provided in Chapter 1.0, "Site Characteristics," of HNF-SD-WM-SAR-067, *Tank Waste Remediation System Final Safety Analysis Report* (FSAR) due to the performance of the mixer pump test. Tank 241-AZ-101 is located in the Aging Waste Facility (AWF) of the Tank Waste Remediation System (TWRS) in the 200 East Area of the Hanford Site. See Chapter 2 of this addendum for the changes to the facility descriptions provided in Chapter 2.0, "Facility Description," of the TWRS FSAR and for the process descriptions of the mixer pump test.

It is not the intent of this chapter (including its references to the FSAR) to provide all of the information suggested by the guidance of DOE-STD-3009-94. The objective of this chapter is to provide the information necessary to describe the facility's location, identify any hazards due to that location, and identify critical parameters used in Chapter 3 of this addendum.

1.2 REQUIREMENTS

See Section 1.2, "Requirements," of the FSAR for the requirements for Hanford Site characterization in support of safety analysis and design. There are no changes to these requirements as a result of the performance of the mixer pump test.

1.3 SITE DESCRIPTION

See Section 1.3, "Site Description," of the FSAR for the Hanford Site description. There are no changes to the site description as a result of the performance of the mixer pump test.

1.4 ENVIRONMENTAL DESCRIPTION

See Section 1.4, "Environmental Description," of the FSAR for a discussion of the meteorology, hydrology, and geology of the Hanford Site. There are no changes to the environmental description as a result of performance of the mixer pump test. This data from the FSAR is used to calculate radiological and toxicological impacts to receptors (onsite and offsite) from accident scenarios outlined in Chapter 3 of this addendum.

1.5 NATURAL PHENOMENA THREATS

See Section 1.5, "Natural Phenomena Threats," of the FSAR for a description of the natural phenomena threats. There are no changes to the natural phenomena threats as a result of performance of the mixer pump test.

1.6 EXTERNAL MAN-MADE THREATS

See Section 1.6, "External Man-Made Threats," of the FSAR for a description of the external man-made threats. There are no changes to the external man-made threats as a result of the performance of the mixer pump test.

1.7 NEARBY FACILITIES

See Section 1.7, "Nearby Facilities," of the FSAR for a description of nearby facilities. There are no changes to the potential effects on Tank Waste Remediation System (TWRS) facilities from nearby facilities as a result of performance of the mixer pump test. Accidents associated with performance of the mixer pump test with the potential to affect the maximum onsite individual (which may include people at some of the facilities listed in Section 1.7.2 of the FSAR) are discussed in Chapter 3 of this addendum.

1.8 VALIDITY OF EXISTING ENVIRONMENTAL ANALYSES

Project W-151 and the performance of the mixer pump test were evaluated by the U.S. Department of Energy, Richland Operations Office (RL) (Gerton 1990) and found to be within the scope of the existing Environmental Impact Statement (EIS) DOE-EIS-0113, "Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes." The site characteristics data are in agreement with the data contained in the TWRS Environmental Impact Statement (DOE-EIS-0189).

2.0 FACILITY DESCRIPTION

2.1 INTRODUCTION

The purpose of this chapter is to describe any changes to the description of the Tank Waste Remediation Systems (TWRS) Aging Waste Facility (AWF) provided in Section 2.4.4.1.1, "241-AY and 241-AZ Tank Farms (Aging Waste Facility)," of the *Tank Waste Remediation System Final Safety Analysis Report* (FSAR), HNF-SD-WM-SAR-067, due to the performance of the mixer pump test. The mixer pump test is similar in concept to previous mixer pump operations performed in Hanford waste tanks (Wicks 1997). However, the size and power of the mixer pumps used during this test will be considerably larger than those used in the past (300 hp vs. 75 hp), necessitating this safety analysis to be performed because of the increased thermal output and potential accident consequences. This chapter describes the process test to be performed in Tank 241-AZ-101. The facility and process descriptions (both in this chapter and the FSAR) support the assumptions used in Chapter 3 of this addendum.

The scope of this document is limited to the performance of the mixer pump test. Unreviewed Safety Question Determinations (USQDs) TF-96-0018, TF-96-0461, TF-96-0448, and TF-96-0805 verified that the installation of the two mixer pumps, the in-tank camera system, the profile thermocouples, and the Ultrasonic Interface Level Analyzer (URSILLA), respectively, into Tank 241-AZ-101 were within the current TWRS authorization basis. USQD TF-96-1041 verified that checkout testing of the installed equipment was within the current TWRS authorization basis. Safety considerations associated with performance of the mixer pump test are evaluated by this FSAR Addendum.

This document augments the current TWRS authorization basis. This document does not evaluate removal of the mixer pumps since no decision had been made regarding pump removal at the time that this FSAR Addendum was approved. Safety considerations for removal of the pumps will be addressed by separate safety documentation if the decision is made to remove the pumps.

The mixer pump test has been evaluated to cover use of the previously existing ventilation system (241-A-702) or the new ventilation system upgrade provided by Project W-030 (241-AZ-702) because at the time this addendum was first written, both systems remained viable. The 241-A-702 system has since been taken out of service. This system will continue to be mentioned in this addendum, however, because some of the original consequence analyses indicated that its failure provided bounding consequences in some accident scenarios. Though listing the 241-A-702 system consequences adds some additional conservatism to the analyses, it adds no additional controls to the mixer pump test.The hazard and accident analysis within this FSAR Addendum is limited to the scope and impact of the mixer pump test, and therefore, does not address hazards already addressed within the current authorization basis and not related to or affected by the mixer pump test.

The mixer pump test will use two high-capacity mixer pumps to demonstrate solids mobilization on Hanford waste in Tank 241-AZ-101 (Figure 2-1 of this addendum). The information and experience gained during the test will provide data for comparison with sludge mobilization prediction models; provide data

to estimate the number, location and cycle times of the mixer pumps; and provide indication of the effects of mixer pump operation on the AWF Tank systems and components. The slurry produced will be evaluated for future pretreatment processing. This process test does not transfer waste from or to the tank; the waste is mixed and confined within the existing system. At the completion of the mixer pump test; Tank Farm Operations will stop the mixer pumps and resume normal tank operations, maintenance and surveillance. Periodic rotation of the mixer pumps and motor shafts, along with bearing greasing, is required to maintain the pumps following the mixer pump test. The test is equivalent to any maintenance testing of pumping equipment, and provides a gradual operation of the system to determine maximum and minimum effectiveness.

2.2 REQUIREMENTS

See Project W-151 Functional Design Criteria (FDC) (Nordquist 1997), which has been approved by the U.S. Department of Energy, Richland Operations Office (RL) for identification of design codes, standards, regulations, and the U.S. Department of Energy (DOE) orders relevant to the design and construction of Project W-151.

2.3 FACILITY OVERVIEW

Project W-151 and the mixer pump test do not impact the currently defined mission of the TWRS facilities or the basic processes in use, as defined in Section 2.3.1, "Current Mission of Tank Waste Remediation System Facilities and Operations Supporting That Mission," of the FSAR. The following discussion is limited to providing information applicable to Project W-151 and the mixer pump test. Information provided here consists of any and all changes to the Aging Waste Facility (AWF) configuration and process description provided in Chapter 2.0, "Facility Description," of the FSAR.

The AWF tanks currently contain a mixture of liquid and sludge with both radioactive and hazardous compounds. The current waste inventory for Tank 241-AZ-101 is presented in Lambert 1998. The current heat generation rate associated with Tank 241-AZ-101, without the mixer pumps, is 79,700 W (271,900 Btu/h) (MacLean 1998). The 300 hp mixer pumps have a thermal input to the waste of 201,000 W (687,000 Btu/h) each (Nordquist 1997), resulting in a total heat load for the tank, with both mixer pumps, of 481,700 W (1,645,900 Btu/h).

2.4 FACILITY STRUCTURE

The following discussion is limited to providing information applicable to mixer pump test equipment. Information provided here consists of any and all changes to the AWF equipment description provided in Chapter 2.0, Sections 2.4.3, "Common Structures and Systems of Double-Shell Tanks," and 2.4.4, "Specific Structures and Systems of Double-Shell Tanks," of the FSAR.

Figure 2-1 of this addendum provides a top-view of the tank and locates the mixer pumps and temperature monitoring equipment within the tank provided by Project W-151. See Chapter 2.0 of the FSAR for additional information on AWF tank temperature monitoring equipment.

A brief listing of the characteristics of each mixer pump is provided in Table 2-1 of this addendum. Additional pump information is provided in Nordquist 1997, and WHC 1996a and WHC 1996b. The following is an excerpt from Nordquist 1997: "Each mixer pump shall take in fluid from the tank bottom and discharge the fluid horizontally through two opposing nozzles located 12 to 18 inches above the tank bottom. The nozzle assembly shall oscillate rotationally (180 °) or rotate 360 ° at 0.05 to 0.2 rpm to sweep the entire projected area of the tank bottom." The two mixer pumps are installed in Tank 241-AZ-101 through existing 1.1 m (42-in.) risers in the tank (see Figure 2-2 of this addendum). The mixer pumps are driven by 300 hp induction motors and rotation of the whole assembly is performed by 1/3 hp induction motors with a 900:1 gear reduction. The design life of the individual mixer pump components is five years or 44,000 hours. The design life of the permanent modifications of Tank 241-AZ-101 and non-replacement ancillary and support equipment is consistent with the remainder of the 50-year design life of the 241-AZ tank farm, which was completed in 1976. Replaceable equipment and components may have a shorter design life, but generally not less than five years.

Analysis of pump-to-pump interaction has been completed in the vendor supplied information (Nordquist 1996). Pump effects, which included the effects of pump operational and environmental conditions, were found to be much greater on the smaller equipment already existing in the tank than for pump-to-pump interaction.

To determine the effects of pump operation on in-tank equipment, structural analyses were performed. Waters and Heimberger 1993 states that for the small number of cycles involved, the stress levels on in-tank components (including the air lift circulators [ALCs]) are well below the allowable limits. Additional analysis (Julyk 1997) states there is a potential for some damage to the thermocouples attached to the ALCs (not safety related equipment) if there are agglomerations of hardened sludge adhering to the thermocouples. Tank 241-AZ-101 has 22 ALCs used to establish convective currents within the tank's supernatant region, and to some degree, mobilize the sludge which settles to the bottom of the tank. During the mixer pump test, the ALCs will be left off as much as possible to determine the effectiveness of the mixer pumps. For the steam coil installed in Tank 241-AZ-101, an analysis was performed to determine the allowable number of stress cycles that could be withstood to support mixer pump operation at the steam coil's current location (Crass 1996). The number of stress cycles are determined by multiplying the mixer pump's rotational speed (the speed at which the entire mixer pump unit rotates about its vertical axis in the oscillating mode) by the time of the mixer pump operation. The rotational speed of the mixer pump assembly, including the casing, is relatively slow as compared to the pump impeller speeds (0.05 to 0.2 rpm, as compared to 1,200 rpm). Initially, it was thought that the steam coil would have to be raised out of the path of pump discharge. However, at the current location of the steam coil (approximately 53 cm [21-in.] from the tank bottom), the

allowable stress cycles are 200,000. These 200,000 stress cycles at a rotational speed of 0.1 rpm translates to 16,600 hours. At a maximum rotational speed of 0.2 rpm the pumps can safely operate for 160,000 cycles or 6,650 hours (Crass 1996) versus a test duration of approximately 1,300 hours.

In addition, the potential for pump operation to result in erosion of the tank liner is addressed in Section 3.4.2.3.4 of this addendum. Erosion of in-tank equipment is considered to be bounded by that of the tank liner analysis. Erosion of in-tank equipment will not affect equipment operability and therefore is considered acceptable for the duration of the test.

Mixer pump system components and assemblies located at or within the double-shell tank (DST) are designed to withstand the anticipated radiation environment as specified in Nordquist 1997. In addition, mixer pump system components and assemblies that will contact the waste are compatible with the waste fluid properties present in the tank as specified in Nordquist 1997. Those in-tank parts of the mixer pumps and other in-tank equipment submerged in the liquid may potentially be exposed to waste at temperatures from 40 °C to 100 °C (104 °F to 212 °F) during normal operations.

2.5 PROCESS DESCRIPTION

Other than the addition of the mixer pumps, Project W-151 and the mixer pump test do not impact the facility's currently defined mission or the basic processes in use. This section describes the mixer pump test.

2.5.1 Mixer Pump Testing

Tank 241-AZ-101 has been selected for the first full-scale demonstration testing of a mixer pump system. The tank currently holds over 3.63 ML (960 Kgal) of neutralized current acid waste, including approximately 31.8 cm (12.7 in) of settling solids (sludge) at the bottom of the tank (Lambert 1998).

The mixer pump test goals are to provide actual in-tank operations of mixer pumps, effectively mobilize solids within the supernatant, provide empirical data for determination of the mixer pump effective cleaning radius (distance out from pump discharge at which the effectiveness of the pump in mobilizing tank solids significantly decreases), and provide further justification for use of mixer pumps on other DSTs. The mixer pump test may consist of three pump configuration phases, including:

- Single Pump - Fixed Mode
- Single Pump - Oscillating Mode
- Two Pumps - Oscillating Mode.

In addition to the pumping or mixing modes, two other tank conditions during the mixer pump test are considered in this FSAR Addendum and discussed as "modes":

- Pump Shutdown - Initial Waste Settling Phase (up to one month)
- Long-Term Re-compaction of solids (up to one year).

The mixer pumps are designed to operate in a fixed position (fixed mode during the single pump portion of the test) or to continuously oscillate from ± 180 ° to 0 ° (oscillating mode). In the oscillating mode, the effective rotation rate of the jet nozzles will be operated from 0.05 rpm to 0.2 rpm during the mixer pump test. Testing will also initially include slowly increasing from 700 rpm to 1,200 rpm instead of increasing directly to full power in order to evaluate the accuracy of modeling conclusions. The duration of each of the modes is contingent on the success (or lack thereof) of sludge mobilization. Within each accident analysis in Chapter 3 of this addendum, the worst case mode was chosen for evaluation. It is expected that a reasonable duration of mixing to achieve maximum mobilization is from 10 to 20 days (Symons and Staehr 1996). Due to a loss of mixer pump test data, the mixer pumps will be turned off whenever all of the air lift circulators are running.

2.6 CONFINEMENT SYSTEMS

The mixer pump test was analyzed to cover the use of either the ventilation system upgrade provided by Project W-030 (241-AZ-702) or the previous ventilation system. The previous ventilation system for Tank 241-AZ-101 was the 241-A-702 AWF ventilation system described in Section 2.4.3.7.1, "241-AY and 241-AZ (Aging Waste Facility) Tank Farm Ventilation Systems," of the FSAR (Figure 2-2 of this addendum). This system was replaced by the 241-AZ-702 ventilation system, as described in FSAR Addendum 3, since the original analyses for the mixer pump test were performed. Because there was uncertainty about which of these systems would be operational at the time that the mixer pump test was performed, the safety analyses provided in this document evaluated both ventilation systems, and the accident consequences were considered for the bounding case condition. Even though this uncertainty no longer remains, the consequences for the 241-A-702 system (where they were bounding) remain in this document, because they remain bounding and their removal would not affect any of the safety controls associated with the mixer pump test. Either ventilation system can remove the calculated heat load for bulk waste temperatures (Sathyanarayana 1994, Rice 1992a, Rice 1992b,and Collins 1992) for mixer pump operation (see Table 2-2 and Section 3.4.2.2 of this addendum for additional information).

2.6.1 241-AY and 241-AZ (Aging Waste Facility) Tank Farm Ventilation System - 241-AZ-702 (Project W-030)

See FSAR Addendum 3, as well as Figures 2-3, 2-4, and 2-5 of this addendum for a description of the Project 241-AZ-702 ventilation system.

There are no changes to this ventilation system as a result of performance of the mixer pump test.

2.6.2 241-AY and 241-AZ (Aging Waste Facility) Tank Farm Ventilation System - 241-A-702

See Section 2.4.3.7.1 of the FSAR, and Figure 2-6 of this addendum for a description of the 241-A-702 AWF ventilation system. There are no changes to this ventilation system as a result of the operation of the mixer pump test.

2.6.3 Annulus Exhaust Flow Description

See Section 2.4.3.7.1 of the FSAR, and Figure 2-22 of the FSAR for a description of the AWF annulus ventilation system. There are no changes to this ventilation system as a result of operation of the mixer pump test. Currently, the annulus exhauster is non-operational, and the conservative assumption has been made for the thermal analyses of Chapter 3 of this addendum that it will remain unavailable during the mixer pump test. Should it be returned to service prior to the mixer pump test, additional tank cooling would be provided by the system, and all tank thermal margins to operational and safety limits would be increased.

2.7 SAFETY SUPPORT SYSTEMS

Existing equipment in Tank 241-AZ-101 monitors and records selected parameters during the mixer pump test. The following describes (1) the appropriate section of the FSAR where descriptions of the existing equipment may be located, and (2) the Tank 241-AZ-101 mixer pump system equipment.

2.7.1 Existing Equipment

See Section 2.4.11, "Common Sitewide Instrumentation and Surveillance Monitoring Systems," of the FSAR for a description of the existing equipment within Tank 241-AZ-101 which will be used to monitor and record parameters during the mixer pump test. Any changes or additional cautions involved with using this equipment during the mixer pump test are discussed below.

2.7.1.1 Liquid Level Measurement System. During the mixer pump test, liquid level measurement will be taken either manually using a tape or by using an ENRAF(TM) gauge to comply with TWRS TSR Limiting Condition for Operation (LCO) 3.3.4, "Air Lift Circulators (ALCs)." Caution is to be taken during mixer pump operation because the ENRAF(TM) liquid level detector could be damaged when lowered into the tank during mixer pump operation. The ENRAF(TM) liquid level is a micro-processor-controlled tank gauge which accurately measures the liquid level. During testing, liquid level measurement with an ENRAF(TM) gauge will be taken when the mixer pump(s) is off, or by other means (e.g., manual tape). For the mixer pump test, level data will be measured and manually logged.

2.7.1.2 Temperature Monitoring. Temperature monitoring in the waste tanks is required to maintain tank operating conditions. For the mixer pump test, as described in the mixer pump test plan (Symons and Staehr 1996), the temperature data, collected and analyzed, provides information about the waste temperature within the tank before, during and after the mixer pump test. This system provides one method of identifying any potential localized "hot spots" leading to tank bump conditions (refer to Section 3.4.2.2 of this addendum).

In accordance with Symons and Staehr 1996, the tank bottom thermocouples, profile thermocouples, air lift circulator thermocouples, and sludge thermocouples may be used to monitor the growth of the effective cleaning radius area when the mixer pumps are operating. The thermocouple data will be monitored before, during, and after pump operation. See Section 2.4.11.4.2, "Double-Shell Tank Farm Temperature Monitoring," of the FSAR for a description of AWF tank temperature monitoring equipment and locations.

Several different temperatures relating to the mixer pump test and Tank 241-AZ-101 are to be used throughout this FSAR Addendum. Some of these temperatures result from predicted temperature responses of the waste to the mixer pump action, some relate to saturation temperatures of the tank solids, supernate, or mixed slurry, and some relate to design and/or safety limits. For clarity, Table 2-3 of this addendum is provided to outline all of these temperatures.

2.7.1.3 Hydrogen Monitoring. Monitoring requirements for flammable gas accumulation in tank headspace are specified in the TWRS TSR AC 5.11. A Standard Hydrogen Monitoring System (SHMS) cabinet has been installed on Tank 241-AZ-101, which will be used to take hydrogen concentration readings, as required, during the testing. Data from the SHMS (or a hand-held monitor if an SHMS is unavailable) will be recorded manually, as specified in Symons and Staehr 1996.

2.7.1.4 Tank Pressure Monitoring. The pressure/vacuum within the 241-AZ-101 primary tank (i.e., vapor space) is continuously monitored as discussed in Section 2.4.12.6, "Pressure Monitoring Systems,"of the FSAR.

2.7.1.5 Air Lift Circulator System. The air lift circulator system consists of air lift circulators (ALCs) in each of the aging waste tanks and a compressed air system. The compressed air system provides process air to operate the ALCs. Instrument air is also generated to operate critical valves on the 702-A ventilation system.

2.7.1.5.1 Air Lift Circulators. The air lift circulator system is composed of the process air (described above) and 22 air lift circulators (ALCs) in each of the 241-AY and 241-AZ Tanks. See Section 2.4.4.1.1 of the FSAR for a brief general description of the ALCs. Additional ALC system details are provided below.

The ALCs are relatively simple devices consisting of two basic components: a vertical lift riser pipe 76 cm (30-in.) in diameter, and a foot piece (air nozzle) located within and near the lower end. A 15 cm (6-in.) pipe suspends the lift riser from the tank dome and concentrically extends to

a 3.8 cm (1.5-in.) inner diameter nipple. A 2.5 cm (1-in.) pipe, which supplies the motive air, is a removable insert that extends within the 15 cm (6-in) pipe to 5 cm (2-in.) below the swaged nipple. This is the one component which can be replaced in the event of a plug. The entire unit is of mild steel construction. The lower ends of all the lift risers are 76 cm (30-in) above the tank bottom.

Air is injected into the lift riser at the foot of the air lift, draws in liquid from the bottom of the tank, and pushes the fluids up the circulator and out the top. The large liquid flow rates generated with the circulators will create turbulent flow in the tank contents. Liquids flowing along the bottom of the tank and up the draft tubes will carry solid particles out the top of the circulator as they are discharged in the upper region of the tank. The vertical fluid motion decreases the temperature differential between the top and bottom of the tank by transporting warm liquids and solids from the bottom of the tank to the cooler regions at the top. A computer analysis of the adequacy of the circulator capabilities for suspending and mixing was made by Pacific Northwest Laboratory (Fineman 1984). This analysis compiles several modeling reports which show the air lift circulators are capable of keeping the solids suspended and maintaining a more even temperature distribution, preventing tank bumps (see Section 3.4.2.2 of this addendum).

2.7.1.5.2 Air Compressor Building. Process and instrument air is supplied to the 241-AY and 241-AZ Tank Farms from the 241-A-701 Compressor Building. The 241-A-701 Building compressed air system was upgraded from late 1993 to 1995. It contains two Ingersoll-Rand glycol/water cooled electric air compressors. Each compressor is powered by a 125 hp electric motor and will supply about 2.1×10^{-1} m^3/s (440 cubic feet per minute [CFM]) at 1.0 MPa (150 lbf/in^2 gauge). Normally one compressor will be operated, and the other acts as a backup. They will be rotated to ensure that they have about the same amount of use and that they remain operable. A dedicated portable diesel driven air compressor is available at the Compressor Building as backup. A portable air separator and air dryer system is available (in use) outside of 241-A-701 building.

Air from the compressors passes through a cooler and separator to remove moisture and droplets. The air goes to an air receiver tank located behind 241-A-701. For instrument air, the air is routed through a separator and air dryer to further remove water droplets, particulates, and vapors. For process air, these dryers and filters are bypassed.

Process air is reduced to 0.3 MPa (41 lbf/in^2 gauge) through a pressure reducing valve and then one 7.6 cm (3-in.) line is routed to the 241-AX, AY, and AZ tank farms. Process air is piped to the 801 buildings in the 241-AZ and 241-AY Tank Farms. Another pipeline leaves the Compressor Building to the 241-A tank farm.

Instrument air from 241-A-701 is routed to an air accumulator, reduced in pressure to 0.2 MPa (35 lbf/in^2 gauge) and then to the 241-A-702 ventilation building. Instrument air is routed to 241-AX, AY and AZ farms through a 2.5 cm (1-in.) line.

Rotameters located in the 241-AY-801A and 241-AZ-801A Instrument Buildings are used to indicate the air flow rate to the individual circulators. An adjoining raw water header (and associated valves) are provided at these locations for water flushing of the ALC lines. Connections are available for the emergency diesel air compressor at the air headers in the 241-AY-801A and 241-AZ-801A buildings, if required.

2.7.2 Tank 241-AZ-101 Mixer Pump System Equipment

The process control system for the mixer pump test consists of:

- Pump column water pressure normal and low indicators
- Pump column supply filter normal and high indicators
- Motor bearing high temperature alarm, and motor bearing maximum temperature alarm
- High pump current alarm, and maximum pump current alarm and interlock.

In addition, the mixer pump test will use three existing safety control systems in support of process control. These existing systems are:

- Tank vapor pressure alarm and tank low vacuum alarms
- Tank liquid level minimum, absolute minimum, and maximum alarms

The mixer pump motors and connections are above tank farm grade (i.e., in an area without direct connection or exposure to tank headspace) and contain no accumulation areas for flammable gas buildup around the motors. To provide cooling and lubrication, the mixer pump line shaft bearings are enclosed in a water column, which also prevents sparking. In addition, the volute and impeller are 304 stainless steel and the process bearing is submerged in the waste, which prevent sparks (Crass 1993).

As noted in Section 2.5 of this addendum, the mixer pumps are being started slowly as part of the mixer pump process test. This will serve as a preventive measure against a sudden gas release, although gas pockets within the sludge are not expected (Hodgson 1996). In addition, the mixer pump test procedure (Ross 1997) contains requirements to comply with the flammable gas requirements of the FSAR and Administrative Controls (AC) 5.9, 5.10, and 5.11. Prior to startup of a mixer pump or change in the mixing test mode, the tank's exhaust or headspace must be sampled for flammable gas to verify it to be <25% of the lower flammability limit (LFL) (see AC 5.11).

The waste profile thermocouples and transfer pump are carbon steel and are installed in carbon steel risers. Normally, there is no movement of any of these pieces of equipment. However, due to mixer pump operation, they may sway (Waters and Heimberger 1993). The flammable gas hazard has been evaluated in Chapter 3, Section 3.4.2.3.1 of this addendum.

A closed-circuit television system, with videocassette recorder capabilities, will be installed in the tank headspace and will be monitored for information purposes to determine whether any in-tank equipment has been damaged or is being damaged by the mixer pumps. The use of the camera has been determined to be a prudent measure for defense-in-depth. (Analyses have shown safety equipment to be within allowable stress margins, though Julyk 1997 recommended that the ALCs be monitored by camera to avoid flow-induced resonant vibration coupling for more than a duration of one hour. Julyk 1997 also states that resonant coupling is not likely in the tank because of the non-uniform nature of the flow patterns.) It is intended that the closed-circuit television be operated during the entire mixer pump test. But, if the functionality of the camera is lost during the mixer pump test, the test may be continued, once the reason for the camera failure has been determined, since the camera is not needed to fulfill a safety function.

The surveillance camera is housed in a stainless steel, purged enclosure. This enclosure is designed, in accordance with the requirements of flammable gas controls (AC 5.9, 5.10, and 5.11) and approved by the Flammable Gas Equipment Advisory Board (Smet 1997), to provide a continuously isolated (purged and pressurized) environment for a potentially sparking camera system (either the electronics of the camera itself or the direct current pan and tilt motor for the unit) from a potentially flammable gas environment. Upon loss of purge, the in-tank camera equipment will shut down automatically, deenergizing the system and stopping all sparking potential.

Two gamma profilers may be installed in existing drywell locations to help determine the mixer pump effective cleaning radius during the test and the degree of solids distribution within the supernatant. These pieces of equipment are manually operated (i.e., raised and lowered in the drywell manually) and the readings may be taken during mixer pump operation. The housing of the profilers are made from stainless steel and all electrical connections are above tank farm grade (i.e., in an area without direct connection or exposure to tank headspace).

Strain gauges installed on the profile thermocouple trees will monitor the impingement jet force from the mixer pump. The strain gauges are used while the mixer pumps are in operation. The collected data will be measured and stored in a personal computer data spreadsheet program, maintained by the operators. The strain gauges on the profile thermocouple trees are non-sparking during normal operation and all electrical connections are above tank farm grade (i.e., in an area without direct connection or exposure to tank headspace). The strain gauges are also isolated from the tank's vapor space with a welded cover.

Vibration of the mixer pump assembly will be measured by the use of a vibration switch mounted to the pump motor, which is preset to provide indication, should vibrations exceed vibration set-points.

The ultrasonic interface level analyzer (URSILLA) (Royce Model 2511) system consists of three individual units that use an ultrasonic ranging technique to measure the depth of the sludge interfaces within the supernatant. The URSILLA will be operated continuously, and collected data measured and stored in a personal computer data spreadsheet program,

maintained by the test engineers. The URSILLA's sensors will be located approximately 4.5 m (15 ft) off the tank bottom, and will be housed and sealed from the tank's atmosphere and waste in 5.1-cm dia (2-in) stainless steel housings and all electrical connections are above tank farm grade (i.e., in an area without direct connection or exposure to tank headspace). The three units provide a high degree of redundancy for process data. The mixer pump test plan only requires two of the three units to be operational during the mixer pump test.

Instrumentation monitors the following:

- Mixer pump motor and bearing temperature
- Pressure readings on pump bearing/seal lubrication water pressure
- Electrical parameters including current, voltage, and frequency
- Rotary position to determine pump orientation
- Bending of selected in-tank equipment through the use of strain gauges (Figure 2-1 of this addendum).

2.8 UTILITY DISTRIBUTION SYSTEMS

Utility distribution systems impacted by Project W-151 include the following:

- Water Supply Systems and
- Electrical Power Distribution System.

2.8.1 Water Supply Systems

All water for the 200 East Area is supplied from the Hanford Site export water system. Export water is defined as water that is pumped from the Hanford Site reservoir to reservoirs located in the 200 East and West areas. Water is distributed throughout the area by two separate systems, the raw water system and the sanitary water system. Raw water is untreated, and unchlorinated, and is used principally for cooling, flushing, and dilution systems. Sanitary water is treated (filtered, purified, etc.) and used for drinking and sanitary facilities, process, and fire protection.

For Project W-151, raw water is provided for mixer pump mechanical seals and bearings. Heat trace of the water piping from the raw water connection to the mixer pump is provided. Flushing of the mixer pump for decontamination during potential failed equipment removal and replacement would be provided by tanker-supplied hot water from the power house.

2.8.2 Electric Power Systems

An electrical substation and pump control facility was installed for Project W-151. The substation replaced the previous transformer (C8-S27) and, in addition to the existing C8-S27 loads, has the capacity to supply power for the two mixer pumps and associated equipment.

2.9 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

No systems or facilities other than those described in the previous sections of this addendum were identified as requiring descriptions in this document.

Table 2-1. Project W-151 Mixer Pump Characteristics.

Pump type	Vertical line shaft drive mixer pump
Motor type	Induction-type, 300 hp, 1,200 rpm, 480V/3 Phase/60HZ weather-protected enclosure
Total pump weight	12,247 kg (27,000 lb) (water column filled)
Pump dimensions	17 m by 41 cm (56 ft by 16 in) (from support connection to bottom of the screen)
Number of jet nozzles	(2) 180 ° opposed
Diameter of each nozzle	15 cm (6 in)
Max Flow rate of each nozzle	19,680 L/minute (5,200 gpm)
(Velocity) x (nozzle diameter)	2.7 m^2/s (29.4 ft^2/s)
Jet flow direction	Horizontal
Nozzle centerline distribution above floor	43 cm (17 in.)
Pump rotation	Fixed, or 180 ° oscillating at 0.05 to 0.2 rpm

Table 2-2. Heat Generation and Removal.

241-AZ-101 Heat Generation without Mixer Pumps[1]	241-AZ-101 Heat Generation with one Mixer Pump	241-AZ-101 Heat Generation with two Mixer Pumps[2]	241-A-702 Heat Removal Capacity[3]	W-030 Ventilation System Heat Removal Capacity[4]
79,700 W (271,900 Btu/h)	280,700 W (958,900 Btu/h)	481,700 W (1,645,900 Btu/h)	1,172,284 W (4,000,000 Btu/h)	486,791 W (1,661,000 Btu/h)

[1]MacLean 1998
[2]Nordquist 1997 (note, one pump heat load is a linear interpolation from none to two mixer pumps)
[3]Kronvall 1982
[4]Rice 1992b

Table 2-3. Mixer Pump Test Temperature Outline.

Pre-test Supernatant temperature in 241-AZ-101	146 °F
Pre-test Sludge temperature in 241-AZ-101	178 °F
Temperature at which the mixer pumps are turned off	≥195 °F top 15 feet of waste -or- ≥215 °F bottom 15 feet of waste
Temperature at which ALCs must be started	>190 °F average waste solution -and- >230 °F below 20 feet
Supernatant saturation temperature	220-230 °F
Sludge saturation temperature	255 °F
Safety limit maximum tank temperature to prevent organic nitrate reaction	250 °F
Temperature at which concrete degradation potential increases	300 °F

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3.0 HAZARD AND ACCIDENT ANALYSIS

3.1 INTRODUCTION

This chapter identifies and evaluates the hazards associated with the mixer pump test in Tank 241-AZ-101. In addition, it evaluates the consequences of potential accidents that could lead to a release of radioactive and hazardous materials. Potential consequences to the offsite public and onsite individuals are considered, as are the corresponding preventive and mitigative features. This chapter is limited to the scope and impact of the Tank 241-AZ-101 mixer pump test and therefore does not address all of the hazards analyzed and presented in the Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR), HNF-SD-WM-SAR-067.

3.2 REQUIREMENTS

The standards and U.S. Department of Energy (DOE) Orders that are required for establishing the safety basis of the mixer pump test are listed below, and are consistent with those listed in Chapter 3.0, "Hazards and Accident Analysis," of the TWRS FSAR. Only portions of these documents are relevant to this safety document; namely, those requirements pertinent to safety analysis.

- DOE 5480.22, *Technical Safety Requirements* (1992)
- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1, (1994)
- DOE 6430.1A, *General Design Criteria* (1989)[1]
- DOE Standard 1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*
- DOE Standard 3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*
- DOE Standard 3011-94, *Guidance for Preparation of DOE-5480.22 (TSR) and DOE-5480.23 (SAR) Implementation Plans.*

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[1]Non-safety related sections of DOE 6430.1A will be phased out/canceled upon meeting the implementation conditions of DOE O 430.1. The portions of DOE 6430.1A related to nuclear safety for non-reactor nuclear facilities are canceled by DOE O 420.1. As of this writing, the new orders have not been transmitted for compliance and therefore, compliance with DOE 6430.1A is required.

3.3 HAZARDS ANALYSIS

3.3.1 Methodology

The methodology used to perform this safety analysis is described in Section 3.3.1, "Methodology," of the FSAR. The purpose of this safety analysis is to analyze the specific hazards related to the operation of two 300 hp mixer pumps in Tank 241-AZ-101 and also to assess the changes (i.e., assumptions and conclusions) in the current analysis due to the performance of the test.

The hazards analyzed were those identified in the Hazards and Operability (HazOp) effort presented in Appendix 3A enhanced by subsequent evaluation and comparison with hazards analyses performed for the FSAR and Tanks 241-SY-101 and 241-AP-102 mixer pump additions (Section 3.3.2.4 of this addendum). Sabotage and terrorism are not included. Single and multiple failures (equipment and human errors) are considered as well as common-cause failures.

3.3.1.1 Hazard Identification. The hazard identification procedure used is consistent with that described in Section 3.3.1.1, "Hazard Identification," of the FSAR. Radiological hazards (excerpted from Table 3.4.1-4, "Derived In-Tank Concentrations of the 11 Radionuclides Chosen for Inclusion in Accident Analysis," of the FSAR) are listed in Table 3-8 of this addendum, and toxicological hazards (excerpted from Table 3.4.1-10, "Composite Concentrations for the 24 Analytes of the Tank Waste Remediation System Tank Farm," of the FSAR) are listed in Table 3-11 of this addendum.

3.3.1.2 Hazard Evaluation. The technique chosen for the mixer pump test hazards evaluation was the HazOp study which is the method used in the FSAR. Additional analysis has been performed in conjunction with the FSAR for non-operational hazards (for example, flammable gas) and the analysis is unchanged for the mixer pump test. Refer to the FSAR Section 3.3.2.3, "Hazard Evaluation."

3.3.1.3 Worker Health and Safety Requirements. This safety analysis addresses the risks to hypothetical onsite individuals at 100 m (330 ft) and to the public at the Site boundary, and provides for safety equipment and administrative controls to reduce such risks to within risk evaluation guidelines (see Table 3.3.1.5-1, "Risk Guidelines," of the FSAR). Included are the risks from radioactive materials, toxic gases, and toxic chemicals. The risk evaluation guidelines for the workers and the public are those defined in Table 3.3.1.5-1 of the FSAR (see Tables 3-3 and 3-4 of this addendum). The onsite receptor is assumed to be 100 m (330 ft) from the source of releases. This safety analysis does not specify any new controls necessary to protect workers who are located closer than 100 m (330 ft) to the activity. The current controls that protect workers during operations within 100 m (330 ft) are defined in the *Hanford Site Radiological Control Manual* (HSRCM-1 1995) and the *Tank Farm Health and Safety Plan* (HASP) (Hewitt 1996). The controls necessary to protect the workers against uncontrolled releases are documented in the FSAR Chapter 5.0, "Derivation of Technical Safety Requirements," and Chapter 5 of this addendum.

There is a potential for worker exposure to high concentrations of toxic gases during tank intrusive work around open tank risers or from emissions from the ventilation exhauster, including ammonia, nitrous oxide, and various organic species. Concentrations of these gases in the tank vapor space during the mixer pump operation work may be in excess of Occupational Safety and Health Administration (OSHA)-allowed values. Because the tank vapor space will be exhausted to the ambient air above the tank, a pathway for worker exposure is recognized to exist. Assessment of the hazards from these materials and protection of the workers is provided as required by the HASP. Significant elements of this plan include monitoring of the work area for organic vapors, ammonia, and other chemical species whenever there is a potential for elevated employee exposure levels (i.e., above the established administrative action level defined by TWRS Industrial Health & Safety, which is one-half of the lower of either the Permissible Exposure Limit [PEL] or the Threshold Limit Value [TLV]). In addition, personnel monitoring is performed on those tasks which are judged to have the highest potential for exposure. The potential for elevated employee exposure is determined from a specific job hazards analysis performed on each work package prior to the work performed in the field, evaluating the potential levels of exposure from the baseline sample data available for the specific facility.

The Tank Farms are considered to be a Resource Conservation and Recovery Act (RCRA) Treatment, Storage and Disposal (TSD) facility, and all work in Tank Farms must comply with the HASP. The TWRS Industrial Hygiene staff has responsibility for implementation of the HASP, including monitoring and personnel sampling. Trained industrial hygiene technicians perform monitoring during each task. If any tank vapor levels are detected that present a possibility of employee over-exposure, the industrial hygiene technicians will take appropriate actions (as defined in the TWRS HASP), including the use of personal protective equipment or suspending the activity to ensure that no employee over-exposures occur.

It is important to note that the analysis addressing State Route 240 transient populations discussed in Chapter 15.0, "Emergency Preparedness Program," of the FSAR is also applicable to the 241-AZ-101 mixer pump process test analysis.

3.3.2 Hazard Analysis Results

The following section presents and evaluates the results of the HazOp for the mixer pump test.

3.3.2.1 Hazard Identification. See FSAR Section 3.3.2.1, "Hazard Identification." There are no new hazards presented by the mixer pump test. See Table 3-8 of this addendum for the radionuclide hazards and Table 3-11 of this addendum for the toxicological hazards which are tables excerpted from the FSAR, Tables 3.4.1-4 and 3.4.1-10 respectively.

3.3.2.2 Hazard Classification. The hazard category, as defined in DOE-STD-1027-92 for Tank 241-AZ-101, which is a Double-Shell Aging Waste Tank, has been determined to be Category 2 (Table 3.3.2.2-3, "Final Hazard Category for Tank Waste Remediation System Facilities," in the FSAR). Since the mixer

pump test does not segment the facility, change the type or form of waste being stored within the tank, and does not change its location (other than mobilizing the waste within the tank), the hazard classification remains Category 2.

3.3.2.3 Hazard Evaluation. The hazards evaluated in the FSAR were re-evaluated for potential changes as a result of the mixer pump test. Results of the HazOp (Appendix 3A of this document) were also considered during this re-evaluation and subsequent accident selection.

3.3.2.4 Accident Selection. The results of the HazOp are a number of postulated abnormal events that are ranked with respect to severity and frequency of occurrence. The Event Severity Index and Event Frequency Index are provided in Tables 3A-2 and 3A-3, respectively, of Appendix 3A of this addendum. These tables are reproduced in this section, as Tables 3-1 and 3-2.

The complete product of the HazOp study is presented as a series of tables (Appendix 3A of this addendum) showing the results of the study.

Using the HazOp evaluation techniques, a Hazard Analysis Summary table (Appendix 3B of this addendum) was constructed. Hazard Analysis Summary tables have been used to compile the results of the hazard identification and evaluation process for this test. Each column in the hazard tables is described below.

Event Number. Sequential identification for the hazard or accident evaluated.

Event Category. Event category descriptor.

Postulated Event Description. Details on how the hazard or accident can occur.

Significant Causes or Energy Sources. Hazard or accident initiators.

Receptor. Identifies the affected party (facility worker, onsite worker, public).

Credited Prevention. Engineered or administrative features that would prevent or reduce the probability of the hazard/accident from occurring.

Event Frequency. The qualitative or semi-quantitative assessment of the frequency of occurrence of the hazard/accident with and without preventive features.

Credited mitigation. Engineered or administrative features that would mitigate or reduce the consequences of the hazard/accident.

Consequences. The qualitative or semi-quantitative assessment of the consequences of the hazard/accident with and without mitigative features.

Risk Bin Number. Risk number based on the frequency, the consequences, and the receptor. This number, as used in the HazOp, was an arbitrary numbering system to gather together accidents of similar risk.

Defense-in-Depth Controls. Preventive and mitigative features not credited in the accident analyses.

HazOp study estimates were made for the likelihood of occurrence (frequency) for each accident shown in the HazOp study tables. There are four frequency categories. Also shown are four severity categories. These categories were used along with common release mechanisms to categorize or bin accidents with common attributes (i.e., accidents that would benefit from the same control and protection strategy). Bin numbers were generated during the HazOp as an arbitrary method of gathering together accidents of similar risk potential, and are shown on the HazOp study tables.

An accident scenario was developed which bounds all common attribute accidents assigned to a bin. Only those accidents with a severity category of S3 and S2 were selected for further accident analysis (Section 3.3.1.4, "Candidate Accident Selection," in the FSAR). The accidents appearing in these categories for further analysis were grouped according to release mechanisms that could result in dispersal of contaminants to an occupied area of the facility, and/or to the onsite and/or offsite receptor. Six bins were identified and therefore, six bounding (candidate) accident scenarios were developed from the HazOp.

The HazOp study detailed in Appendix 3A resulted in the identification of six postulated events which were binned from all the postulated accidents. These events and their related causes and conditions are identified in Appendix 3B. These six postulated events are: (1) a ventilation system High Efficiency Particulate Air (HEPA) filter failure, (2) backflow through open tank risers, (3) leakage via failed vent ducting, (4) a breach of the tank due to internal or external mechanisms, (5) a nuclear criticality induced by mixer pump operations, and (6) a seismic event.

The next step in the accident selection process involved an evaluation of the specific causes and conditions associated with the postulated events. Using the results of the HazOp as a starting point, and evaluating the events identified with the analyses of the FSAR and other analyses performed in support of the similar mixer pump additions to Tanks 241-SY-101 and 241-AP-102 (though these pumps are smaller than the 241-AZ-101 mixer pump, many of the hazards are the same), a reconciliation was performed between the HazOp and these other analyses to arrive at an integrated set of design basis accidents (using updated information from these later analyses to update the results of the HazOp). The HazOp and Hazards Evaluation Tables are included for historical reference. This evaluation identified causes and conditions related and not related to the mixer pump test. Postulated events that involve causes and conditions not related to the mixer pump test are not analyzed. In addition, postulated events bounded by similar accidents are not analyzed. For example, leakage via failed vent ducting is not analyzed since the causes of this accident are not related to the mixer pump test and the accident is bounded by the HEPA filter failure.

This evaluation process resulted in the identification of four design basis accidents requiring further analysis: (1) unfiltered release of radionuclides and toxic aerosols from the tank, (2) tank bump, (3) breach of containment, and (4) overpressurization caused by criticality. The unfiltered release includes an evaluation of HEPA filter failure and reverse flow through the tank.

The tank bump accident scenario is considered separately from the unfiltered release. The breach of containment accident scenario includes many causes and conditions, with the most significant being flammable gas deflagration.

Table 3-5 of this addendum provides the four design basis accidents, causes and conditions of the accident scenarios, and manping of the postulated events to the accident analysis in Section 3.4 of this addendum.

Table 3-1. Event Severity Index.

Safety-class category designation	Description
S3	Potential significant radiological dose consequences or chemical exposure to the offsite receptor.
S2	Potential significant radiological dose consequences or chemical exposure to the onsite co-located worker.
S1	Potential industrial injury, radiological dose consequences or chemical exposure to the facility worker.
S0	No effect outside the facility confinement systems and no safety concerns for the facility worker, the onsite worker, or members of the general public.

Table 3-2. Event Frequency Index.

Frequency category designation	Numeric definition	Word definition
F3	$> 10^{-2}$/year	Anticipated
F2	$> 10^{-4}$ to $\leq 10^{-2}$/year	Unlikely
F1	$> 10^{-6}$ to $\leq 10^{-4}$/year	Extremely unlikely
F0	$\leq 10^{-6}$/year	Beyond extremely unlikely

3.4 ACCIDENT ANALYSIS

This section presents the formal development of potential accidents. Section 3.4.1 refers to the relevant sections of the FSAR for the description of the consequence calculation methods common to the accidents analyzed. Section 3.4.2 presents analyses of the design basis accidents (DBA). No beyond design basis accidents (BDBA) were evaluated for the mixer pump test, for the reasons stated in Section 3.4.3.

3.4.1 Methodology

This section summarizes the radiological and toxicological consequence calculation assumptions used in the mixer pump test related accidents selected for further analysis in Section 3.3.2.4 of this addendum.

The calculation methods of the FSAR as derived in Van Keuren 1996 and Van Keuren et al. 1996 have been applied to determine health effects. Where assumptions vary from those of the FSAR because of the mixer pump test, consequence calculations are summarized in Sections 3.4.2 and 3.4.3. Accident consequences are combined with the accident frequency and compared to the risk evaluation guidelines as shown in Tables 3-3 and 3-4 below (excerpts of Table 3.3.1.5-1 of the FSAR).

Table 3-3. Radiological Risk Evaluation Guidelines.
(Excerpted from FSAR Table 3.3.1.5-1)

Frequency category	Frequency range (yr^{-1})	mSv (rem)	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^{0}$	5 (0.5)	1 (0.1)
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	50 (5)	5 (0.5)
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	100 (10)	40 (4)

Table 3-4. Toxicological Risk Evaluation Guidelines.
(Excerpted from FSAR Table 3.3.1.5-1)

Frequency category	Frequency range (yr^{-1})	Primary concentration guidelines	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^{0}$	≤ ERPG-1	≤ PEL-TWA
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	≤ ERPG-2	≤ ERPG-1
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	≤ ERPG-3	≤ ERPG-2

ERPG = Emergency Response Planning Guidelines
PEL = Permissible Exposure Limit
TWA = Time-Weighted Average

Table 3-5. Accident Selection and Mapping to Analysis. (2 sheets)

Accident	Cause or condition due to mixer pump operation	Map to accident analysis
1. Unfiltered release of radionuclides and toxic aerosols from the tank (Section 3.4.2.1)	HEPA filter failure due to:	
	• Aerosol generation from chemical reaction	Waste is not to be added by or during this process test. Therefore, this scenario is not relevant to this analysis.
	• Ignition of flammable gases in dome void space	See Flammable Gas discussion in Section 3.4.2.3.1. This scenario is presumed to cause an overpressure peak that damages the ventilation equipment and is analyzed in Section 3.4.2.1.2.
	• Increased aerosol generation due to mixer pump action and heat input	Aerosol generation during the mixer pump process test is analyzed in Section 3.4.2.1.1.
	• Plugging of filters with particulates or moisture	Increased particulates and moisture generated due to mixer pump operation that would result in a HEPA filter plugging is analyzed in Section 3.4.2.1.1.
	• Tank bump	A tank bump resulting in HEPA filter blowout is analyzed in Section 3.4.2.2. The tank bump scenario is not considered representative of this class of accident and is therefore analyzed separately.
	• Tank dome collapse and breach of containment	Tank dome collapse is analyzed in Section 3.4.2.3.7.
	• Breach of vent ducting due to seismic event	The consequences of a breach of vent ducting leading to continuous unfiltered release are bounded by the HEPA filter failure (3.4.2.1.2 of this addendum), and are within guidelines for an unlikely event (seismic initiator). Therefore, this scenario is not analyzed further.
2. Tank bump (Section 3.4.2.2)	Uncontrolled waste overheating above saturation temperature:	The tank bump scenario is analyzed in Section 3.4.2.2.
	• Waste re-distribution causing poor heat transfer from the sludge to the liquid or potential ALC draft tube blockage	
	• Loss of ventilation	
	• Increased waste temperature due to mixer pump operation heat input	
	• Seismic event during pump operation	

Table 3-5. Accident Selection and Mapping to Analysis. (2 sheets)

Accident	Cause or condition due to mixer pump operation	Map to accident analysis
3. Breach of containment (Section 3.4.2.3)	Excess vacuum draw down	Tank buckling that would result in a breach of containment is not a credible scenario. The waste level in the tank prevents buckling. Waste will not be added or removed during the test. (No change from BIO analysis due to mixer pump operation.)
	Pressure from a flammable gas burn	See Flammable Gas discussion in Section 3.4.2.3.1.
	Equipment dropped into the tank during installation or removal	USQDs TF-96-0018, TF-96-0461, TF-96-0448, and TF-96-0805 address equipment installation. This analysis only deals with the mixer pump process test (Section 3.4.2.3.2) and does not address installation or removal of equipment.
	Missiles from pumps (pump impeller failure)	Internal missiles are analyzed in Section 3.4.2.3.3.
	Erosion during mixer pump operation	A breach of containment from erosion caused by mixer pump operation is analyzed in Section 3.4.2.3.4.
	Material degradation due to high temperature	The analysis of this scenario is addressed in Section 3.4.2.3.5.
	Tank dome collapse due to overloading	The analysis of this scenario is addressed in Section 3.4.2.3.6.
	Seismic event during pumping operations	A seismic event leading to failure of the mixer pump support assembly, riser extension, and/or spray wash system is analyzed in Section 3.4.2.3.7.
4. Overpressurization caused by criticality (Section 3.4.2.4)	Mixer pump action during operation	Criticality is analyzed in Section 3.4.2.4.
	Waste settling after mixer pump shutdown	Criticality is analyzed in Section 3.4.2.4.

ALC = air lift circulator.
HEPA = high-efficiency particulate air (filter).
USQD = Unreviewed Safety Question Determination.

3.4.1.1 Radiological Consequence Calculation Methodology. The radiological consequence calculation methodology is provided in Section 3.4.1.1, "Radiological Consequence Calculation Methodology," of the FSAR. This section provides the assumptions and data applicable to the consequence calculations for the mixer pump test. This specific information is provided in Tables 3-6 through 3-10.

The radionuclide concentration data in Table 3-8 above represents bounding activity concentrations for dose assessments and were used to derive the ULDs of Table 3-9. The data are bounding for all the AWF tanks and are, therefore, conservative for 241-AZ-101.

Tank 241-AZ-101 contains radioactive materials in the form of liquid and sludge. Table 3-9 below presents the inhalation and ingestion Unit Liter Doses (ULD)s for the liquid and solid constituents of AWF tank waste. The inhalation and ingestion ULDs were reported in Cowley 1996. They were calculated with dose conversion factors in EPA 1988 using the GENII computer program (Napier et al. 1988).

Table 3-6. Centerline Atmospheric Dispersion Coefficients.
(Excerpt from Van Keuren 1996)

Maximum individual	Bounding (99.5 percentile) integrated χ/Q' (s/m^3)	Bounding integrated χ/Q' (s/m^3) with PM*	Maximum puff χ/Q ($1/m^3$)
Onsite (sector and distance)	3.41 E-02 (E 100 m)	1.13 E-02 (ESE 100 m)	9.85 E-03 (E 100 m)
Offsite (sector and distance)	2.83 E-05 (N 8,760 m)	2.12 E-05 (N 8,760 m)	1.14 E-07 (NNW 8,690 m)

*NRC Regulatory Guide 1.145 (NRC 1982) plume meander correction applied.

Table 3-7. Chronic Annual Average Atmospheric Dispersion Coefficients for 200 Area Tank Farms.
(excerpt from Van Keuren 1996)

Maximum individual	Integrated χ/Q' (s/m^3)
Onsite (sector and distance)	4.03 E-04 (ESE 100 m)
Offsite (sector and distance)	1.24 E-07 (E 12,630 m)

Table 3-8. In-Tank Concentration of the 11 Radionuclides Chosen for Inclusion in Accident Analysis. (excerpt from Table 3.4.1-4 of the FSAR)

Nuclide	Activity concentration (Bq/L)	
	AWF liquids	AWF solids
^{60}Co	7.7 E+05	4.9 E+08
^{90}Sr	5.6 E+09	2.9 E+12
^{90}Y	5.6 E+09	2.9 E+12
^{137}Cs	8.8 E+10	9.8 E+10
^{154}Eu	a	1.1 E+10
^{237}Np	9.2 E+04	9.9 E+08
^{238}Pu	2.8 E+03	6.7 E+07
^{239}Pu[b]	1.2 E+06	4.4 E+08
^{241}Pu	3.4 E+05	1.7 E+09
^{241}Am	1.1 E+06	1.1 E+10
^{244}Cm	1.1 E+04	6.1 E+07

a) No valid sample result exists. Analysis indicates this isotope, in the liquids, is a negligible contributor to dose.
b) The ^{239}Pu activity concentration also includes ^{240}Pu.

AWF = Aging Waste Facility

Table 3-9. Unit Liter Doses for Inhalation and Ingestion. (Excerpt from Table 3.4.1-9 of the FSAR)

Composite	Inhalation ULD (Sv/L)	Ingestion ULD* (Sv-m3/s-L)
AWF liquids	1.4 E+03	0.092
AWF solids	1.7 E+06	8.1

*Includes 24 hour ingestion of fruits and vegetables, ground shine, inadvertent soil ingestion, and inhalation of material re-suspended from the ground.

Table 3-10. Release Durations for which the Maximum Puff χ/Q can be Applied.

Release	Duration
Onsite receptor, ground-level release	≤3.5s
Offsite receptor, ground-level release	≤250s

NOTE: The information in this table is from Van Keuren et al. 1996.

3.4.1.2 Toxicological Consequence Calculation Methodology. The toxicological consequence calculation methodology is provided in Section 3.4.1.2, "Toxicological Consequence Calculation Methodology," of the FSAR and defined as the toxicological sum-of-fractions (SOF) methodology. This methodology is based on the methodology provided in Van Keuren et al. 1996. This section provides the assumptions and data applicable to the consequence calculations for the mixer pump test. This specific information is provided in Tables 3-11 and 3-12.

Since the toxicological SOF methodology does not directly correlate to single, chemical-specific emergency response planning guideline (ERPG) values, the toxicological SOF values calculated for a specific accident do not provide

enough information for emergency response purposes. Depending upon the type, form, and location of waste released, the 24 analytes used in the toxicological SOF methodology may be reduced to a smaller set of peak contributors to be initially considered for emergency response purposes. For example, in double-shell tank liquids, there are five peak analytes (Na, NaOH, NH3, TOC, and U). For double shell tank solids, there are twelve peak analytes (Na, Cd, NaOH, Co, Oxalate, Cr, As, Tl, U, Be, TOC, and Se). Determination of emergency response actions relies upon the location of the release, the potential release quantity, consideration of the primary (peak) analytes, and the location of any potentially affected individuals (onsite or offsite).

Table 3-11. Tank Waste Liquids and Solids Analyte Concentrations

Analyte	Composite concentration (g/L)	
	DST solids[c]	DST liquids[c]
Ammonia (NH_3)	6.6 E+00	7.1 E+00
Antimony (Sb)	9.2 E-01	6.4 E-03
Arsenic (As)	5.7 E+00	1.1 E-02
Barium (Ba)	5.9 E+00	3.3 E-02
Beryllium (Be)	2.4 E-01	3.8 E-03
Cadmium (Cd)	2.6 E+01	7.0 E-02
Calcium (Ca)	2.6 E+01	1.3 E+00
Cerium (Ce)	2.6 E+00	5.8 E-02
Chromium (Cr^{+3})	1.5 E+02	a
Cobalt (Co)	4.4 E+00	8.8 E-03
Cyanide (CN)	4.7 E-01	9.1 E-02
Dysprosium (Dy)	a	a
Lanthanum (La)	3.0 E+01	1.0 E+00
Mercury (Hg)	1.2 E-01	2.4 E-04
Neodymium (Nd)	7.0 E+00	5.6 E-03
Oxalate (C_2O_4)	2.8 E+02	a
Selenium (Se)	1.9 E+00	2.8 E-01
Sodium hydroxide (NaOH)	2.3 E+02	2.1 E+02
Sodium (Na) - NaOH[b]	3.5 E+02	2.1 E+02
Tellurium (Te)	9.3 E-01	2.7 E-03
Thallium (Tl)	1.5 E+01	3.7 E-02
Total organic carbon (TOC)-oxalate[b]	7.5 E+01	4.0 E+01
Uranium (U)	4.4 E+01	1.1 E+01
Vanadium (V)	1.2 E-01	2.1 E-03

NOTE: The information in this table is from Table 3.4.1-10 from the FSAR.
a) The best available data indicates there is not a significant concentration of this analyte in the composite.
b) To avoid counting the same analyte twice, the oxalate concentration was subtracted from the TOC concentration and NaOH was subtracted from the Na concentration.
c) The Aging Waste Facility tanks, including 241-AZ-101, are grouped with the other double-shell tanks for toxicological analysis.

DST = double-shell tank.

Table 3-12. Sum-of-Fractions for Risk Evaluation Guidelines for a Unit Release of Waste Chemicals. (excerpt from Table 3.4.1-13 of the FSAR)

Tank waste type	Maximum individual	Sum-of-fractions (s/L) as a function of accident frequency (1/yr)		
		$1 - 10^{-2}$	$10^{-2} - 10^{-4}$	$10^{-4} - 10^{-6}$
DST solid or liquid continuous release				
DST liquids	Onsite	1.0 E+04	7.5 E+02	2.1 E+02
	Offsite	8.4 E+00	8.4 E+00	6.2 E-01
DST solids	Onsite	1.8 E+04	3.3 E+03	6.3 E+02
	Offsite	1.9 E+02	1.5 E+01	2.8 E+00
DST solid or liquid puff release				
DST liquids	Onsite	2.9 E+03	2.2 E+02	6.0 E+01
	Offsite	3.4 E-02	3.4 E-02	2.5 E-03
DST solids	Onsite	5.2 E+03	9.7 E+02	1.8 E+02
	Offsite	7.7 E-01	5.9 E-02	1.1 E-02

Note: The Aging Waste Facility tanks are grouped with the other double-shell tanks for the toxicological analysis.

3.4.2 Design Basis Accidents

3.4.2.1 Unfiltered Release of Radionuclides and Toxic Aerosols From the Tank. In the following sections, potential releases of radioactive and hazardous materials resulting from HEPA filter failures are evaluated.
Section 3.4.2.1.1 evaluates the scenario of HEPA filter plugging due to aerosol generation. Section 3.4.2.1.2 presents an accident analysis of HEPA filter failure due to overpressure. Section 3.4.2.1.3 presents an accident analysis of HEPA filter failure caused by exposure to high temperatures, and Section 3.4.2.1.4 presents the accident analysis for an unfiltered release.

3.4.2.1.1 HEPA Filter Plugging Due to Mixer Pump Aerosols Generation. The consequences resulting from HEPA filter plugging and subsequent damage caused by moisture overload are reduced by TWRS TSR AC 5.18. This requirement includes limiting the radioactive material inventories on HEPA filters, High-Efficiency Mist Eliminators (HEMEs), and High-Efficiency Gas Absorbers (HEGAs) and to ensure the capability of the HEPA filters, HEMEs, and HEGAs to mitigate the consequences of specific accident scenarios. Surveillances are also performed by checking the pressure drop across the filters. Therefore, any trending toward HEPA filter plugging due to mixer pump and/or ALC operation will be detected, and corrective action taken. The following paragraphs discuss the process by which this conclusion was reached.

Wong and Waters 1994 attempted to evaluate the ability of a ventilation system to provide adequate de-entrainment of liquid and solid aerosols during mixer pump operations, and to determine if the radioactive aerosols will overload the HEPA filters.

Wong and Waters 1994 concluded that insufficient data exist to confidently estimate the magnitude of aerosol generation during tank waste mixer pump operations. However, it was noted by Wong and Waters 1994 that, qualitatively, aerosol generation would not be expected to be a severe problem

during full-scale operations due to (1) the existing cooling system being able to handle the additional heat generated from mixer pump operations so that significant vapor rates are not expected to carry aerosols beyond the condensers (20,000,000 Btu/h cooling capacity), (2) aerosol testing conducted during mixer pump testing in Tank 241-AP-102 did not indicate a significant increase in aerosols (also, surface agitation as viewed by a camera indicated less disturbance than that produced by air lift circulators), and (3) development tests indicate that 241-AZ-702 will also adequately control the aerosol generation (FSAR Addendum 3).

In addition, as stated in a letter report by Ligotke et al. 1994, analysis shows the operation of the two mixer pumps may increase the generation of aerosols slightly over normal storage operations without air lift circulators (ALCs) operating but that the aerosol generation would be less than that expected for normal storage operation with ALCs operating. Temperature variations are considered to be small contributors to aerosol generation, as compared to physical agitation, so that these analyses adequately bound worst-case expected temperature conditions in the tank.

The values used in this document to calculate the amount of aerosolized liquid in the vapor space bound operations with the mixer pumps alone, the ALCs alone, and the mixer pumps and ALCs together. This is based on the information provided above along with the following discussions. The partition fraction of 1×10^{-8} used in the TWRS FSAR (Kimura and Lindsey 1987) is based on a test report which published measured values in various waste tanks. Attachment 9 of Himes 1998 added specific justification for the partition fraction used, based on test results from 1995. Since the consequences do not approach the risk evaluation guidelines, confirmation testing is not required at this time.

Two off-normal situations are considered. The first is the failure of the ventilation system heater (in either the 241-A-702 or 241-AZ-702 systems). This failure would result in condensation build-up in the ventilation ducting. The second failure scenario considered is the situation where mixer pump and/or ALC aerosol generation rates exceed the upstream equipment's (de-entrainers in the 241-A-702 system, or the high-efficiency mist eliminator [HEME] and high-efficiency gas absorber [HEGA] in the 241-AZ-702 system) capabilities to prevent wetting of HEPA filters (by allowing increased liquid carryover). This release is mitigated through the implementation of AC 5.18, addressing radioactive material maximum loading on HEPA filters (Section 3.4.2.1.2).

3.4.2.1.2 HEPA Filter Failure Due to Overpressure.

3.4.2.1.2.1 HEPA Filter Failure Due to Overpressure Accident Scenario. The HEPA Filter Failure due to overpressure accident is an AWF Design Basis Accident documented in Section 3.3.2.4.2, "High-Efficiency Particulate Air Filter Failure-Exposure to High Temperature or Pressure," of the FSAR and supported by Himes 1998, which was used in Addendum 1 of the FSAR analysis. However, this accident scenario requires additional evaluation due to the

assumption that mixer pump operation could result in (1) an increased contribution to the initial filter loading dose consequences due to the increased AWF solids in the airstream above that analyzed in Addendum 1 of the FSAR, and (2) the release of higher levels of AWF solids entrained in the liquid during a continuous unfiltered release. Thus, the potential release of increased AWF solid waste requires a re-assessment of the consequences calculated in the FSAR Addendum 1.

This section evaluates the consequences of an unprevented HEPA filter failure due to overpressure accident scenario using the same initial assumptions as were used in the FSAR analysis (i.e., using the maximum radionuclide loading on HEPA filters equating to a dose rate of 200 mrem/h). Therefore, all consequences given in this FSAR Addendum for this scenario are considered to contain some degree of mitigation. Filter failure due to overpressure is postulated to require a mechanism such as hydrogen deflagration, which is an anticipated event without controls (Section 3.4.2.2, Flammable Gas Deflagration," of the FSAR). The estimated frequency for this accident scenario (deflagration in Tank 241-AZ-101 during the mixer pump test with a complete filter failure due to overpressure), was determined to be extremely unlikely. This frequency determination is based on the configuration of the ventilation systems and the duration of the mixer pump test as well as the assertion that the potential for a waste disturbance to generate a gas release event of sufficient magnitude to be beyond the capabilities of the tank ventilation system is very small (based on available characterization data for Tank 241-AZ-101, refer to Section 3.4.3.2.1, "Gas Release Event," of this addendum). For the 241-AZ-702 ventilation system (see FSAR Addendum 3 and Himes 1998 for additional details), there is one HEME, followed by two parallel filtration trains, each of which contains three filtration elements in series (two HEPA filters, and a HEGA), remotely located from each of the AWF tanks that would have to fail to varying degrees for this accident scenario. The varying degrees of failure for these pieces of equipment relate to the physical mechanisms involved for each component during a pressure pulse. For the HEME and the HEGA, which are not designed specifically for particulate filtration, the pressure pulse results in a temporary decrease in decontamination efficiency and carryover of additional liquids through the equipment. For the analysis regarding the HEPA filters, however, the pressure pulse results in a permanent rupture of the filtration media. For the 702-A ventilation system, the pressure pulse from a deflagration accident would be dampened by approximately one-quarter mile of 20-inch diameter ventilation ducting and two de-entrainers (similar "failure" mechanism as discussed above for a HEGA and/or a HEME) (Section 2.4.3.7.1 of the FSAR for additional details). The accident frequency is further reduced when considering that the mixer pump test has an anticipated duration of 1,300 hours, or 0.15 year. Based on the above considerations, the likelihood of a deflagration event occurring during the approximate 1,300 hour time period of the mixer pump test with a sufficiently powerful pressure pulse to fail the HEPA filters is considered to be extremely unlikely (frequency of 10^{-4} to 10^{-6} per year). These findings are also applicable to the currently anticipated 241-AZ-702 ventilation system (four elements in series that would have to fail to varying degrees).

In this scenario, the failure due to overpressure of the ventilation system filters is assumed to be followed by the active ventilation of the tank headspace. This would be a puff release (i.e., the loss of the HEPA filters) followed by a continuous release of unfiltered airflow as the system continues to operate for 10 minutes (the time necessary for the ventilation system stack CAM interlock system [LCO 3.1.4] to shut down a ventilation system).

The accident involving failure due to overpressure of the inlet HEPA filters (only existing on the 241-AZ-702 ventilation system) was considered during the HazOp study. It is true that this accident has a higher frequency than the accident involving the downstream filters, but the consequences are significantly lower. The consequences of the HEPA filter failure due to overpressure evaluated in this FSAR Addendum derive from two separate source terms: (1) radioactivity previously entrained on the HEPA filters and released during the accident, and (2) radioactivity released from continued 24 hours operation of the ventilation system with no filtration. The consequences are dominated by the 24-hour release scenario. It is unlikely that the inlet HEPA filter would be as heavily loaded as the downstream HEPA filters, but even if it were, the consequences of an inlet filter failure due to overpressure would be about three orders of magnitude less than a complete failure of the downstream filtration system. The ventilation system would continue to operate, provide negative pressure on the tank, and exhaust tank headspace vapors through the downstream HEPA filters.

The first step of the analysis is to evaluate the HEPA filter loading of particulates. To determine the consequences of releasing the accumulated particulates in a puff release, it is conservatively assumed that a combination of aging waste solid and liquid waste constituents accumulate on the filters (i.e., waste re-condenses downstream of either the de-entrainers or the HEME/HEGA [241-A-702 or 241-AZ-702 ventilation systems, respectively]) during the mixer pump test. This assumption provides consequences which bound the scenarios of quiescent waste storage, mixer pump test alone, or mixer pump test in combination with Tank 241-C-106 sluicing retrieval to Tank 241-AY-102, since the filter solids-loading assumptions made for the mixer pump test (10% aging waste solids entrainment) shows more severe consequences than those for the sluicing retrieval addressed in FSAR Addendum 1 (i.e., due to the higher dose contribution from AWF solids for the mixer pump test than those described for the sluicing retrieval of Tank 241-C-106 ([Himes 1998]). The next step is to evaluate the continuous flow contribution, conservatively assuming mixed waste aerosols (term "mixed waste" used in this document to denote a composite of liquids and solids as opposed to the regulatory usage of radioactive and hazardous wastes) are released due to mixer pump re-suspension. Two scenarios are investigated for this unfiltered release: (1) the release with the mixer pump test being performed in Tank 241-AZ-101, and (2) the release with the combination of the mixer pump test and the sluicing retrieval into Tank 241-AY-102. The final step is to determine the radiological and toxicological consequences of this accident scenario.

3.4.2.1.2.2 HEPA Filter Failure Due to Overpressure Accident Source Term.

A. Source Term from the Filter

The consequences of a HEPA filter failure due to overpressure are dependent upon the initial filter loading and the loading in the ventilation ductwork and other components. For the 241-AZ-702 ventilation system, the amount of material released would be that from both banks of filters (two HEPA filters and one HEGA in series in each of two parallel ventilation trains), and additional volume equivalents to account for the loading in the HEME, HEGA, and the ventilation duct work (see Himes 1998 for details regarding determination of the filter loading equivalents). For the 241-A-702 ventilation system, Himes 1998 considers 2 de-entrainers, condensers, a heater, and 6 banks of 2 HEPA filters each.

From Himes 1998, the maximum total amount of material potentially released for the overpressure event is found to be 3.62 E-2 L for the 241-A-702 ventilation system and 2.33 E-2 L for the 241-AZ-702 ventilation system. The value from the 241-A-702 ventilation system is bounding. These results are based on considering ^{137m}Ba and ^{60}Co as the predominant gamma emitters for the AWF source material for the liquids and solids (the other gamma emitters have much smaller concentrations). However, because of the agitation of the tank solids into the supernatant, this analysis must take into account gamma contributors from the solids within the tank as well as the contributors from the liquids. Therefore, the ULD (radiological) and SOF (toxicological) values used in this analysis will be a weighted average of the values given in Lambert 1998 for AWF liquids and solids with an additional margin to allow for future variations in the tank liquid and solid inventory due to precipitation or dissolution of solids, and/or evaporation of liquid or addition of low activity liquids (e.g., flush water or caustic additions) (10% solids and 90% liquid). In addition, a maximum loading on the filter is assumed to be no greater than the activity that would result from the maximum allowable loading before filter change-out (AC 5.18). The amount of material on the filter is based on the Himes 1998 calculation note, as this bounds the amount of material which could be on the filter under quiescent operations, Tank 241-AZ-101 Mixer Pump Test alone, or Tank 241-AZ-101 Mixer Pump Test in conjunction with Tank 241-C-106 sluicing retrieval into Tank 241-AY-102.

B. Source Term Released from Unfiltered Operation of the Ventilation System

For the 241-AZ-702 ventilation system, the design airflow through the ventilation system is 4.7 x 10^{-1} m^3/s (1,000 cubic feet per minute [CFM]). Also for 241-AZ-702, the rate used for the unfiltered continuous release of the ventilation system assumes the simultaneous operation of both fans or 9.4 x 10^{-1} m^3/s (2,000 CFM) to bound the scenario. For the 241-A-702 ventilation system, the design airflow through the system is 1.89 m^3/s (4,000 CFM), which is more limiting.

With the mixer pumps running in Tank 241-AZ-101 during unfiltered operation of the ventilation system, it is assumed that the supernatant and sludge is homogeneously mixed. This requires modification of the ULDs listed

in Table 3-9 of this addendum to reflect the presence of sludge particles in aerosols released to the tank headspace. The ULDs for the liquid/sludge mixture are calculated using the liquid and solid ULDs given in Table 3-9 of this addendum and the volume fractions of liquid and sludge in Tank 241-AZ-101,

$$ULD_{mix} = (f_1 \times ULD_{liq}) + (f_2 \times ULD_{sol})$$

where:

f_1 = 0.90, bounding volume fraction of liquid in Tank 241-AZ-101

f_2 = 0.10, bounding volume fraction of solids in Tank 241-AZ-101

ULD_{liq} = unit liter dose for AWF liquids (Table 3-9 of this addendum)

ULD_{sol} = unit liter dose for AWF solids (Table 3-9 of this addendum)

Using the above formula, the Inhalation and Ingestion ULDs for Tank 241-AZ-101 mixed liquids and solids are calculated to be:

Inhalation ULD_{mix} (Sv/L) = 1.7×10^5

Ingestion ULD_{mix} (Sv-m^3/s-L) = 0.89

The source term released from unfiltered operation of the ventilation system is drawn from all four AWF tanks, but the mixer pumps operate only in one tank. However, because there are no controls preventing full system flow being drawn through Tank 241-AZ-101, it will be conservatively assumed that the ULD of the material being exhausted through the ventilation system is the ULD for the mixed liquids and solids. With this assumption, the calculations performed for the loss of ventilation filter scenarios bound the performance of the mixer pump either before, during, or after the sluicing retrieval performed into Tank 241-AY-102 (FSAR Addendum 1). This is true because the source term assumption (total ventilation stream at 10% AWF solids) yields a higher source term than that used for FSAR Addendum 1.

3.4.2.1.2.3 HEPA Filter Failure Due to Overpressure Accident Offsite Radiological Consequence Analysis.

A. Offsite Radiological Consequence for a Puff Release from Filter Failure Due to Overpressure

The CEDE for inhalation for offsite consequences for the loss of a HEPA filter can be found using the following equation:

$$D_{inh\text{-}filter}(Sv) = Q(L) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right]$$

where:

$D_{inh-filter}$ = dose due to inhalation

Q = source term

χ/Q' = atmospheric dispersion coefficient

R = breathing rate

ULD_{inh} = inhalation unit liter dose

The type of material accumulating on the AWF filters is from the AWF liquids and solids being deposited on the filter from mixer pump test normal ventilation air flow. The committed effective dose equivalent (CEDE) for offsite filter consequence is found from Himes 1998 to be:

$D_{inh-filter}$ = 5.75×10^{-5} Sv (5.75×10^{-3} rem)

The CEDE for ingestion for offsite consequences for the loss of a HEPA filter can be found using the following equation:

$$D_{ing}(Sv) = Q(L) \times \frac{\chi}{Q'} \left[\frac{s}{m^3}\right] \times ULD_{ing} \left[\frac{Svm^3}{s-L}\right]$$

where:

D_{ing} = dose due to ingestion

Q = source term

χ/Q' = atmospheric dispersion coefficient

ULD_{ing} = ingestion unit liter dose

The CEDE for offsite consequence is found from Himes 1998 to be:

$D_{ing\ filter}$ = 9.12×10^{-7} Sv (9.12×10^{-5} rem)

B. Offsite Radiological Consequence for 10 Minutes Continuous Venting After Filter Failure due to Overpressure

The duration of 10 minutes was selected to represent the continued venting of the system until the ventilation system stack continuous air monitor interlock shuts down the ventilation system (LCO 3.1.4). Radioactive material is carried from the tank waste material into the tank vapor space atmosphere through several physical processes. Only a fraction of the liquid waste constituents, the partition fraction (PF), in a tank will migrate into the vapor space atmosphere. The PF for AWF tanks is found to be 1×10^{-8} under the worst case liquid waste agitation conditions (based on experimental results published in Kimura and Lindsey 1987 for agitated (1.0×10^{-8}) and

unagitated (1.0×10^{-10}) tanks under active and passive ventilation, as used in the TWRS FSAR consequence analysis and the analysis of the FSAR Addendum 1. The value bounds severe waste surface agitation, such as ALC operation and tank boiling.

The amount of mixed waste released by operating the ventilation system can be found by:

$$V_{release\ rate} = V_{rate} \times PF$$

$$V_{release\ rate} = (1.89 \times 10^{3}\ L/s) \times (1 \times 10^{-8})$$

$$V_{release\ rate} = 1.89 \times 10^{-5}\ L/s$$

where:

V_{rate} = 1.89×10^{3} L/s (4,000 CFM)

PF (Kimura and Lindsey 1987) = 1×10^{-8}

For the 10-minute unfiltered release, the volume of released material is 1.13×10^{-2} L. The corresponding inhalation dose for this release volume is calculated in Himes 1988 as 1.8×10^{-5} Sv (1.8×10^{-3} rem).

The CEDE for ingestion for offsite consequences for the continued release for 10 minutes after the loss of a HEPA filter is calculated in Himes 1998 as 2.86×10^{-7} Sv (2.86×10^{-5} rem).

C. Total Offsite Radiological Consequence

Total offsite consequences ($D_{offsite}$) for HEPA filter failure due to overpressure is the sum of the filter offsite consequences and the unfiltered operation of the ventilation system offsite consequences. The total offsite consequence is found to be:

$$D_{offsite} = D_{inh\text{-}filter} + D_{ing\ filter} + D_{inh\ vent} + D_{ing\ vent}$$

$$D_{offsite} = 5.72 \times 10^{-5}\ Sv + 9.12 \times 10^{-7}\ Sv + 1.8 \times 10^{-5}\ Sv + 2.88 \times 10^{-7}\ Sv$$

$$D_{offsite} = 7.7 \times 10^{-5}\ Sv\ (7.7 \times 10^{-3}\ rem)$$

This value for the 241-A-702 ventilation system bounds the lower flow rate and source term from the 241-AZ-702 ventilation system.

3.4.2.1.2.4 HEPA Filter Failure Due to Overpressure Onsite Radiological Consequence.

A. Onsite Radiological Consequence For a Puff Release from Filter Failure Due to Overpressure

The CEDE for onsite consequences for the HEPA filter is found using the same methodology and equation (Section 3.4.2.1.2.3.A of this addendum) as for the offsite. The CEDE for onsite consequence is found in Himes 1998 to be:

$$D_{inh\text{-}filter} = 6.93 \times 10^{-2} \text{ Sv } (6.93 \text{ rem})$$

B. Onsite Radiological Consequence for 10 Minute Continuous Release After Filter Failure Due to Overpressure

Using the same equations as in Section 3.4.2.1.2.3 of this addendum, the CEDE for onsite consequences from the continuous release is found from Himes 1998 to be:

$$D_{inh\ vent} = 2.17 \times 10^{-2} \text{ Sv } (2.17 \text{ rem})$$

C. Total Onsite Radiological Consequence

Total onsite consequences (D_{onsite}) for HEPA filter failure due to overpressure is the sum of the puff and the continuous releases. This is found to be:

$$D_{onsite} = D_{inh\text{-}filter} + D_{inh\ vent}$$

$$D_{onsite} = 6.93 \times 10^{-2} \text{ Sv} + 2.17 \times 10^{-2} \text{ Sv}$$

$$D_{onsite} = 9.1 \times 10^{-2} \text{ Sv } (9.1 \text{ rem})$$

This value for the 241-A-702 ventilation system bounds the lower flow rate and source term from the 241-AZ-702 ventilation system.

3.4.2.1.2.5 HEPA Filter Failure Due to Overpressure Toxicological Consequences. The toxicological consequences for the HEPA filter failure due to overpressure can be found using the method outlined in Section 3.4.1.2 of the FSAR and the assumptions listed in Section 3.4.1.2 of this addendum. The unmitigated, unprevented HEPA filter failure due to overpressure accident frequency was determined to be extremely unlikely. The amount of material released from the filter was determined to be 3.62×10^{-2} L which can be modeled conservatively as a two minute continuous release (main body of Himes 1998). The release rate for operation of the ventilation system without filters is 1.89 m^3/s (4,000 CFM) and is a continuous type release.

A. HEPA Filter Failure Due to Overpressure Toxicological Consequences Due to the Filter Release

As with the radiological source term, the type of material accumulating on Tank 241-AZ-101 filters is from liquids and solids being deposited on the filters from the mixer pump test (Sections 3.4.2.1.2.3 and 3.4.2.1.1 of this

addendum). To obtain the SOF for the release of the liquids and solids on the filter media, the SOF for the AWF liquids and solids for the filter release for the extremely unlikely event (Table 3-12 of this addendum) must be adjusted (as in Section 3.4.2.1.2.2 of this addendum) to account for the percentage of solids in the aerosol stream as well as the fact that only one of the four tanks in the Aging Waste Facility will be emitting the increased solids levels as a result of the mixer pump test. This adjusted SOF can be obtained from:

$$SOF_{mix\ filter\ off} = (f_1 \times SOF_{liq\ cont\ off}) + (f_2 \times SOF_{sol\ cont\ off})$$

Using the above equation, the offsite SOF for the liquid/solid mix is calculated to be:

$$SOF_{mix\ filter\ off} = 8.4 \times 10^{-1}\ s/L$$

The consequences for the offsite receptor from a filter failure due to overpressure unmitigated filter release is:

$$T_{filter\ off} = V_{released} \times SOF_{mix\ filter\ off}$$

For the 241-A-702 system:

$$T_{filter\ off} = (3.03 \times 10^{-4}\ L/s) \times (8.4 \times 10^{-1}\ s/L)$$

$$T_{filter\ off} = 2.5 \times 10^{-4}$$

where:

$$V_{released} = 3.62 \times 10^{-2}\ L\ \text{(Section 3.4.2.1.2.2 of this addendum)}/120\ s = 3.03 \times 10^{-4}\ L/s$$

For the 241-AZ-702 system:

$$T_{filter\ off} = (1.94 \times 10^{-4}\ L/s) \times (8.4 \times 10^{-1}\ s/L)$$

$$T_{filter\ off} = 1.6 \times 10^{-4}$$

where:

$$V_{released} = 2.33 \times 10^{-2}\ L\ \text{(Section 3.4.2.1.2.2 of this addendum)}/120\ s = 1.94 \times 10^{-4}\ L/s$$

For the onsite receptor, the SOF for an extremely unlikely event are also calculated in the same fashion as for the offsite receptor (i.e., adjusting the SOF to account for the percentage of solids in the aerosols). As above, the adjusted SOF can be obtained from:

$$SOF_{mix\ puff\ on} = (f_1 \times SOF_{liq\ cont\ on}) + (f_2 \times SOF_{sol\ cont\ on})$$

$$SOF_{mix\ filter\ on} = 2.5 \times 10^{-2}\ s/L$$

The consequence for the onsite receptor from a filter failure due to overpressure unmitigated filter release is:

$$T_{filter\ on} = V_{released} \times SOF_{mix\ filter\ on}$$

For the 241-A-702 system:

$$T_{filter\ on} = (3.03 \times 10^{-4}\ L/s) \times (2.5 \times 10^{2}\ s/L)$$

$$T_{filter\ on} = 7.6 \times 10^{-2}$$

For the 241-AZ-702 system:

$$T_{filter\ on} = (1.94 \times 10^{-4}\ L/s) \times (2.5 \times 10^{2}\ s/L)$$

$$T_{filter\ on} = 4.9 \times 10^{-2}$$

B. HEPA Filter Failure Due to Overpressure Toxicological Consequences Due to a Continuous Release Following the Filter Failure

For the continuous release, the offsite SOF for an extremely unlikely event are calculated considering a liquid/sludge mixture source term.

$$SOF_{mix\ cont\ off} = (f_1 \times SOF_{liq\ cont\ off}) + (f_2 \times SOF_{sol\ cont\ off})$$

where:

f_1 = 0.90, bounding volume fraction of liquid in Tank 241-AZ-101

f_2 = 0.10, bounding volume fraction of solids in Tank 241-AZ-101

$SOF_{liq\ cont\ off}$ = for DST liquids (Table 3-12 of this addendum) = 6.2×10^{-1} s/L

$SOF_{sol\ cont\ off}$ = for DST solids (Table 3-12 of this addendum) = 2.8×10^{0} s/L

Using the above formula, the SOF for Tank 241-AZ-101 mixed liquids and solids is calculated to be:

$$SOF_{mix\ cont\ off} = 8.4 \times 10^{-1}\ s/L$$

The consequence for the offsite receptor from the loss of an AWF filter is:

$$T_{cont\ off} = V_{released} \times SOF_{mix\ cont\ off}$$

For the 241-A-702 system:

$T_{cont\ off}$ = $(1.89 \times 10^{-5}$ L/s) x $(8.4 \times 10^{-1}$ s/L)

$T_{cont\ off}$ = 1.6×10^{-5}

For the 241-AZ-702 system:

$T_{cont\ off}$ = $(9.4 \times 10^{-6}$ L/s) x $(8.4 \times 10^{-1}$ s/L)

$T_{cont\ off}$ = 7.9×10^{-6}

For the onsite receptor, the SOF for an extremely unlikely event is also calculated in the same fashion as for the offsite receptor for the liquid/sludge mixture.

$SOF_{mix\ cont\ on}$ = $(f_1 \times SOF_{liq\ cont\ on}) + (f_2 \times SOF_{sol\ cont\ on})$

where:

f_1 = 0.90, bounding volume fraction of liquid in Tank 241-AZ-101

f_2 = 0.10, bounding volume fraction of solids in Tank 241-AZ-101

$SOF_{liq\ cont\ on}$ = for DST liquids (Table 3-12 of this addendum)
= 2.1×10^2 s/L

$SOF_{sol\ cont\ on}$ = for DST solids (Table 3-12 of this addendum)
= 6.3×10^2 s/L

Using the above formula, the SOF for Tank 241-AZ-101 mixed liquids and solids is calculated to be:

$SOF_{mix\ cont\ on}$ = 2.5×10^2 s/L

The consequence for the onsite receptor from the loss of an AWF filter is:

$T_{cont\ on}$ = $V_{released} \times SOF_{mix\ cont\ on}$

For the 241-A-702 system:

$T_{cont\ on}$ = $(1.89 \times 10^{-5}$ L/s) x $(2.5 \times 10^2$ s/L)

$T_{cont\ on}$ = 4.76×10^{-3}

For the 241-AZ-702 system:

$T_{cont\ on}$ = $(9.4 \times 10^{-6}$ L/s) x $(2.5 \times 10^2$ s/L)

$T_{cont\ on}$ = 2.38×10^{-3}

C. Sum of the Offsite Toxicological Consequence

The sum of the offsite filter release toxicological consequence and the offsite continuous release toxicological consequence gives the total offsite toxicological consequence:

$$T_{total\ off} = T_{filter\ off} + T_{cont\ off}$$

For the 241-A-702 system:

$$T_{total\ off} = 2.5 \times 10^{-4} + 1.6 \times 10^{-5}$$

$$T_{total\ off} = 2.7 \times 10^{-4}$$

For the 241-AZ-702 system:

$$T_{total\ off} = 1.6 \times 10^{-4} + 7.9 \times 10^{-6}$$

$$T_{total\ off} = 1.7 \times 10^{-4}$$

D. Sum of the Onsite Toxicological Consequence

The sum of the onsite filter release toxicological consequence and the onsite continuous release toxicological consequence gives the total onsite toxicological consequence:

$$T_{total\ on} = T_{filter\ on} + T_{cont\ on}$$

For the 241-A-702 system:

$$T_{total\ on} = 7.6 \times 10^{-2} + 4.8 \times 10^{-3}$$

$$T_{total\ on} = 8.1 \times 10^{-2}$$

For the 241-AZ-702 system:

$$T_{total\ on} = 4.9 \times 10^{-2} + 2.4 \times 10^{-3}$$

$$T_{total\ on} = 5.1 \times 10^{-2}$$

3.4.2.1.2.6 HEPA Filter Failure Due to Overpressure Accident Comparison to Guidelines. For the overpressure accident, the doses for the HEPA filter failure must be added to the initiating event (e.g., Tank Bump or Deflagration accident) to obtain total doses to compare against Risk Evaluation Guidelines. Consequences are given in these sections so that perspective may be gained regarding the minor contribution of the HEPA filter due to overpressure when compared to the overall consequences of the initiating event (see Sections 3.4.2.2 and 3.4.2.3).

3.4.2.1.2.7 HEPA Filter Failure Due to Overpressure Accident Summary of Safety-Class/Safety-Significant Structures, Systems, and Components (SSC)s and Technical Safety Requirement (TSR) Controls. There are no new Safety SSCs required by this project to either 241-AZ-702 or the 241-AZ-702 ventilation

systems associated with preventing or mitigating the consequences of the HEPA filter failure due to overpressure accident.

The controls (LCO 3.1.4 and AC 5.18) are still required to ensure the consequences of a HEPA filter failure due to overpressure accident remain within assumptions of this analysis:

- LCO 3.1.4 requires that an operable stack continuous air monitor (CAM) interlock system be maintained on the ventilation system. The stack CAM interlock system is credited in the TWRS FSAR accident analyses with terminating an unfiltered release from the primary ventilation systems within 10 minutes.

- AC 5.18 requires the HEPA filters to be maintained such that the dose rate from them is < 200 mrem/h, from the HEME is ≤800 mrem/h, and that the HEGA be changed out at least every 20 changes of the upstream HEPA filter. This ensures that ventilation system loadings do not exceed the values assumed in this addendum.

3.4.2.1.3 HEPA Filter Failure Due to High Temperature

3.4.2.1.3.1 HEPA Filter Failure Due to High Temperature Accident Scenario. The HEPA Filter Failure due to high temperature accident is an AWF Design Basis Accident documented in Section 5.3.2.2 of the TWRS FSAR and supported by Himes 1998, which was used in Addendum 1 of the FSAR. However, this accident scenario requires additional evaluation due to the assumptions that mixer pump operation could result in (1) an increased contribution to the initial filter loading dose consequences due to the increased AWF solids content in the airstream above that analyzed in Addendum 1 of the FSAR, and (2) the release of higher levels of AWF solids entrained in the liquid during a continuous unfiltered release. Thus, the potential release of increased solid (as well as liquid) waste requires a re-assessment of the consequences calculated in the TWRS FSAR Addendum 1.

This section evaluates the consequences of a HEPA filter failure due to high temperature accident scenario using the same initial assumptions as were used in the TWRS FSAR analysis (i.e., using the maximum radionuclide loading on HEPA filters equating to a dose rate of 200 mrem/h). Therefore, all consequences given in this FSAR Addendum for this scenario are considered to contain some degree of mitigation. The estimated frequency for this accident scenario was determined in the FSAR to be "anticipated." However, due to the short duration of the mixer pump test, the frequency for this accident during the mixer pump test was determined for this analysis to be "unlikely" (frequency of 10^{-4} to 10^{-2} per year). These findings are also applicable to the 241-AZ-702 ventilation system.

The high temperature event is assumed to involve a heater failure and fire within the ventilation ductwork or a fire external to the duct which leads to the melting/burning of the HEPA filters (and, for the 241-AZ-702 ventilation system, combustion of the HEGA filter's activated charcoal beds). For the 241-A-702 ventilation system, the two de-entrainers are upstream of the heater and are not subject to release scenarios involving only high temperatures or fire. For the 241-AZ-702 ventilation system, the two filter trains each contain their own heater and the two filter trains are separated by a firewall. Therefore, only one of the filter trains is expected to be affected by a high temperature release. Another assumption for the 241-AZ-702 ventilation system is that the HEME is in a concrete vault and is upstream of the heaters and is therefore not subject to the high temperature release scenario. For both systems, the scenario is conservatively assumed (for purposes of calculating toxicological release rates) that the release takes place approximately uniformly over 2 minutes (120 seconds).

3.4.2.1.3.2 HEPA Filter Failure Due to High Temperature Accident Source Term

A. Source Term from the Filter

Based upon the assumptions outlined for the high temperature scenario (Section 3.4.2.1.3.1) and Himes 1998, the equivalent liters of waste released during the high temperature event for the 241-A-702 ventilation system is 6.19×10^{-5} L, and for the 241-AZ-702 ventilation system, the equivalent liters of waste released is 2.19×10^{-3} L (see Himes 1998 for details regarding determination of the filter loading equivalents). The value from the 241-AZ-702 ventilation system is bounding.

Similar to Section 3.4.2.1.2.2, because of the agitation of the tank solids into the supernatant, this analysis must take into account gamma contributors from the solids within the tank as well as the contributors from the liquids. Therefore, the ULD (radiological) and SOF (toxicological) values used in this analysis will once again be a weighted average of the values given in Lambert 1998 for AWF liquids and solids with an additional margin to allow for future variations in the tank liquid and solid inventory due to precipitation or dissolution of solids, and/or evaporation of liquid or addition of low activity liquids (e.g., flush water or caustic additions) (10% solids and 90% liquid). In addition, a maximum loading on the filter is assumed to be no greater than the activity that would result in maximum allowable loading before filter change-out (TWRS TSR AC 5.18). The amount of material on the filter will be taken from the Himes 1998 calculation note, as this bounds the amount of material which could be on the filter under quiescent operations, Tank 241-AZ-101 Mixer Pump Test alone, or Tank 241-AZ-101 Mixer Pump Test in conjunction with Tank 241-C-106 sluicing retrieval into Tank 241-AY-102.

B. Source Term Released from Unfiltered Operation of the Ventilation System

For the 241-AZ-702 ventilation system, the design airflow through the ventilation system is 4.7×10^{-1} m^3/s (1,000 cubic feet per minute [CFM]). Also for 241-AZ-702, the rate used for the unfiltered continuous release of the ventilation system assumes the simultaneous operation of both fans or 9.4×10^{-1} m^3/s (2,000 CFM) to bound the scenario. For the 241-A-702

ventilation system, the design airflow through the system is 1.89 m^3/s (4,000 CFM), which is more limiting. Because, for this accident scenario, the 241-AZ-702 vent system has the bounding equivalent release, while the 241-A-702 vent system has the bounding release rate (for the overpressure accident, the 241-A-702 vent system was bounding in both of these parameters), the doses from both of these systems will be provided in this analysis.

As shown in Section 3.4.2.1.2.2.B, the Inhalation and Ingestion ULDs for Tank 241-AZ-101 mixed liquids and solids are calculated to be:

Inhalation ULD_{mix} (Sv/L) = 1.7×10^5
Ingestion ULD_{mix} (Sv-m^3/s-L) = 0.89

The source term released from unfiltered operation of the ventilation system is drawn from all four AWF tanks, but the mixer pumps operate only in one tank. However, because there are no controls preventing full system flow being drawn through Tank 241-AZ-101, it will be conservatively assumed that the ULD of the material being exhausted through the ventilation system is the ULD for the mixed liquids and solids. With this assumption, the calculations performed for the loss of ventilation filter scenarios bound the performance of the mixer pump either before, during, or after the sluicing retrieval performed into Tank 241-AY-102 (FSAR Addendum 1). This is true because the source term assumption (total ventilation stream at 10% AWF solids) yields a higher source term than that used for FSAR Addendum 1.

3.4.2.1.3.3 HEPA Filter Failure Due to High Temperature Accident Offsite Radiological Consequence Analysis

A. Offsite Radiological Consequence for a Release from Filter Failure Due to High Temperature

Using the methodology outlined in Section 3.4.2.1.2.3.A, the committed effective dose equivalent (CEDE) for offsite consequence is found from Himes 1998 to be:

For the 241-A-702 system:

$D_{inh\text{-}filter}$ = 9.83×10^{-8} Sv (9.83×10^{-6} rem)

$D_{ing\ filter}$ = 1.56×10^{-9} Sv (1.56×10^{-7} rem)

For the 241-AZ-702 system:

$D_{inh\text{-}filter}$ = 3.48×10^{-6} Sv (3.48×10^{-4} rem)

$D_{ing\ filter}$ = 5.52×10^{-8} Sv (5.52×10^{-6} rem)

B. Offsite Radiological Consequence for 10 Minute Continuous Venting After Filter Failure due to High Temperature

Using the methodology outlined in Section 3.4.2.1.2.3.B, for the 10-minute unfiltered release from 241-A-702, the volume of released material is 1.13×10^{-2} L. The corresponding inhalation dose for this release volume is calculated in Himes 1998 as 1.80×10^{-5} Sv (1.80×10^{-3} rem).

For the 241-AZ-702 system, the volume of released material is 5.66×10^{-3} L. The corresponding inhalation dose for this release is calculated in Himes 1998 as 8.99×10^{-6} Sv (8.99×10^{-4} rem).

The CEDE for ingestion for offsite consequences for the continued release for 10 minutes after the loss of a HEPA filter due to high temperature of the 241-A-702 vent system is calculated in Himes 1998 as 2.86×10^{-7} Sv (2.86×10^{-5} rem).

For the 241-AZ-702 vent system, the CEDE for ingestion for offsite consequences for the 10 minute release is calculated in Himes 1998 to be 1.43×10^{-7} Sv (1.43×10^{-5} rem).

C. Total Offsite Radiological Consequence

Total offsite consequences ($D_{offsite}$) for HEPA filter failure due to high temperature is the sum of the filter offsite consequences and the unfiltered operation of the ventilation system offsite consequences. The total offsite consequence is found to be:

$$D_{offsite} = D_{inh\text{-}filter} + D_{ing\ filter} + D_{inh\ vent} + D_{ing\ vent}$$

For the 241-A-702 system:

$$D_{offsite} = 9.83 \times 10^{-8}\ \text{Sv} + 1.56 \times 10^{-9}\ \text{Sv} + 1.80 \times 10^{-5}\ \text{Sv} + 2.86 \times 10^{-7}\ \text{Sv}$$

$$D_{offsite} = 1.8 \times 10^{-5}\ \text{Sv}\ (1.8 \times 10^{-3}\ \text{rem})$$

For the 241-AZ-702 system:

$$D_{offsite} = 3.48 \times 10^{-6}\ \text{Sv} + 5.52 \times 10^{-8}\ \text{Sv} + 8.99 \times 10^{-6}\ \text{Sv} + 1.43 \times 10^{-7}\ \text{Sv}$$

$$D_{offsite} = 1.3 \times 10^{-5}\ \text{Sv}\ (1.3 \times 10^{-3}\ \text{rem})$$

3.4.2.1.3.4 HEPA Filter Failure Due to High Temperature Onsite Radiological Consequence

A. Onsite Radiological Consequence For a Release from Filter Failure Due to High Temperature

The CEDE for onsite consequences for the HEPA filter is found using the same methodology and equation (see Section 3.4.2.1.2.3.A of this addendum) as for the offsite. The CEDE for onsite consequence is found in Himes 1998 to be:

For the 241-A-702 system:

$D_{inh\text{-}filter}$ = 1.18×10^{-4} Sv (1.18×10^{-2} rem)

For the 241-AZ-702 system:

$D_{inh\text{-}filter}$ = 4.19×10^{-3} Sv (4.19×10^{-1} rem)

B. Onsite Radiological Consequence for 10 minute Continuous Release After Filter Failure Due to High Temperature

Using the same equations as in Section 3.4.2.1.2.3 of this addendum, the CEDE for onsite consequences from the continuous release is found from Himes 1998 to be:

For the 241-A-702 system:

$D_{inh\ vent}$ = 2.17×10^{-2} Sv (2.17 rem)

For the 241-AZ-702 system:

$D_{inh\ vent}$ = 1.08×10^{-2} Sv (1.08 rem)

C. Total Onsite Radiological Consequence

Total onsite consequences (D_{onsite}) for HEPA filter failure due to high temperature is the sum of the filter and the continuous releases. This is found to be:

D_{onsite} = $D_{inh\text{-}filter} + D_{inh\ vent}$

For the 241-A-702 system:

D_{onsite} = 1.18×10^{-4} Sv + 2.17×10^{-2} Sv

D_{onsite} = 2.2×10^{-2} Sv (2.2 rem)

For the 241-AZ-702 system:

D_{onsite} = 4.19×10^{-3} Sv + 1.08×10^{-2} Sv

D_{onsite} = 1.5×10^{-2} Sv (1.5 rem)

3.4.2.1.3.5 HEPA Filter Failure Due to High Temperature Toxicological Consequences. The toxicological consequences for the HEPA filter failure due to high temperature can be found using the method outlined in Section 3.4.2.1.2.5 of this addendum. The unmitigated HEPA filter failure due to high temperature accident frequency was determined to be unlikely. The amount of material released from the filter was determined from Himes 1998 to be 6.19×10^{-5} L for the 241-A-702 ventilation system and 2.19×10^{-5} L for the 241-AZ-702 ventilation system, and is a continuous release over 2 minutes. The release rate for operation of the ventilation system without filters is 1.89 m^3/s (4,000 CFM) for the 241-A-702 vent system and 0.94 m^3/s (2,000 CFM) for the 241-AZ-702 vent system, and is a continuous type release.

A. HEPA Filter Failure Due to High Temperature Toxicological Consequences Due to the Filter Release

As with the overpressure accident scenario of 3.4.2.1.2.5, to obtain the SOF for the release of the liquids and solids on the filter media, the SOF for the AWF liquids and solids for the filter release for the unlikely event (Table 3-12 of this addendum) must be adjusted to account for the percentage of solids in the aerosol stream. This results in:

$$SOF_{mix\ filter\ off} = (f_1 \times SOF_{liq\ cont\ off}) + (f_2 \times SOF_{sol\ cont\ off})$$

Using the above equation, the SOF for the liquid/solid mix is calculated to be:

$$SOF_{mix\ filter\ off} = 9.1\ s/L$$

The consequences for the offsite receptor from a filter failure due to over-temperature unmitigated filter release is:

$$T_{filter\ off} = V_{released} \times SOF_{mix\ filter\ off}$$

For the 241-A-702 system:

$$T_{filter\ off} = (5.16 \times 10^{-7}\ L/s) \times (9.1\ s/L)$$

$$T_{filter\ off} = 4.7 \times 10^{-6}$$

where:

$$V_{released} = 6.19 \times 10^{-5}\ L\ (\text{Himes } 1998)/120\ s$$

$$= 5.16 \times 10^{-7}\ L/s$$

For the 241-AZ-702 system:

$$T_{filter\ off} = (1.83 \times 10^{-5}\ L/s) \times (9.1\ s/L)$$

$$T_{filter\ off} = 1.65 \times 10^{-4}$$

where:

$V_{released}$ = 2.19×10^{-3} L (Himes 1998)/120 s

= 1.83×10^{-5} L/s

For the onsite receptor, the SOF for an unlikely event are also calculated in the same fashion as for the offsite receptor (i.e., adjusting the SOF to account for the percentage of solids in the aerosols). As above, the adjusted SOF can be obtained from:

$SOF_{mix\ filter\ on}$ = $(f_1 \times SOF_{liq\ cont\ on}) + (f_2 \times SOF_{sol\ cont\ on})$

$SOF_{mix\ filter\ on}$ = 1.0×10^3 s/L

The consequence for the onsite receptor from a filter failure due to high temperature unmitigated filter release is:

$T_{filter\ on}$ = $V_{released} \times SOF_{mix\ filter\ on}$

For the 241-A-702 system:

$T_{filter\ on}$ = $(5.16 \times 10^{-7}$ L/s) x $(1.0 \times 10^3$ s/L)

$T_{filter\ on}$ = 5.2×10^{-4}

For the 241-AZ-702 system:

$T_{filter\ on}$ = $(1.83 \times 10^{-5}$ L/s) x $(1.0 \times 10^3$ s/L)

$T_{filter\ on}$ = 1.8×10^{-2}

B. HEPA Filter Failure Due to High Temperature Toxicological Consequences Due to a Continuous Release Following the Filter Failure

For the continuous release, the SOF for an unlikely event are calculated considering a liquid/sludge mixture source term as in the filter release SOF calculations.

$SOF_{mix\ cont\ off}$ = $(f_1 \times SOF_{liq\ cont\ off}) + (f_2 \times SOF_{sol\ cont\ off})$

Using the above formula, the SOF for Tank 241-AZ-101 mixed liquids and solids is calculated to be:

$SOF_{mix\ cont\ off}$ = 9.1 s/L

The consequence for the offsite receptor from the loss of an AWF filter is:

$T_{cont\ off}$ = $V_{released} \times SOF_{mix\ cont\ off}$

For the 241-A-702 system:

$T_{cont\ off}$ = $(1.89 \times 10^{-5}$ L/s) x (9.1 s/L)

$T_{cont\ off}$ = 1.7×10^{-4}

For the 241-AZ-702 system:

$T_{cont\ off} = (9.44 \times 10^{-6}\ L/s) \times (9.1\ s/L)$

$T_{cont\ off} = 8.6 \times 10^{-5}$

For the onsite receptor, the SOF for an unlikely event is also calculated in the same fashion as for the offsite receptor for the liquid/sludge mixture.

$SOF_{mix\ cont\ on} = (f_1 \times SOF_{liq\ cont\ on}) + (f_2 \times SOF_{sol\ cont\ on})$

Using the above formula, the SOF for Tank 241-AZ-101 mixed liquids and solids is calculated to be:

$SOF_{mix\ cont\ on} = 1.0 \times 10^3\ s/L$

The consequence for the onsite receptor from the loss of an AWF filter is:

$T_{cont\ on} = V_{released} \times SOF_{mix\ cont\ on}$

For the 241-A-702 system:

$T_{cont\ on} = (1.89 \times 10^{-5} L/s) \times (1.0 \times 10^3\ s/L)$

$T_{cont\ on} = 1.9 \times 10^{-2}$

For the 241-AZ-702 system:

$T_{cont\ on} = (9.44 \times 10^{-6} L/s) \times (1.0 \times 10^3\ s/L)$

$T_{cont\ on} = 9.5 \times 10^{-3}$

C. Sum of the Offsite Toxicological Consequence

The sum of the offsite filter release toxicological consequence and the offsite continuous release toxicological consequence gives the total offsite toxicological consequence:

$T_{total\ off} = T_{filter\ off} + T_{cont\ off}$

For the 241-A-702 ventilation system:

$T_{total\ off} = 4.7 \times 10^{-6} + 1.7 \times 10^{-4}$

$T_{total\ off} = 1.8 \times 10^{-4}$

For the 241-AZ-702 ventilation system:

$T_{total\ off} = 1.65 \times 10^{-4} + 8.6 \times 10^{-5}$

$T_{total\ off} = 2.5 \times 10^{-4}$

D. Sum of the Onsite Toxicological Consequence

The sum of the onsite filter release toxicological consequence and the onsite continuous release toxicological consequence gives the total onsite toxicological consequence:

$$T_{total\ on} = T_{filter\ on} + T_{cont\ on}$$

For the 241-A-702 ventilation system:

$$T_{total\ on} = 5.2 \times 10^{-4} + 1.9 \times 10^{-2}$$

$$T_{total\ on} = 2.0 \times 10^{-2}$$

For the 241-AZ-702 ventilation system:

$$T_{total\ on} = 1.8 \times 10^{-2} + 9.5 \times 10^{-3}$$

$$T_{total\ on} = 2.8 \times 10^{-2}$$

3.4.2.1.3.6 HEPA Filter Failure Due to High Temperature Accident Comparison to Guidelines. Table 3-13 shows the comparisons of both radiological and toxicological consequences of a HEPA filter failure due to high temperature to the risk guidelines for the unlikely frequency category.

Table 3-13. Radiological and Toxicological Consequences of a HEPA Filter Failure Due to High Temperature Accident, with Comparison to Risk Guidelines for Frequency of "Unlikely."

RECEPTOR	RADIOLOGICAL			TOXICOLOGICAL		
	241-A-702 Consequence	241-AZ-702 Consequence	Guideline	241-A-702 Consequence (SOF)	241-AZ-702 Consequence (SOF)	Guideline (SOF)
Onsite	2.2 x 10-2 Sv (2.2 rem)	1.5×10^{-2} Sv (1.5 rem)	0.05 Sv (5 rem)	2.0×10^{-2}	2.8×10^{-2}	1 (ERPG-2)
Offsite	1.8×10^{-5} Sv (1.8×10^{-3} rem)	1.3×10^{-5} Sv (1.3×10^{-3} rem)	0.005 Sv (0.5 rem)	1.8×10^{-4}	2.5×10^{-4}	1 (ERPG-1)

3.4.2.1.3.7 HEPA Filter Failure Due to High Temperature Accident Summary of Safety-Class/Safety-Significant Structures, Systems, and Components (SSC)s and Technical Safety Requirement (TSR) Controls. There are no new Safety SSCs required by this project to either the 241-A-702 or the 241-AZ-702 ventilation systems, associated with preventing or mitigating the consequences of the HEPA filter failure due to high temperature accident.

The controls (LCO 3.1.4 and AC 5.18) are still required to ensure the consequences of a HEPA filter failure due to high temperature accident remain within assumptions of this analysis:

- LCO 3.1.4 requires that an operable stack continuous air monitor (CAM) interlock system be maintained on the ventilation system. The

stack CAM interlock system is credited in the TWRS FSAR accident analyses with terminating an unfiltered release from the primary ventilation systems within 10 minutes.

- AC 5.18 requires the HEPA filters to be maintained such that the dose rate from them is ≤ 200 mrem/h, from the HEME is ≤ 800 mrem/h, and that the HEGA be changed out at least every 20 changes of the upstream HEPA for the 241-AZ-702 ventilation system. This ensures that ventilation train component loadings do not exceed the values assumed in this addendum.

3.4.2.1.4 Continued Unfiltered Release due to HEPA Filter Failure. This scenario investigates the consequences of a continuous unfiltered release event where it is assumed that the HEPA filters fail due to wetting, seal failure, or to one of the other scenarios listed in Section 3.4.2.1. No credit is taken for any filtration in the de-entrainers. This unfiltered release is mitigated by the ventilation system Stack CAM Interlock System (LCO 3.1.4), which shuts down the exhaust fan on detection of radiation above defined setpoint (10 minutes).

The consequences resulting from this scenario are bounded by the other HEPA filter scenarios investigated in Section 3.4.2.1, since the duration of the unfiltered release is the same, and there is no contribution to the consequences from any material residing on the ventilation system components at the initiation of the event.

3.4.2.2 Tank Bump Accident.

3.4.2.2.1 Aging Waste Facility Tank Bump Accident Scenario. The thermal phenomenon known as a tank bump occurs when steam stored in the waste causes a waste rollover and a rapid steam pressurization of the tank headspace. The Aging Waste Facility Tank Bump Accident Scenario analysis strategy is addressed in Section 3.4.2.11, "Tank Bump" of the FSAR. A tank bump is a safety concern because of the potential for a release of aerosolized waste to the environment. The following tank bump scenario description, used as a basis for the Tank 241-AZ-101 mixer pump test analysis, is summarized from Section 3.4.2.11 of the FSAR.

The initial conditions for a tank bump accident to occur are those leading to local saturation temperature and steam buildup within the waste. Those require:

(1) a heat generation rate greater than 7,600 W (26,000 Btu/h), assuming no active ventilation, to reach waste saturation temperature 104 °C (220 °F) at atmospheric pressure,

Note: For Tank 241-AZ-101, the saturation temperature would be 126 °C (258 °F) at the bottom of the tank (accounting for hydrostatic pressure) and 104 °C (220 °F) at the surface (Sathyanarayana 1994),

(2) an amount of non-convective and highly viscous sludge holding steam bubbles, and

(3) an in-tank waste heat removal system failure.

In addition to this, the higher the waste level is, the higher the saturation temperature and the energy stored before a bump.

3.4.2.2.2 Tank Bump Scenario Analysis and Controls for Tank 241-AZ-101 Mixer Pump Test. Tank 241-AZ-101 currently contains waste with a heat generation rate of approximately 79,700 W (271,900 Btu/h) (MacLean 1998). The operation of the two 300 hp mixer pumps will raise the tank heat generation rate significantly (i.e., by 402,000 W [1,374,000 Btu/h] for a total heat generation rate of 481,700 W [1,645,900 Btu/h] from Nordquist 1997). This is well above the minimum heat load value (7.6 kW [26,000 Btu/h]) that may lead, in certain conditions, to waste saturation temperatures; therefore, 241-AZ-101 is judged to have the conditions necessary for a tank bump.

For the unmitigated and unprevented accident scenario, it was postulated that the cooling capability of the primary tank active ventilation system for Tank 241-AZ-101 would be lost for an indefinite amount of time. The annulus ventilation system is under repair as of this writing, and is therefore, not available to provide additional cooling for the tank waste. The conservative assumption has been made that this system would not be available during the mixer pump test. This results in a bounding analysis in that, should the annulus system be made available, all safety margins would be increased over analyzed values. Therefore, considering the assumption of the loss of the primary ventilation system, the frequency of a Tank 241-AZ-101 tank bump during the mixer pump test was categorized as an unlikely event (due to the short duration of the test). This is based on the fact that a similar ventilation system on 101-SY was determined to have a probability of failure of 4.8×10^{-3} per gas release event (LANL 1996, Appendix J, Section 2.1.1).

A. Normal Operation of the Pumps and the Primary Ventilation System

In addition to the heat introduced by the operation of the mixer pumps in Tank 241-AZ-101, an increase in waste temperature may occur due to changes in heat transfer characteristics within the waste. These changes may result from re-suspension of solid particulates within the liquid waste as well as non-mobilized sludge areas (even with two pumps operating, it has yet to be determined how long it might take before the sludge becomes completely mixed). When the pumps are turned off at the end of the test or during test interruptions, the bottom of the tank could potentially experience a temperature excursion due to reduced thermal conductivity as the waste solids resettle. This effect is expected even with the primary ventilation system operating normally.

The tank bump protection strategy is one of prevention and relies on air lift circulator (ALC) operation to prevent the potential for heat and steam bubble buildup within the sludge. Several tanks during the history of aging waste tanks (Bendixsen 1990) have had tank bumps. These tank bump accidents only occurred in "boiling" tanks (from 1 to 7 Million Btu/h, and sludge temperatures well above 115.6 °C [240 °F]) prior to ALC full implementation (the cases involved situations in which either no ALCs were operating, only 4 ALCs were operating, or a case in which the ALCs had been stopped and were in the process of being re-started at the time of the bump). In most of the

cases, these tanks were not provided with any active cooling ventilation system at the time of the bump. During over 40 years of Hanford Site operation, the ALCs have been the most successful method used to prevent "boiling" tanks from bumping. Several studies have been performed to assess ALC use for tank bump prevention. Among these are Fineman and Lawler 1982, which measured ALC convective flow rates, and Fineman 1984, which contains a Pacific Northwest National Laboratory (PNNL) modelling evaluation of the minimum number of ALCs necessary to prevent tank bumps in full-scale, partial tank laboratory experiments. The latter study also included some modelling for in-tank equipment effects on ALC use (no effect was noted). The lack of effect of in-tank hardware (such as drywells, thermocouples, etc.) on ALC operation can also be seen in photographic evidence (PNL 1979) in which the surface of the liquid waste can clearly be seen to be entirely disturbed by the ALC operation, with no null areas visible. Tank 241-AZ-101 was constructed with 22 ALCs and, using established procedures for ALC use, has never experienced a tank bump. The AWF Interim Operational Safety Requirement (IOSR) (Heubach 1996, LCO 3.4.4), converted to LCO 3.3.4, requires that the ALCs be operated as soon as the temperature reaches 110 °C (230 °F) for the sludge (or the bottom of the tank) and 87.8 °C (190 °F) for the average waste solution temperature. Thus, the normal operation of the mixer pumps requires no additional controls. This LCO also requires that a minimum number of ALCs be available for operation, should the temperatures exceed the LCO temperature limits.

B. Off-normal Situations

A prolonged and total loss of primary ventilation could result in tank waste conditions conducive to a thermal bump. This scenario is very unlikely given the design redundancies within the primary ventilation system (241-A-702 or 241-AZ-702), as well as the existence of connection ports for hook-up of an alternate exhauster. The 241-A-702 ventilation system contains redundant fans (see Figure 2-6) with a 1.89 m^3/s (4,000 CFM) exhauster as backup, and the 241-AZ-702 ventilation system (see Figure 2-3) contains redundant filter trains as well as redundant exhaust fans. Either ventilation system can remove the calculated heat load for bulk waste temperatures for mixer pump operation. However, in the case of a total loss of ventilation, the pumps will be turned off in accordance with LCO 3.2.1 which requires that all waste disturbing operations and activities within the tank stop upon a loss of ventilation in order to prevent further buildup of heat and gases. The tank bump potential arises because the ALCs are interlocked to turn off when the ventilation system is down. LCO 3.2.1 requires that, whenever active ventilation is lost within a waste storage tank, actions be initiated immediately to restore ventilation.

For these off-normal situations, very conservative scoping thermal calculations (Sathyanarayana 1997) have shown that the time for the waste temperature to increase from maximum estimated initial conditions and reach local saturation is significantly greater than historical time periods of ventilation loss (previous AWF IOSR 3.4.1 time requirements of 40 hours if ALCs were not required to be operating per AWF IOSR 3.4.4 and 16 hours if ALCs were required to be operating per AWF IOSR 3.4.4 are considered to be indicative of maximum historical ventilation outage periods). Indeed, the analysis considers the hypothetical case of having half of the area of the

tank's sludge (approximately 31.5 cm [12.5 inches] thick) being non-mobilized during the mixer pump test, and being covered by freshly settled solids from the other half of the tank with loss of power, and hence loss of mixer pumps, ventilation, and ALCs. This fraction of sludge mobilization results in the maximum postulated thickness of sludge buildup in the non-mobilized zone. This would normally be an additional 15.75 cm (6.25 inches) of sludge, since it would be distributed over the entire tank area, but an additional conservatism is included that the sludge volume may be increased (or fluffed) by up to a factor of 2 because of the pumping action. This results in an additional 31.5 cm (12.5 inches) of sludge deposition, for a conservative value of 63 cm (25 inches) for the scenario. For this scenario, the time for the sludge temperature to increase from a maximum anticipated sludge temperature of 110 °C (230 °F) to sludge saturation temperature (125.6 °C [258 °F]) is greater than 53 hours, well in excess of the historical maximum for ventilation outages (16 hours). (Higher sludge temperatures before accident onset would have resulted in ALC operation, equilibrating sludge temperatures to a value closer to supernatant levels.) Moreover, this 53 hour minimum time needed to reach sludge saturation temperature conservatively assumes an instantaneous settling time for sludge after waste disturbance has ceased (actual settling time is more on the order of several days, based on sludge sample from Tank 241-AZ-101) (Gray et al. 1993).

In addition to this scoping study, empirical data from previous Tank 241-AZ-101 ALC shutdown testing show no bottom temperature peaks close to waste saturation temperatures (Winkler 1995). The average sludge temperature rose 14.9 °C (5.2 °F) over 1,296 hours (with primary ventilation on and annulus ventilation off). These data lend credence to the assertion that current controls are adequate for the performance of the Tank 241-AZ-101 mixer pump test without the need for additional controls.

3.4.2.2.3 Tank Bump Offsite and Onsite Radiological and Toxicological Consequences Analysis and Comparison to Risk Guidelines. The bounding accident analysis in Section 3.4.2.11 of the FSAR is consistent with the Tank 241-AZ-101 assumptions. The associated calculations are documented in Board 1996.

The results are presented in Table 3-14.

The values of 2.2×10^{-3} Sv (2.2×10^{-1} rem) for the offsite radiological dose meets risk guidelines, but the value of 2.5×10^{0} Sv (2.5×10^{2} rem) for onsite radiological doses exceed the risk guidelines for the unlikely event of an unprevented, unmitigated AWF tank bump accident analyzed in the FSAR.

The offsite toxicological value is below one and is within the risk guidelines. The onsite toxicological dose is above one and exceeds the risk guidelines for an unprevented, unmitigated tank bump accident.

The safety control and prevention strategy regarding the tank bump accident is to rely on the current LCO 3.3.2 for temperature limits. LCO 3.3.4 for ALC operation provides additional control and prevention based on prior history of its use as AWF IOSR LCO 3.4.4 (Heubach 1996). This LCO provides an enveloping set of controls covering the behavior of the waste

during and after the mixer pump test, as well as the heat load additions from the pumps and waste mobilization effectiveness.

Given several uncertainties with respect to the heat load brought to the waste by the pumps and the waste mobilization effectiveness of the pumps (i.e., amount of sludge initially mobilized and time necessary to achieve maximum waste mobilization), the safety control strategy is to: (1) maintain operation of the primary ventilation system, (2) monitor the waste temperatures (and shut-off mixer pumps per LCO 3.3.2), and (3) maintain availability of the ALCs to prevent steam bubble formation and turn on ALCs if the waste temperature below 20 feet reaches 110 °C (230 °F) (in the bottom region of the tank after the pumps are turned off, or in non-mobilized areas) per LCO 3.3.4.

Table 3-14. Tank Bump Radiological and Toxicological Consequences. (Excerpt from Table 3.4.2.11-3 of the FSAR)

Receptor	Radiological		Toxicological	
	Consequence	Guideline	Consequence (SOF)	Guideline (SOF)
Onsite	2.5 Sv (250 rem)	5×10^{-2} Sv (5 rem)	4.9×10^{3}	1 (ERPG-2)
Offsite	2.2×10^{-3} Sv (0.22 rem)	5×10^{-3} Sv (0.5 rem)	0.73	1 (ERPG-1)

3.4.2.2.4 Tank Bump Accident Summary of Safety-Class/Safety-Significant SSCs and TSR Controls. The safety SSCs associated with this accident are the ALC system (Section 2.7.1.5 of this addendum), which prevents steam accumulation and rollover occurrences, and the primary tank exhaust ventilation system. Both of these systems are Safety-Significant SSCs. Note, the FSAR currently classifies the primary tank exhaust ventilation system as Safety-Class based on the flammable gas deflagration accident. Therefore, the postulated tank bump accident described in this addendum does not change the primary tank exhaust ventilation system safety classification.

The following existing controls are preventive measures against the AWF tank bump (note, there are no mitigative controls):

- Monitor waste temperature and turn off mixer pumps when the top 15 feet of waste reaches 90.6 °C (195 °F) or the waste below 15 feet reaches 101.7°C (215 °F) (LCO 3.3.2);
- Monitor waste temperature and operate ALCs when the waste temperature below 20 feet reaches 110 °C (230 °F) and the average waste solution temperature reaches 87.8 °C (190 °F) (LCO 3.3.4);
- Upon total loss of the ventilation system, turn off the mixer pump(s) to control heat addition to the tank and potential tank overpressurization and comply with requirements of LCO 3.2.1.

3.4.2.3 Breach of Containment. The following mechanisms (i.e., flammable gas deflagration, dropped equipment, internal missiles, erosion, and material degradation due to high temperatures) due to mixer pump operation result in

scenarios already discussed in Squires 1987 and the FSAR. Therefore, no additional consequence calculations were performed.

3.4.2.3.1 Flammable Gas Deflagration. This section discusses the hazards and controls associated with the generation, accumulation, storage, release, and postulated combustion of flammable gases in the tank headspace.

The controls for flammable gas hazard are derived in FSAR Appendix K, "Flammable Gas Hazards and Controls in Hanford Waste Storage Tanks and Waste Transfer Facilities," and have been incorporated in the TSRs as Administrative Controls (AC) 5.9, 5.10, and 5.11. This FSAR Addendum affirms the applicability of the RL approved controls for the mixer pump test. This affirmation is required for two reasons. First, the initiation of the mixer pump test has the potential to release any flammable gas that has accumulated in the waste matrix and is trapped beneath the waste surface. Second, operation of the mixer pumps will increase waste temperature and will, therefore, increase the rate of flammable gas generation. This results in an increase in the chronic (or "steady state") gas release rate to the tank vapor space.

Radioactive waste generates hydrogen through the radiolysis of water, thermolytic decomposition of organic compounds, and corrosion of the tank's carbon steel walls. Radiolysis and thermolytic decomposition also generate ammonia. Additional flammable gases (such as methane) and an oxidizer (nitrous oxide) are generated by chemical reactions between various degradation products of organic chemicals originally present in the tank. Volatile or semi-volatile organic chemicals also produce organic vapors.

The gas generated through these processes may be released continually to the tank vapor spaces (historically referred to as steady state flammable gas generation) or be retained by the tank's waste matrix, potentially resulting in an episodic gas release event (GRE). Steady state flammable gas generation from radiolysis, chemical decomposition, and corrosion is expected from all of the AWF tanks. With a GRE, gas is retained in the tank's waste matrix until it is spontaneously released or a release is induced during waste disturbing activities, such as mixer pump operations.

An accident scenario for a representative flammable gas deflagration resulting from a GRE in an AWF tank is provided in the TWRS FSAR, Section 3.4.2.2. The source terms and consequences associated with this event were developed in Van Vleet 1996b. The representative GRE accident analysis assumes the release and ignition of sufficient trapped gas such that the resulting energy creates unfiltered release paths, but is insufficient to collapse the tank dome. A gas release of this size has never been observed, and is not expected for the current waste contents of Tank 241-AZ-101. Therefore, the energy associated with the deflagration of such a release is considered bounding for Tank 241-AZ-101 with its current waste contents.

The source term selected for the representative GRE accident analysis is based on the assumption that only the liquid component of the waste would be released by the deflagration event. While likely to be valid for a quiescent initial waste condition, the liquid source term assumption may be questioned for the condition where mixer pump operation mobilizes a significant portion

of the waste solids. In this case, it may be argued that some fraction of the release due to a deflagration consists of waste solids. As seen in Van Keuren 1996, the existence of a solids component in the source term would result in an increased radiological dose at the receptor locations. Determination of the fraction of solids that may be entrained in the release is an additional uncertainty associated with this event.

As indicated in the FSAR, the consequence analysis for the representative GRE is not considered bounding. However, the analysis serves to indicate the need for an Authorization Basis control strategy. As provided in the current authorization basis (FSAR), the control strategy is prevention. Controls related to monitoring and ignition sources are assigned to specific facilities and tanks on the basis of observed and estimated gas release behavior. These controls are not specifically derived from GRE consequence analysis, and would not be changed by variations in the magnitude of the calculated consequences presented in the FSAR. For information, the FSAR analysis results were modified similar to the HEPA filter failure analysis contained in Section 3.4.2.1.2 and 3.4.2.1.3 of this addendum (i.e., changing the vapor space concentration to include the solids/liquid mixture due to tank mixing). The calculation modifications are contained in Harris 1998.

The specific monitoring and ignition source controls applicable to the AWF tanks are driven by assignment of the AWF tanks to flammable gas Facility Group 2 (FSAR) and the nature of activities and operations performed in the tanks. The mixer pump test does not alter the assignment of Tank 241-AZ-101 to Facility Group 2. In addition, performance of the test falls within the authorization basis definitions for the nature and location of activities and operations. Therefore, with respect to GRE behavior that may be associated with the mixer pump test, the existing authorization basis monitoring and ignition source controls continue to apply.

Thus, the strategy to prevent or mitigate potential hazards associated with flammable gas in Tank 241-AZ-101 during the performance of the mixer pump test involves implementation of the controls detailed in the FSAR. The FSAR strategy is to expeditiously implement achievable and practical controls to manage postulated flammable gas risks. While doing so, progress towards safety issue resolution and closure will continue to concentrate on remaining uncertainties regarding the quantification of risk and effectiveness of control strategies.

The controls are aimed primarily at prevention of ignition of flammable gas (although certain aspects of the control strategy are mitigative in nature). Provisions for ventilation serve to prevent accumulation of chronically released gases and possibly reduce the time at risk assuming the occurrence of a spontaneous or induced gas release. Flammable gas monitoring requirements serve to validate ventilation effectiveness as well as prevent or halt manned activities when margin of safety is considered to be insufficient (i.e., conditions are such that the flammable gases exist in concentrations greater than 25% of the lower flammability limit). Ignition controls related to work practices and equipment requirements serve to eliminate, to the greatest extent practical, ignition sources.

This three-pronged control strategy (ventilation, monitoring, and ignition source control) is assumed to be effective in preventing the accumulation of flammable gases where ignition sources may be present or to eliminate ignition sources where flammable gases may potentially be present.

Steady State Generation

The performance of the tests associated with running the mixer pumps could potentially affect the steady state generation of flammable gases. Steady state flammable gas generation is dependent on several parameters including decay heat load, waste temperature, organic complexant chemical concentrations, and nitrate/nitrite concentration. Running the mixer pumps will increase the waste temperature, potentially resulting in increased steady state flammable gas generation.

The implementation of the TSR control strategy during mixer pump operation in Tank 241-AZ-101 provides ventilation to prevent accumulation resulting from a steady state gas release. However, the safety margin provided by compliance with the ventilation requirements of the TSR flammable gas controls (AC 5.9, 5.10, and 5.11) may be decreased as a result of the mixer pump test. This is due to the expected increases in waste temperature resulting from mixer pump heat input as well as a possible reduction in waste heat conduction during a potential fluffed sludge condition (see Section 3.4.2.2.2B of this addendum) during initial settling following operation of the mixer pumps. The increased waste temperature can result in an increased hydrogen generation rate.

In order to provide some degree of confidence that the ventilation flow and TSRs for ventilation restoration are adequate to prevent a flammable gas deflagration resulting from the increased hydrogen generation rate, a brief review was performed of the FSAR supporting calculation (Hu 1997). This calculation note provides a numerical analysis for estimating the steady-state hydrogen release rate for double-shell tanks. This numerical analysis provides various equations for the three contributors of hydrogen generation; radiolysis, thermolysis, and corrosion. Of the three, thermolysis will vary according to temperature as indicated in the following equation (Hu 1997 Equation 6):

$$G_{chemical}=G_{bl} * M * \left(\frac{TOC}{TOC_{bl}}\right) * \left(\frac{Al}{Al_{bl}}\right) * \exp\left[-\frac{Ea}{R} * \left(\frac{1}{T}-\frac{1}{T_{bl}}\right)\right]$$

where:

bl	=	baseline tank, 241-SY-103
G	=	hydrogen generation rate, mole/(kg * day) (baseline 3.5 E-7)
M	=	total mass of liquid, kg
TOC	=	total organic carbon concentration
Al	=	total aluminum concentration
Ea	=	baseline tank hydrogen generation activation energy (91,000 J)
R	=	gas constant (8.314 J/mole/ °K)
T	=	temperature, °K (baseline = 304.7 °K)

Using the numbers contained in the calculation note for 241-AZ-101 but substituting 110 °C (230 °F) as a bounding temperature for the mixer pump test yields 1.77E-5 m^3/s (0.0376 CFM). This added to the other two hydrogen generation components yields 2.63E-5 m^3/s (0.0557 CFM).

Equation 8 of Hu 1997 determines the time to reach a specified hydrogen concentration and Equation 9 determines the minimum ventilation flow rate to keep the hydrogen concentration below a specified limit. Using the revised flow rate above yields 8.25 days to reach 25% of the LFL (8.09 days using Project W-030's high heat flow rate of 0.24 m^3/s [500 CFM]). The 7 day limit of 241-SY-101 still bounds the completion time of Recovery Action A.3 of TWRS LCO 3.2.1. The minimum flow rate to keep the hydrogen concentration below 25% of the LFL is 2.8 E-3 m^3/s (5.9 CFM).

This evaluation provides some confidence in the adequacy of the ventilation system to prevent the steady state accumulation of flammable gas to levels above the LFL since the minimum ventilation flow rate provided by the existing 241-A-702 AWF ventilation system ranges from approximately 400 to 600 CFM and the minimum ventilation flow rate provided by the W-030 ventilation system is approximately 100 CFM.

The increased gas generation rates will be reduced to their prior values after temperatures have re-stabilized to the lower, typical values measured today (within 30 days, extrapolating data from Sathyanarayana 1997).

Thus, the implementation of the TSR control strategy during mixer pump operation in Tank 241-AZ-101 in conjunction with the application of the TSRs provides adequate controls to prevent a flammable gas deflagration as a result of steady state flammable gas generation.

<u>Gas Release Event</u>

The performance of the mixer pump test could also potentially result in a gas release event (GRE). This test involves running the mixer pumps which is defined as a global waste disturbing operation (FSAR). Waste disturbing activities represent the primary means of releasing gas retained in the waste matrix resulting in a GRE.

The controls required by the FSAR are graded based on the tank Facility Group assignment and the nature of the operation or activity. The AWF tanks are assigned Facility Group 2 status. However, the assignment of Facility Group 2 is based on consideration for future use of the tanks rather than current waste inventory. This facility assignment means that GRE controls are focused on dome space intrusive and waste intrusive regions during non-waste disturbing or local waste disturbing operations. Controls are extended to ex-

tank intrusive regions during global waste disturbing operations. This test involves running the mixer pumps which is defined as a global waste disturbing operation. Therefore, the expanded controls are required during operation of the mixer pumps with the exception of the lightning controls of AC 5.10. The ALCs or mixer pumps can be operated, even with lightning within a 30 mile radius of the tank farm. This is because of the small potential for retained gas in Tank 241-AZ-101 (as outlined in the remainder of this section through references to tank-specific analyses), the short duration of the test and the time when ALCs would be necessary for tank bump prevention. The ALCs would only be needed (potentially) after a time of tank mixing through mixer pump operation (when the waste could potentially re-settle non-uniformly and cause localized hot-spots) such that any retained gas would have been evolved and the potential for a GRE significantly reduced.

The equipment, materials, and work practices associated with this project were evaluated by the Flammable Gas Equipment Advisory Board (FGEAB) (Smet 1997) to verify compliance with the Ignition Source Control Sets #1 and #2 as detailed in the FSAR. The FGEAB evaluation of the equipment, materials, and work practices associated with this project determined that the applicable Ignition Source Control Sets were satisfied in all cases, including the case of carbon steel profile thermocouples and/or transfer pumps swaying in the carbon steel risers (Smet 1997). This determination also concluded the 300 hp induction drive motor and the 1/3 hp induction rotation motors mounted on top of the risers met the applicable Ignition Source Control Sets.

Comprehensive compliance with the applicable Ignition Source Control Sets not only minimizes the potential for an ignition source following a steady state gas release, but also minimizes the potential for an ignition source following a GRE. This control implementation provides an additional level of safety in order to prevent a flammable gas deflagration even if a large GRE were to occur. However, a large GRE is not expected to occur during mixer pump operation. These expectations are based on the following information:

- Tank 241-AZ-101 currently contains only a small amount of sludge, approximately 35,000 gallons, which limits the maximum amount of potentially retained gas to small amounts (Lambert 1998).

- A conservative scoping analysis indicates that if the sludge in Tank 241-AZ-101 retained and released flammable gas in the same volumetric proportion as did Tank 241-SY-101 (prior to mitigation), then a GRE would be insufficient to cause a well mixed headspace to exceed 25% of the LFL (Hodgson 1996). This scoping analysis uses barometric pressure versus tank level rise to estimate the amount of trapped gas. The gas release event used in Hodgson 1996 assumed 25% of the trapped gas was released and its hydrogen concentration was 97% unless data supported a reduction. Analysis of Tank 241-AZ-101 resulted in a steady-state gas generation of 0.16% LFL and a worst case episodic release of 20% of the LFL (Hodgson 1996 Table 2-1). Also, Hodgson 1996 reported no correlation seen between barometric pressure changes and surface level rise for Tank 241-AZ-101 (i.e., minimal amounts of trapped gas).

- An evaluation of actual amounts of retained gas using the limited data available indicates that the amounts of retained gas in Tank 241-AZ-101 are very small to non-existent (Hodgson 1996).

- Even though mixer pump operation is defined as global waste disturbing, the test is performed in phases of increasing expected sludge mobilization. Complete and rapid mobilization of all of the sludge is not expected during the first phases of the test.

- After the sludge has been re-distributed and settled, it should not retain significantly more gas than prior to the test.

In the time period between waste sludge mobilization and complete settling, the sludge volume may be larger than it is currently. That is, it will be less compacted. This may result in an increase in the total amount of retained gas and may alter the retention and release (i.e., GRE) behavior postulated as the basis for the flammable gas controls. GRE behavior in the partially settled sludge is not postulated to be worse than the "small" spontaneous GRE or the "large" induced GRE postulated for Facility Group 2 tanks in the FSAR.

Thus, the implementation of the TSR control strategy during mixer pump operation in Tank 241-AZ-101 provides adequate control to prevent a flammable gas deflagration as a result of a GRE, even though a large GRE is not expected to occur.

Table 3-15. Radiological and Toxicological Consequences of a Flammable Gas Deflagration.

Receptor	Radiological		Toxicological	
	Consequence	Guideline	Consequence (SOF)	Guideline (SOF)
Onsite	5.29×10^{-2} Sv (5.29 rem)	5×10^{-3} Sv (0.5 rem)	8.42×10^{1}	1 (ERPG-1)
Offsite	4.46 x 10-3 Sv (0.45 rem)	1×10^{-3} Sv (0.1 rem)	0.96	1 (PEL-TWA)

3.4.2.3.2 Dropped Equipment. Consequences of scenarios for dropped equipment were not analyzed in this addendum. No equipment is planned to be installed or removed during the test. If non-safety-related in-tank process equipment is damaged through the use of the mixer pumps, an evaluation will be performed to determine the impact of restarting or continuing the test.

3.4.2.3.3 Internal Missile. The pumps have an installed screen (5 cm [2 in] openings) to keep out items that have the potential for damaging the impeller (Nordquist 1997). Any debris items smaller than the screen openings would pass directly through the pump, and have the potential to exit the pump discharge at approximately 18 m/s (58 ft/s). An assessment has been made, based on qualitative engineering judgement, that these potential missiles could not damage the tank wall or safety-related in-tank equipment. This assessment is based on: (1) the discharge height of the mixer pump from the tank bottom (43 cm [17 in]) is below the level of any safety-related equipment; (2) the pump discharge is horizontal (i.e., does not angle upward);

and (3) the tank wall is greater than 4.6 m (15 ft) distant from the discharge points of the pump. This distance, combined with the discharge velocity and the 5 cP assumed viscosity of the waste (Nordquist 1997) makes it highly unlikely that any potential missile will retain sufficient energy to impart damage to a 1.3 cm (1/2 in) tank wall.

An assessment was performed to determine whether a pump impeller failure (the largest potential missile) would penetrate the pump housing and subsequently penetrate the tank wall. It was determined in LANL 1996 that, at an approximate impeller speed of 1,200 rpm (the maximum pump speed) the resulting fragment could not penetrate the pump casing and therefore, could not impact the tank. It was also concluded in the same analysis that if the entire pump impeller (13.0 kg [28.7 lb]) were separated from the shaft and dropped axially downward in the tank, the mass of the impeller would not be large enough to penetrate the tank. The mass of the 241-AZ-101 mixer pump impeller is 65.7 kg (144.5 lb) but is much closer to the tank bottom (50 cm for 241-AZ-101 versus 370 cm for 241-SY-101). The 241-AZ-101 mixer pump impeller is not expected to achieve any significant velocity from dropping due to its short height above the floor. Another conclusion reached in LANL 1996 was that the dropping of small parts up to a mass of 45.4 kg (100 lb) would not affect the tank's integrity.

3.4.2.3.4 Erosion. Smith and Elmore 1992 evaluated the effect of an impinging slurry jet on the corrosion rate of the tank wall and floor. Results of the tests indicate that, because of the action of the mixer pump slurry jets, the mixer pump activity will moderately accelerate corrosion of the tank wall and floor. A time averaged corrosion rate of approximately 4 mils/yr was calculated for the highest jet velocity tested for the Neutralized Current Acid Waste (NCAW) test (4.6 m/s [15 ft/s]). The maximum total base metal loss for the 150-day NCAW test was approximately 1.6 mils. Analysis of the weight loss data from the NCAW test coupons with the oxide layer intact indicates it is likely that a lower corrosion rate of 2.5 mils/yr or less may occur over the long term during actual waste mixer pump operations. This reduction in the corrosion rate is due to the thickness of the oxide layer within the tank. The tank surfaces are heavily oxidized following fabrication as a result of the stress relief process and since their fabrication the tanks have contained corrosive wastes to further increase the impermeability of the layer.

For the mixer pump test, approximately only 1,300 hours are planned, including many hours at reduced jet velocities. Smith and Elmore 1992 also provides data at 42 days, which is representative of the planned mixer pump test duration. The 42-day results are less than 17% of the 150-day values. Therefore, for the mixer pump test, between 0.27 and 0.68 mils of base metal loss is predicted, depending on which of the above 150-day values is used. For the short duration use of the mixer pumps addressed by this safety analysis, and tank walls in Tank 241-AZ-101 that were constructed to be a minimum of 1.3 cm (1/2 inch [500 mil]) thick, the predicted erosion-corrosion of the tank steel is insignificant.

3.4.2.3.5 Material Degradation due to High Temperatures. The TSR controls include a waste temperature limit of 121.1 °C (250 °F) (Safety Limit [SL] 2.1.1) to protect against runaway exothermic organic nitrate chemical

reactions. This limit is less than the previous AWF IOSR limit of 148.9 °C (300 °F), which was designed to preserve the concrete tank wall integrity from temperature excursions above 176.7 °C (350 °F) (AWF IOSR SL 2.2). The risk associated with exothermic organic nitrate chemical reactions is minimal for the mixer pump test in Tank 241-AZ-101 because of three things: (1) the low organic content of the tank of approximately 0.92 weight percent in the solids and 0.09 weight percent in the liquid (Hodgson 1995), (2) none of the mixer pump activities have any potential for reducing the water content of the waste solids, and (3) the use of LCO 3.3.2 provides protection for SL 2.1.1 as described in the bases for LCO 3.3.2 (Noorani 1997).

3.4.2.3.6 Tank Dome Collapse Accident due to Overload. The mixer pump test increases the tank dome load substantially. However, the total of the previous load and the new load placed on the tank by the Project W-151 equipment is below the enhanced total load limit permitted by JCO 1995. A structural analysis was performed (Moody 1996) that includes design calculations for the concrete pad, the steel support frame, the extension riser and riser lifting bails, and the 20.7 MPa (3,000 lbf/in^2) spray wash piping system (refer to Figure 2-2 of this addendum for mixer pump support). Dead load, live load, jet impingement and seismic loads were considered. The mixer pump and mounting plate are bolted to the support frame that is anchored to a concrete pad. A tank riser extension is provided to connect the existing tank riser with the pump support assembly. The pump support system is designed to prevent the transfer of loads directly from the pump to the riser. Thus, the pump is supported by its own on-grade foundation, and is independent of the buried AZ-101 pits and risers.

The Project W-151 Functional Design Criteria (Nordquist 1997) and Supplemental Design Requirements Documents (Kohlman 1993) establish the design basis loads and load combinations by reference to the Hanford Plant Standards Standard Design Criteria (SDC) 4.1[2]. SDC 4.1 requires dynamic analysis for Safety-Class 2 systems unless otherwise justified. The mixer pump support assembly and riser extension have been classified as Safety-Class 2 (Kidder 1994). (See Chapter 4 of this addendum for a correlation between the previous Hanford Site Safety-Class numbering system and the DOE STD 3009-94 system.) Because of this, the mixer pump support assembly and riser extension were analyzed using a "static equivalent" Safety-Class 2 approach.

The mixer pump support foundation earthquake design loading (0.25 g Peak Horizontal Ground Acceleration) complies with SDC 4.1, Rev. 11 for Safety-Class systems. A Peak Acceleration factor of 0.25 g was also applied to the concrete foundation since both of these foundations support the Safety-Class 2 riser extension (Kidder 1994). Calculations of the earthquake loads transferred from the 241-AZ-101 mixer pump to the support frame and concrete foundation are included in the directional load combinations (Moody 1996). Since the mixer pump assembly is designated safety class 3, loading criteria of Conrads 1996 were used to determine the magnitude of load transfer. Using 0.25 g peak, criteria of Conrads 1996, and the fact the mixer pumps are flexible resulted in the following acceleration or "g" factors used in the

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[2]Hanford Plant Standards Standard Design Criteria (SDC) 4.1 has been replaced by GC-LOAD-01, "Design Loads For Facilities."

analysis: (1) Horizontal = 0.675 g and (2) Vertical = 0.45 g, both in excess of those required for Safety-Class 2 components.

The results of the analysis show that all components of the support system are structurally adequate to support the mixer pump for both normal service and extreme loading conditions. Therefore, the Tank Dome Collapse accident is classified as being Beyond Extremely Unlikely, and no consequences are calculated.

3.4.2.3.7 Seismic. The results of the HazOp study given in Appendix 3A show that the deformation or failure of the mixer pump shaft due to a seismic event is extremely unlikely. Moody 1996 evaluated the mixer pump support assembly, riser extension, concrete pad, steel support frame, riser lift bails, and the 20.7 MPa (3,000 lbf/in^2) spray wash piping system. Dead load, live load, jet impingement, and seismic loads are considered in the design calculations.

The 241-AZ-101 mixer pump support assembly, extension riser, and spray wash system structural analysis results show that the pump support and riser configuration are acceptable for the applied design requirements. (See Section 3.4.2.3.6 of this addendum for an additional seismic discussion.)

A breach of containment caused by the deformation or the failure of the mixer pump shaft due to a seismic event is then Beyond Extremely Unlikely and no consequences are calculated.

During and after a seismic event, the scenario could occur wherein the primary ventilation fails (as described in the FSAR Section 3.4.2-12, "Natural Phenomena,") either through electrical power outage or ventilation system mechanical failure, but the mixer pumps are left running, either through human error or a situation in which the operator is prevented, for some reason, from stopping the pumps (injury, etc.). In this scenario, the concern would be for the continued addition of pump energies to the tank with a reduced heat removal capability from the tank to raise the waste temperatures to the point where tank bump would become a potential. The risk associated with this scenario, however, is bounded by that of the HEPA filter failure due to overpressure, discussed in Section 3.4.2.1.2 of this addendum. The frequency of the design basis earthquake, from the FSAR, is 1×10^{-3}. This frequency, combined with the frequency reduction associated with the pump being left running after the seismic event in which the ventilation system is lost (contrary to controls), brings the accident into the extremely unlikely category. The onset of any potential tank bump will be alleviated by the mixer pump action over that of a quiescent tank. Because of these prevention/mitigation factors, this accident is felt to be adequately bounded, and no further analysis is required.

3.4.2.4 Criticality. The Criticality Safety Evaluation Report (CSER) (Vail 1997) documents an evaluation of the criticality safety implications of the mixer pump test to be performed in Tank 241-AZ-101. The CSER does not identify a scenario associated with the mixing test that could lead to a criticality. It is concluded that testing the mixer pumps will not sufficiently increase the concentration of plutonium in any portion of the waste contained in 241-AZ-101 to pose a criticality safety concern.

Mixing the waste will disperse the plutonium, and none of the mechanisms capable of increasing plutonium concentration appear capable of overcoming the dispersal and blending mechanisms. The calculated k-effective (k_{eff}), when limited experimental data exist for a similar system and relatively large but reasonable interpolations or extrapolations are necessary, shall not exceed 0.95 (WHC-CM-4-29). For solid tank waste with a conservative composition, as defined in Rogers 1993, the plutonium concentration corresponding to a k_{eff} of 0.95 is 2.6 g/L. This concentration of plutonium is known as the subcritical limit with respect to tank waste.

A comparison of the concentration of plutonium in 241-AZ-101 sludge and the subcritical limit is valid when the actual solids are shown to be less reactive than the composition of the conservative waste model (Rogers 1993). The measure of reactivity is determined by comparing the macroscopic absorption cross section of the waste in Tank 241-AZ-101 to the macroscopic absorption cross section of the conservative waste model solids. The absorption cross section of the waste based on sample analysis is more than double the cross section of the conservative waste model solids. So, the subcritical limit for the actual waste solids will be higher than 2.6 g/L and a correlation between actual and calculated plutonium concentrations in the waste to the subcritical limit is conservative.

Based on waste transfer data reported in Vail 1997, the highest measured plutonium concentrations from sample analysis in the supernate and the sludge of Tank 241-AZ-101 are 0.000019 g/L and 0.175 g/L, respectively, and the highest plutonium concentration in a waste batch transferred into the tank was 0.0242 g/L. The transfer data also indicates that a very thin layer of solids may reside in the tank with a plutonium concentration of up to 0.63 g/L. It follows that the sample data and waste transfer data support the conclusion that the margin of criticality safety in the undisturbed solids in the tank ranges from a factor of 4.1 to 14.8. Also, the waste composition based on the sample analysis indicates that the neutron absorbing capacity of the non-fissile constituents is 16 times the amount of absorbers necessary to assure sub-criticality for any plutonium concentration.

The primary criticality safety aspect of mixing the waste solids is whether the plutonium remains intimately associated with the neutron poisons while the solids are suspended, and after settling. The exact mechanism which holds the plutonium in the 241-AZ-101 solids is not known, but it is reasonable to suggest that many different mechanisms contribute (i.e., precipitation, adsorption, agglomerated solids, etc.). The preferential segregation of Pu from the other hydroxides is most likely prevented by solid agglomerates containing Pu at very large absorber-to-Pu ratios.
Whyatt et al. 1996 explains that hot-cell settling tests and flocculation calculations lead to the conclusion that particles are flocculated under normal waste tank conditions, and interaction potentials promote a very rapid flocculation rate, even after the agglomerates are broken up by hydraulic forces such as mixer pumps. The investigation into Pu chemistry in waste tank environments does not lead to any scenario which suggests a criticality in the solid phase of the waste is possible.

An evaluation of the criticality safety aspects of mixing the waste in 241-AZ-101 must also investigate the consequences of Pu segregation due to the waste containing discrete particles of PuO_2. Serne et al. 1996 provides "...calculations that show, for the most realistic cases, that the level of segregation of fissiles from neutron absorbers was about a factor of 2.5." This value is the result of particle segregation predictions using the Transient Energy Momentum and Pressure Equations Solutions in Three Dimensions (TEMPEST) Fluid Dynamic Model, the Subsurface Transport Over Multiple Phases (STOMP) code (a simplified one-dimensional stagnant settling model), and mixing experiments which assess particle segregation due to size. For a plutonium concentration increase by a factor of 3 due to particle segregation during settling, the highest plutonium concentration for a thin layer is 1.889 g Pu/L, which is less than the subcritical limit.

Another angle of investigation includes a determination of the consequences of pulling waste with the highest estimated Pu concentration into the mixer pump. The expectation is that the waste layer with the calculated 1.889 g Pu/L will mix with layers of lower Pu concentration resulting in an overall lower average, but the conservative approach is an evaluation which assumes that only the high Pu concentration waste is in the pump. The volume of the mixer pump housing is approximately 134 L (Nordquist 1996). So, at the highest plutonium concentration of 1.889 g Pu/L, only 253 g of plutonium can reside in the pump at any one time. Hence the plutonium concentration is less than the subcritical limit of 2.6 g Pu/L and the total mass of plutonium in the pump is less than the minimum critical mass of plutonium of 520 g.

Modeling used in the CSER was conducted with extremely conservative assumptions:

- The realities of agglomerate formation and their behavior were ignored.
- The presence of neutron absorbers was ignored.
- Mixing of AY-102 and AZ-101 by operation of the air lift circulators (ALCs) was ignored.
- The highest plutonium concentration of the four layers in C-106 was used for modeling.

Based on these assumptions, modeling was conducted with the TEMPEST three-dimensional code to predict the maximum plutonium concentration in the initial settling of solids, the maximum concentration in the pump housing, and the maximum concentration in settled solids after pumping. A one-dimensional code was also used to bound simple settling phenomena, although the one-dimensional approach is not considered realistic, as described in the preceding section.

A summary of the principal concentration factors (CF) used in the modeling is as follows:

- Highest CF in 1-dimensional model using the reported size range of particles for C-106, AZ-101, and AY-102: 10 (rounded from 9.3)

- Highest CF in 3-dimensional TEMPEST model: 3 (rounded from 2.5)
- Highest CF in large pump housing (AZ-101): ~50%
- Effective CF used for all three tanks: 18 (a CF of 6 is used to account for the maximum/average concentration in any layer in the tank and is combined with an additional CF of 3 to account for the maximum segregation by settling as predicted by the TEMPEST code for the largest of particulates).

Finally, an attempt was made to determine if undisturbed waste presently stored in tanks exhibits any indication of increasing plutonium concentration at the bottom of settled sludge. The first such review was made by Braun et al. 1994. That review concluded that no correlation of plutonium concentration with vertical displacement in the tanks could be shown.

Another attempt to determine a plutonium concentration correlation with depth in tank sludge was carried out in support of the CSERs for the W-320 and W-151 projects. Data was requested from the TWRS Characterization Data Base for sludge tanks from which full depth sample cores had been obtained and analyzed for either plutonium concentration or gross alpha activity. Three such tanks were found: B-203, B-204, and U-105. Plots of alpha activity against segment number (proportional to core depth) are shown in Figures 3-1 through 3-3 of this addendum.

Tanks B-203 and B-204 received metal wastes from B-plant through the 224B concentrator. Both tanks are 50,000 gallon capacity, both are near full, and both are administratively stabilized and isolated. Neither tank has been jet pumped. Both tanks received their last transfers in 1976. They are reasonably good examples of undisturbed sludge tanks. As readily observed from Figures 3-1 and 3-2 of this addendum, there is no evidence of plutonium tending to concentrate more toward the bottom.

Tank U-105 once held T-Plant waste, but that was sluiced out for uranium recovery in 1956. Since 1956 there have been three different regions of waste added to the tank; (1) Redox high level waste (coating waste) was added from 1956 to 1961, (2) The tank then received evaporator bottoms from 242-T, and (3) After 1975 the tank again received high level waste from Redox. The profile shown in Figure 3-3 of this addendum is consistent with this history. Redox high level waste is expected to contain about 0.4% of the plutonium in the irradiated fuel. However the 242-T evaporators processed waste tank supernate containing very little plutonium and resulting in relatively low plutonium concentrations even in the evaporator bottoms.

It appears most likely that the actual behavior of plutonium in tanks is typified by B-203 and B-204, namely that there is no evidence of a trend to concentrate plutonium closer to the bottom of a tank. Similarly, the differences in concentration shown by Tank U-105 in Figure 3-3 of this addendum can be completely explained by the historical waste receipt record. If it is argued that the "trend" exhibited for the lower half of U-105 is due in whole or in part to a plutonium concentrating mechanism, then such concentration is roughly consistent with the CF value used in the analyses, i.e., a factor of 18.

The scenarios evaluated, the data presented, and analysis of actual tank data support the conclusion that a large margin of criticality safety exists in waste Tank 241-AZ-101 and the mixer pump test will not pose a criticality safety concern. An added layer of conservatism to this conclusion is that allowances for the quantity of ^{240}Pu in plutonium concentrations has not been taken. Plutonium-240 has a substantial neutron capture cross section, and so will decrease the reactivity of the waste.

Because this scenario is considered to be beyond extremely unlikely, no further study is required.

3.4.3 Beyond Design Basis Accidents

No BDBAs were evaluated for the mixer pump test. Because the test procedure is of relatively short duration (approximately 1300 hours), the identification and evaluation of BDBAs was judged to be unnecessary. This judgement is consistent with the graded approach implementation of DOE 5480.23.

Figure 3-1. Tank B-203 Alpha Activity by Core Segment.
(Sludge)

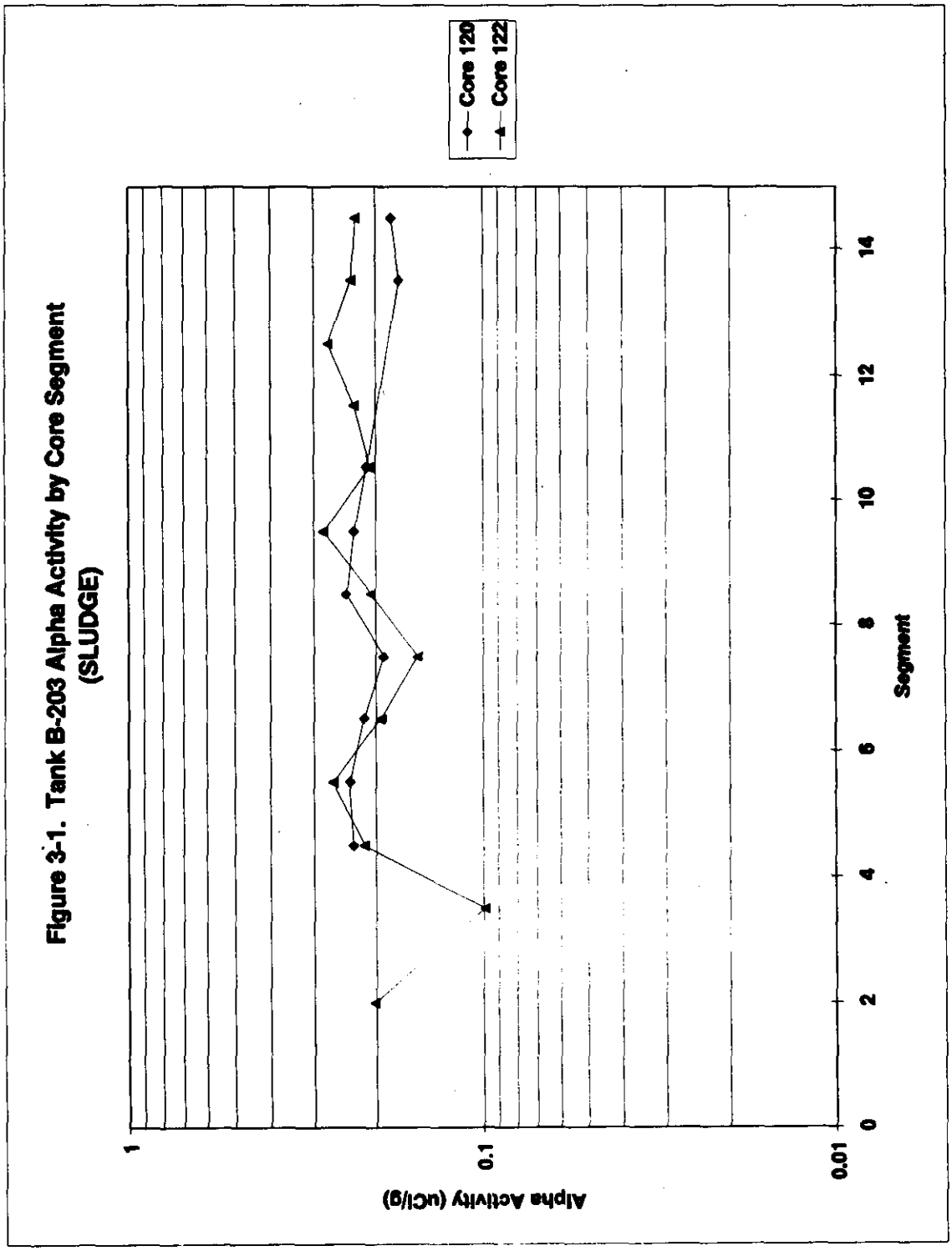


Figure 3-2. Tank B-204 Alpha Activity by Core Segment. (Sludge)

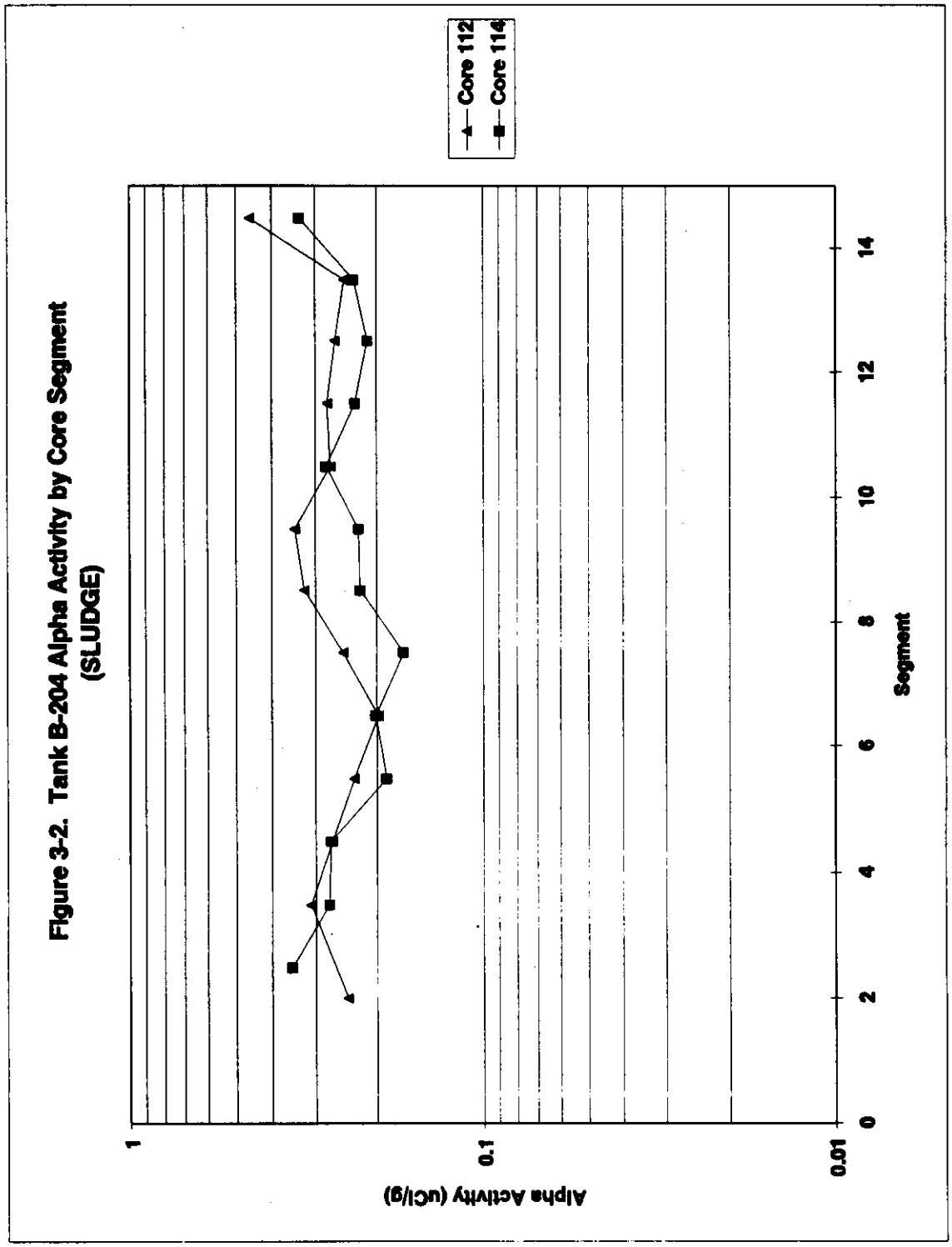
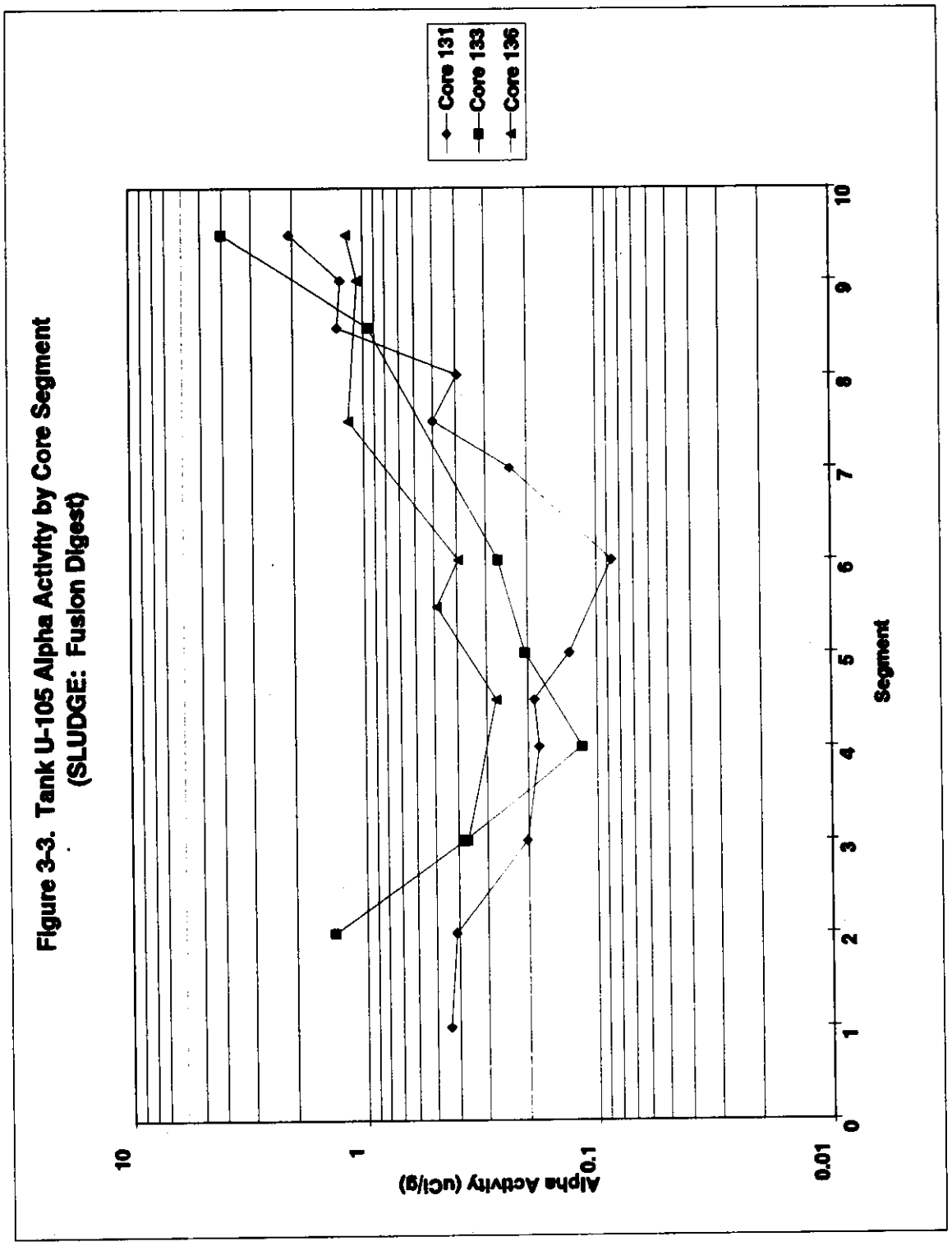


Figure 3-3. Tank U-105 Alpha Activity by Core Segment (Sludge: Fusion Digest).



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4.0 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

The safety classifications for the Project W-151 systems, structures, and components (SSC)s were determined in the project preliminary safety analysis report (Bourger 1993) and remain unchanged as a result of this safety document. As documented in Chapter 3 of this addendum, failure of the added equipment does not cause unacceptable consequences. Since all previous analyses for the 241-AZ-101 mixer pump test have used the former WHC safety classification Class 1, 2, and 3 system, the use of the term "Safety-Significant" as delineated in DOE-STD-3009-94 is used interchangeably with Safety-Class 2 (SC-2) and Safety-Class 3 (SC-3) for the new SSCs added for the 241-AZ-101 mixer pump test. The highest safety classification assigned was Safety-Class 2 which was assigned to the mixer pump support system, though this system was analyzed to equivalent Safety-Class 1 seismic criteria. Refer to Table 4-1 for an excerpted listing of the added project SSCs from Bourger 1993. Refer to Chapter 4.0, "Safety Structures, Systems, and Components," of the FSAR for conversion to Safety-Significant.

The existing tank farm SSCs remain unchanged except for the air lift circulator system for Tank 241-AZ-101. As a result of safety analysis in Chapter 3 of this addendum, the air lift circulator system and the air lift circulators in Tank 241-AZ-101 require a designation change, previously identified as IOSR related equipment (Kidder 1994) but now perform a Safety-Class 2 or Safety-Significant function based on the outcome of the tank bump scenario (the mixer pump process test does not change the tank bump outcome described in the FSAR). This equipment (including support and ancillary equipment systems as discussed in Section 2.7.1.5 of this addendum) is currently installed and can be verified as meeting the requirements for performing their Safety-Significant function.

Table 4-1. Preliminary Safety Equipment List.
(Excerpt from Bourger 1993 Table A)

Component	Safety Function	Safety Class	MRP 5.46/EP-1.4 Criterion
Mixer Pumps	Required for sludge mobilization	3	Failure does not satisfy any of the Safety-Class criteria for SC 1 or 2 listed in Table 1 of MRP 5.46 Rev. 4.
Mixer pump power supply	Required for supply of power to mixer pumps	3	Cause significant harm to facility workers due to industrial safety hazards.
Mixer pump instrumentation	Required to monitor pump operation	3	Failure does not satisfy any of the Safety-Class criteria for SC 1 or 2 listed in Table 1 of MRP 5.46 Rev. 4.
Mixer pump water supply	Required for insertion and rotation of pumps during startup	4	Failure has no significant importance to safety, health, or environmental protection.
Mixer pump support system	Required for support of mixer pumps during operation.	2	Failure could prevent a separate Safety-Class 2 system, component, structure, from performing its safety function, either by loss of control function or by damage.
Shielding plugs		3	Failure could preclude implementing ALARA principles for exposure to radiological or nonradiological hazardous materials.
Four profile thermocouples	Required to monitor tank temperatures	3	Failure does not satisfy any of the Safety-Class criteria for SC 1 or 2 listed in Table 1 of MRP 5.46 Rev. 4.
Sludge thermocouples	Required to monitor tank temperatures	3	Failure does not satisfy any of the Safety-Class criteria for SC 1 or 2 listed in Table 1 of MRP 5.46 Rev. 4.

Note: For conversion from SC-2, SC-3, and SC-4 to Safety-Class and Safety-Significant (as defined in DOE STD-3009), refer to Jensen et al. 1997.

5.0 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

The 241-AZ-101 mixer pump test hazards and accidents identified in Chapter 3.0 are safely mitigated or prevented using currently-approved TSRs (Noorani 1997) in conjunction with Air Lift Circulator TSR controls, converted from Heubach 1996 as identified in Wagoner 1997, thus ensuring protection of the workers and the public.

Table 5-1 on the following page summarizes the preventive or mitigative actions identified for each of the accidents analyzed in Chapter 3 of this addendum, and identifies the applicable TSR controls or other document which implements the required actions.

The air lift circulator control, discussed in the first paragraph of this section, is specifically converted from the AWF Interim Operational Safety Requirement (IOSR) LCO 3.4.4, Air Lift Circulators and its surveillance requirements to LCO 3.3.4 along with its surveillance requirements. LCO 3.3.4 prevents the tank bump and its subsequent unmitigated, unprevented on-site consequences over the risk evaluation guidelines.

Table 5-1. Summary of Preventive/Mitigative Actions.

Accident Scenario	Preventive or Mitigative Actions during mixer pump test	Applicable TSR Control or Other Document
Unfiltered release of radionuclides and toxic aerosols from the tank (Section 3.4.2.1)	• Limiting the maximum activity on each filter to a level that gives an equivalent dose rate of 200 mrem/h on contact controls the amount of particulates that could be expelled. Also ensuring the primary ventilation stack CAM is operable to shut down the ventilation system within 10 minutes.	AC 5.18 LCO 3.1.4
Tank Bump (Section 3.4.2.2)	• Localized high temperatures may be caused by mixer pump operation. The mixer pumps will be turned off if the top 15 feet of waste reaches 90.6 °C (195 °F) or the waste below 15 feet reaches 101.7 °C (215 °F). Air lift circulators (ALCs) will be operated to provide more uniform temperature distributions per limits described below. • Upon loss of the primary ventilation system, the mixer pump(s) will be turned off to control gas and heat buildup in the tank. • During normal operation of the pump(s) and at the end of the test while the pumps are turned off, the waste temperature will be monitored and the ALCs operated as soon as the temperature reaches 110 °C (230 °F) for waste below 20 feet and 87.8 °C (190 °F) for the average waste solution.	LCOs 3.3.2, 3.3.4 LCO 3.2.1 LCO 3.3.4
Breach of Containment (Section 3.4.2.3)	• High temperature (3.4.2.3.5): - Primary tank exhaust ventilation system shall be operable. • Flammable gas deflagration (3.4.2.3.1): - Implementation of Ignition Source Controls as well as monitoring for flammable gas are preventive measures against deflagration, breach of the tank, and breach of ventilation confinement in the event that an episodic gas release exceeds 100% of the lower flammability limit. - LCO 3.2.1 requires ventilation operability to prevent flammable gas accumulations. The vent system operation also prevents tank pressurization and an unfiltered release. • Tank dome collapse due to overload (3.4.2.3.6): - This event is deemed beyond extremely unlikely for the mixer pump test based on analysis of dead load, live load, jet impingement, and seismic loads. All components of the support system were found adequate to support the mixer pumps for both normal service and extreme conditions. • Seismic (3.4.2.3.7): - Structural analysis of seismic loads shows that the pump support and riser configuration are acceptable for the applied design requirements.	LCO 3.2.1 AC 5.9, 5.10, 5.11 LCO 3.2.1 AC 5.16 Moody 1996
Criticality (Section 3.4.2.4)	• A Criticality Safety Evaluation Report prepared for Project W-151 identified no scenario associated with the mixer pump test that could credibly lead to criticality.	AC 5.7

AC = Administrative Control
AWF = Aging Waste Facility
ALC = air lift circulator
LCO = Limiting Condition for Operation
TSR = Technical Safety Requirement (TWRS)

(Section number refers to sections of this addendum.)

6.0 PREVENTION OF INADVERTENT CRITICALITY

This section contains information relevant to prevention of inadvertent criticality as a result of the operation of the mixer pump test. For further information on the Tank Waste Remediation Systems (TWRS) specific criticality safety and protection program, see Chapter 6.0, "Prevention of Inadvertent Criticality," of the FSAR. The program ensures that sufficient controls are in place to reduce the likelihood of inadvertent nuclear criticality excursions as a result of the activities performed within the TWRS facilities.

6.1 REQUIREMENTS

See Section 6.2, "Requirements," of the FSAR for requirements.

6.2 FACILITY IMPLEMENTATION

See Chapter 6.0, "Prevention of Inadvertent Criticality," of the FSAR for facility implementation.

6.3 PROJECT IMPLEMENTATION

Vail 1997 evaluates the safety aspects of the mixer pump test. The Criticality Safety Evaluation Report is necessary to address the potential that mixing, suspension, and settling of tank fissile material may result in a criticality safety concern. See Section 3.4.2.4 of this addendum for further discussion on criticality.

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7.0 RADIATION PROTECTION

This section identifies the requirements for radiation protection as a result of the operation of the mixer pump test.

7.1 REQUIREMENTS

See Section 7.2, "Requirements," of the FSAR for requirements.

7.2 FACILITY IMPLEMENTATION

See Chapter 7.0, "Radiation Protection," of the FSAR for facility implementation.

7.3 PROJECT IMPLEMENTATION

Design of the upgrades necessary for the mixer pump test followed the requirements of Westinghouse Hanford Company Controlled Manual WHC-CM-4-9, *Radiological Design*, which has since been canceled by Evans 1994. A review of Nordquist 1997 shows that the uncontrolled area dose rate limit of 0.5 mrem from WHC-CM-4-9 was used for the design. This limit is conservative from the standpoint of the upgrades being in a controlled tank farm facility. The current dose rate limit from Evans 1994 for controlled full-time use is 2.5 μSv (0.25 mrem). The only designs impacted by this change are the radiation shields built for the new equipment (mixer pumps and new thermocouples). Access to the top of the mixer pumps is very difficult due to the motor and installed support equipment. Full-time exposure above the thermocouples is not expected either during the normal operations or potential abnormal operations.

There were no project specific requirements related to radiation protection during construction of the project equipment as all work activities were performed per Chapter 7.0 of the FSAR.

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8.0 HAZARDOUS MATERIAL PROTECTION

This section identifies the requirements for hazardous material protection other than radiological hazards for the mixer pump test.

8.1 REQUIREMENTS

See Section 8.2, "Requirements," of the FSAR for requirements.

8.2 FACILITY IMPLEMENTATION

See Chapter 8.0, "Hazardous Material Protection," of the FSAR for facility implementation.

8.3 PROJECT IMPLEMENTATION

No project-specific requirements related to hazardous material protection were identified for the mixer pump test.

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9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

This section lists the requirement documents for the radioactive and hazardous waste management for the mixer pump test.

9.1 REQUIREMENTS

See Section 9.2, "Requirements," of the FSAR for requirements.

9.2 FACILITY IMPLEMENTATION

See Chapter 9.0, "Radioactive and Hazardous Waste Management," of the FSAR for facility implementation.

9.3 PROJECT IMPLEMENTATION

No additional requirements relating to radioactive and hazardous waste management were identified for the mixer pump test. The equipment removed from the tank to accomplish the mixer pump test was managed as mixed waste.

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10.0 INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

This section identifies the requirements for testing, surveillance, and maintenance for the mixer pump process test equipment.

10.1 REQUIREMENTS

See Section 10.2, "Requirements," of the FSAR for requirements.

10.2 FACILITY IMPLEMENTATION

See Chapter 10,0, "Initial Testing In-Service Surveillance, and Maintenance," of the FSAR for facility implementation.

10.3 PROJECT IMPLEMENTATION

10.3.1 Initial Testing

USQD TF-96-1041 verified that the checkout testing of the installed equipment was within the current TWRS Authorization Basis.

10.3.2 In-Service Surveillance

New in-service surveillance procedures were not required as a result of the mixer pump test equipment. All new surveillances will only be required during the operation of the mixer pump test and will be documented in the test plan.

10.3.3 Maintenance

New preventive maintenance procedures were not required as all of the new equipment are covered by existing maintenance procedures. Specific maintenance items such as periodicity and types of lubricants were itemized by the various vendors and input into the existing maintenance program as identified in Section 10.5, "Maintenance Program," of the FSAR.

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11.0 OPERATIONAL SAFETY

This section identifies requirements for conduct of operations, Aging Waste Facility (AWF) fire protection, and the implementing program documents directly resulting from the performance of the mixer pump test.

11.1 REQUIREMENTS

See Section 11.2, "Requirements," of the FSAR for requirements.

11.2 FACILITY IMPLEMENTATION

See Chapter 11.0, "Operational Safety," of the FSAR for facility implementation.

11.3 PROJECT IMPLEMENTATION

No project-specific requirements related to operational safety or fire protection were identified for the mixer pump test. Per the requirements of DOE 5480.7, no project-specific fire hazards analysis was required. Motors overheating are already potential fire hazards for Tank Farms. These motors do not represent anything new. The motors are in the open where the damage would be limited only to the motors. The mixer pump operations have been evaluated by the Flammable Gas Equipment Advisory Board (Smet 1997).

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12.0 PROCEDURES AND TRAINING

This section lists the requirements for the procedures and training programs for the mixer pump test.

12.1 REQUIREMENTS

See Section 12.2, "Requirements," of the FSAR for requirements.

12.2 FACILITY IMPLEMENTATION

See Chapter 12,0, "Procedures and Training," of the FSAR for facility implementation.

12.3 PROJECT IMPLEMENTATION

There are specific training requirements for operation of the mixer pumps including on-the-job training cards, required reading, and additional certifications for the nuclear power operators for operating the new equipment. These requirements are specified in Bohan 1996.

The procedure to perform the mixer pump test is TF-OTP-210--001 (Ross 1997).

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13.0 HUMAN FACTORS

This section lists the requirements for a human factors program to demonstrate that human factors are considered in facility design where human actions are relied upon for preventive or mitigative actions.

13.1 REQUIREMENTS

See Section 13.2, "Requirements," of the FSAR for requirements.

13.2 FACILITY IMPLEMENTATION

See Chapter 13.0, "Human Factors," of the FSAR for facility implementation.

13.3 PROJECT IMPLEMENTATION

The application of human factors is graded on project risk, complexity, and level of involvement of the operator at the facility. A human factors systematic inquiry was not required for the mixer pump test. Within TWRS, human factors are considered in the development of procedures and controls, staffing, interface with Safety systems, structures and components, surveillance, maintenance, and Safety Analyses. For the mixer pump test, various human factors were used including development of a written mixer pump test procedure, validation of the procedure, qualification and training of the nuclear power operators, and design of the test monitoring console with design improvement feedback from the operators. Since this is a one-time test, no comparisons were made regarding allocation of mixer pump control functions between the operators versus automatic devices.

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14.0 QUALITY ASSURANCE

This section lists the requirements for a quality assurance program to ensure the safety of personnel and the public, for environmental protection, and for the implementing program documents.

14.1 REQUIREMENTS

See Section 14.2, "Requirements," of the FSAR for requirements.

14.2 FACILITY IMPLEMENTATION

See Chapter 14.0, "Quality Assurance," of the FSAR for facility implementation.

14.3 PROJECT IMPLEMENTATION

Implementation of specific quality assurance requirements for the mixer pump process test equipment was controlled by Manthei 1994.

The Quality Assurance Program consists of the following:

- Personnel performing construction on this project were trained and qualified in accordance with the above quality assurance program plan and DOE 5480.20A.
- Quality Improvement processes described in the quality assurance programs provided for the detection and correction of quality problems throughout the design and construction of this project.
- Documents associated with this project have been independently reviewed for completeness and accuracy. A record index is available to classify all quality assurance records to aid in document retrieval.
- Work processes associated with this project have been and will be strictly adhered to in accordance with this quality assurance program plan. Appropriate administrative procedures have been developed and approved to control key aspects in the design and construction of this project.
- Designs associated with this project were independently reviewed and approved. Completed construction is accurately depicted by as-built drawings.

- Procurement of safety-class and safety-significant items for this project were in compliance with this quality assurance program in that such items have been purchased from qualified suppliers where applicable and all stated requirements have been met as verified through independent inspections, tests, and assessments. All required Certified Vendor Information has been received and appropriately indexed and filed to support continuity of service.

- Inspection and testing of items associated with this project met required standards as verified by properly trained and qualified personnel. Records are on file to attest to accuracy and completeness of the inspection and testing.

- Periodic management assessment of this project was established to ensure this project is compliant with this quality assurance program plan and the objectives stated within met required performance objectives.

- Independent assessments were planned, scheduled, and conducted to confirm that project deliverables and service quality are adequate to meet operational objectives.

15.0 EMERGENCY PREPAREDNESS PROGRAM

This section identifies the requirements for the emergency preparedness functions and response at the site of the mixer pump test.

15.1 REQUIREMENTS

See Section 15.2, "Requirements," of the FSAR for requirements.

15.2 FACILITY IMPLEMENTATION

See Chapter 15.0, "Emergency Preparedness Program," of the FSAR for facility implementation.

15.3 PROJECT IMPLEMENTATION

No project-specific requirements related to emergency preparedness were identified for the mixer pump test.

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16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

This section describes provisions that facilitate future decontamination and decommissioning (D&D) of the facilities.

16.1 REQUIREMENTS

See Section 16.2, "Requirements," of the FSAR for requirements.

16.2 FACILITY IMPLEMENTATION

See Chapter 16.0, "Provisions for Decontamination and Decommissioning," of the FSAR for implementation.

16.3 PROJECT IMPLEMENTATION

This document does not evaluate removal of the mixer pumps and future D&D. D&D considerations were left to the future D&D of the tank farms as there are other in-tank components which will need similar evaluation. Safety considerations for removal of the pumps will be addressed by separate safety documentation once that portion of the mission is defined. At this time removal of the mixer pumps following the mixer pump test is not anticipated. It is expected, following an acceptable test, that the pumps will be used in the future for waste retrieval purposes, supporting the TWRS strategy. If the mixer pumps fail during the test, the test will be concluded.

The design of the installed mixer pumps does include provisions for decontamination and decommissioning, such as a spray ring in the extended riser, capability for installing a flexible receiver to provide tank confinement during mixer pump removal, minimizing cracks and crevices, and using stainless steel for material contacted by tank waste for ease in decontamination.

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17.0 MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

This section provides the requirements specific to this chapter and pertinent to the safety analysis and for the implementing program documents.

17.1 REQUIREMENTS

See Section 17.2, "Requirements," of the FSAR for requirements.

17.2 FACILITY IMPLEMENTATION

See Chapter 17.0, "Management, Organization, and Institutional Safety Provisions," of the FSAR for facility implementation.

17.3 PROJECT IMPLEMENTATION

No project-specific requirements related to management, organization, and institutional safety provisions were identified for the mixer pump test.

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APPENDIX 3A

HAZARDS AND OPERABILITY STUDY FOR PROJECT W-151

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1.0 INTRODUCTION

Project W-151 has been established for the purpose of the installation and process testing of two 300 horsepower mixer pumps weighing 12,247 kg (27,000) each in Aging Waste Facility (AWF) Waste Tank 241-AZ-101. The mixer pumps are intended to mix 90% of the sludge with the supernate in the tank. TWRS SAR Engineering will have the primary role in performing the hazards and accident analysis for the Safety Evaluation. The Safety Evaluation is scheduled to be completed in fiscal year 1996.

The first step in performing an accident analysis is to identify and qualitatively assess the facility hazards. The results of the assessment are used to determine which abnormal events could initiate accidents with the potential to expose site personnel or the general public to radioactive or chemical hazards.

A number of systematic techniques for hazards identification are available. The technique chosen for Project W-151 hazards identification was the Hazards and Operability (HazOp) Study. The HazOp methodology is specifically designed for chemical processing and storage areas. It is one of the most exhaustive techniques available because it is designed to examine process deviations in exhaustive detail, and also because it uses a multi-disciplinary team of knowledgeable individuals in a systematic brainstorming effort. The HazOp results are being used as a scoping tool to determine which potential accident sequences must be analyzed in detail in order to demonstrate that the mixer pumps and ancillary equipment in AWF Waste Tank 241-AZ-101 can be safely operated following installation.

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2.0 SCOPE

The HazOp identifies equipment and facilities shown on configuration drawings and diagrams within the scope of Project W-151 which could contain quantities of hazardous (radiologically hazardous or toxic) materials with a potential to cause significant consequences to the site personnel or the general public. Areas with limited potential to cause consequences outside of the facility boundaries or initiate significant events in other tanks within the tank farms were not included in the scope of the HazOp.

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3.0 ORGANIZATIONAL RESPONSIBILITIES

The HazOp was performed using personnel from Westinghouse Safety Analysis and Nuclear Engineering, Double-Shell Tanks (DST) Retrieval Construction Projects, and other groups essential to the W-151 Project. Safety Analysis and Nuclear Engineering coordinated the effort by providing methodology, facilitation, recording, and HazOp tables (Attachment 1 of Appendix 3A) and HazOp Report development and editing. DST Retrieval Construction Projects produced the initial draft of the HazOp tables from raw notes. Other groups included and represented in the HazOp effort are TWRS Quality Assurance and TWRS Engineering.

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4.0 METHODOLOGY

The HazOp documents the effects of deviations from the design intent of the various "process" parameters. Flow diagrams were used to break the system into nodes. Each major piece of equipment involved in the process is a node, and the piping and/or instrument lines connecting the equipment are also nodes. Pertinent process parameters (guide words) such as flow, pressure, level, and temperature are chosen, and a series of questions are asked about each parameter. Each "question" concerns an abnormal condition of the parameter (for example, "no flow"). The HazOp team, based on design knowledge and operational experience, postulates the cause(s) and effects of the abnormal process condition. From this information, a qualitative estimate of the consequences of the abnormal condition is obtained. The estimate is then used as a screening tool to determine the need for further analysis.

The product of the HazOp study is a series of tables (Attachment 1 of Appendix 3A) showing the results. The results are further categorized to include a list of potential abnormal conditions which might cause consequences in the various categories, which is used to prepare a list of accidents to be considered for further analysis.

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5.0 RESULTS

The summary of results of the HazOp is included in this section.

The results of the HazOp analyses were a number of postulated abnormal events which were ranked with respect to severity and frequency of occurrence. Table 3A-1 of this appendix shows the number of events considered to have potential consequences in each category, for each study node. Note that the number of ranked abnormal events does not have a one-to-one correlation with the node deviations. In some cases, deviations of a parameter associated with one node would cause another deviation of a parameter associated with a second node. (For example, high flow through a line node might cause high level in the destination vessel.) In some cases the cause and consequences of a particular deviation at a node are identical to a deviation at another node. These are cross referenced in the HazOp tables and not generally included in the count as separate ranked abnormal events.

Table 3A-1 of this appendix shows a summary of the consequence severity and probability of occurrence categories for the energy source/hazard potentials shown in the HazOp study tables. Table 3A-2 of this appendix provides a description of the occurrence severity indices and Table 3A-3 of this appendix a description of the indices for frequencies of occurrence. Only those abnormal events having a potential severity consequence of I or II and a probability range $>1.0 \times 10^{-6}$ will be considered for detailed analysis.

The HazOp tables are included in Attachment 1 of this appendix. Abnormal events identified in Table 3A-1 of this appendix as having a frequency $> 1 \times 10^{-6}$/yr and industrial events with risks to hazards commonly accepted in industry are excluded from the events having potential unacceptable safety risk summarized here.

5.1 NODE 1 — INLET TO EXISTING VENTILATION SYSTEM

F3 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when exhauster fails.

F2 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a riser in another tank connected to the AWF ventilation system is opened.

F2 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when ventilation ducting fails due to seismic event, high wind, or impact by construction equipment.

F1 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when a chemical reaction results in igniting tank head space flammable gases creating pressure that fails filters causing unfiltered release.

F1 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when high wind causes reversal of air flow through open riser on tank.

5.2 NODE 2 — INLET TO NEW VENTILATION SYSTEM

F3 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when valve in exhaust duct remains closed allowing pressure to build up, exhaust duct valve then opens pressurizing filters causing them to fail, which results in an unfiltered release.

2. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when exhauster fails.

3. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a riser in another tank connected to the AWF ventilation system is opened.

F2 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when ignition of tank head space flammable gases and resulting pressure and heat fail filters causing unfiltered release.

F2 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when ventilation ducting fails due to seismic event, high wind, or impact by construction equipment.

F1 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when a chemical reaction results in igniting tank head space flammable gases and resulting pressure fails filters causing unfiltered release.

F1 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when high wind causes reversal of air flow through open riser or collapsed stack on tank.

5.3 NODE 3 — WASTE TANK

F3 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when exhauster fails.

2. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a riser in another tank connected to the AWF ventilation system is opened.

3. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a mixer pump is started and mixing action creates a change in the vapor space composition and pressure.

4. Potential exposure of occupational individual to airborne radionuclides and toxic substances when ignition of tank head space flammable gases created by heat input from mixer pump results in pressure and heat that fail filters causing unfiltered release.

F2 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when ignition of tank head space flammable gases results in pressure and heat that fail filters causing unfiltered release.

2. Potential exposure of onsite individual to radionuclides and toxic substances when ignition of tank head space flammable gases results in pressure and heat that breach the tank allowing exposure of the soil column to tank contents.

3. Potential exposure of onsite individual to airborne radionuclides and toxic substances and contamination when ignition of tank head space flammable gases result in pressurizing contaminants through piping leading from tank farm pits when subsequent work is performed in the pits.

F2 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a mixer pump is started and mixing/chemical action creates a change in the vapor space composition and pressure.

F1 - S2

1. Potential exposure of onsite individual to radionuclides and toxic substances when tank containment is breached and tank contents are leaked to the soil column due to impact by dropped equipment during installation or removal operations.

2. Potential exposure of onsite individual to radionuclides and toxic substances when tank containment is breached and tank contents are leaked to the soil column due to impact by a missile ejected by a mixer pump.

3. Potential exposure of onsite individual to radionuclides and toxic substances when tank containment is breached and tank contents are leaked to the soil column due to erosion by mixer pump action.

4. Potential exposure of onsite individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a mixer pump is started and mixing/chemical action creates a change in the vapor space composition and pressure.

5. Potential exposure of onsite individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a mixer pump is started, rearranging tank material which results in critical mass formation and criticality.

5.4 NODE 4 — OLD EXHAUST VENTILATION SYSTEM

F3 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when valve in exhaust duct remains closed, loss of power to exhaust fan or exhaust fan failure allows pressure to build up, then the exhaust duct valve opens pressurizing filters causing them to fail which results in an unfiltered release.

2. Potential exposure of onsite individual to airborne radionuclides and toxic substances when valve in exhaust duct remains closed allowing flammable gases to build up. Ignition of gases creates ventilation system overpressure causing filters to fail which results in an unfiltered release.

3. Potential exposure of onsite individual to airborne radionuclides and toxic substances when valve in exhaust duct remains closed causing diminished cooling which results in tank heating causing a tank bump. Sudden release of gases creates ventilation system overpressure causing filters to fail which results in an unfiltered release.

F3 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a riser in another tank connected to the AWF ventilation system is opened.

F2 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when filters plug with particulate.

F1 - S3

1. Potential exposure of offsite individual to airborne radionuclides and toxic substances when ventilation ducting is breached due to high wind/tornado.

F1 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when ventilation ducting is breached due to Seismic event.

F1 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a riser in another tank connected to the AWF ventilation system is opened.

5.5 NODE 5 — NEW EXHAUST VENTILATION SYSTEM

F3 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when valve in exhaust duct remains closed, loss of power to exhaust fan or exhaust fan failure allows pressure to build up, then the exhaust duct valve opens pressurizing filters causing them to fail which results in an unfiltered release.

2. Potential exposure of onsite individual to airborne radionuclides and toxic substances when valve in exhaust duct remains closed allowing flammable gases to build up. Ignition of gases creates ventilation system overpressure causing filters to fail which results in an unfiltered release.

3. Potential exposure of onsite individual to airborne radionuclides and toxic substances when valve in exhaust duct remains closed causing diminished cooling which results in tank heating causing a tank bump.

Sudden release of gases creates ventilation system overpressure causing filters to fail which results in an unfiltered release.

F3 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when fan control allows it to over-speed.

2. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a riser in another tank connected to the AWF ventilation system is opened.

F2 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when filter fails due to tank overpressure resulting when filters plug with particulate.

2. Potential exposure of onsite individual to airborne radionuclides and toxic substances when ignition of tank head space flammable gases created by plugged filter results in pressure and heat that fail filters causing unfiltered release.

3. Potential exposure of occupational individual to airborne radionuclides and toxic substances when ventilation ducting fails due to impact by construction equipment.

F1 - S2

1. Potential exposure of onsite individual to airborne radionuclides and toxic substances when ventilation ducting is breached due to seismic event.

2. Potential exposure of onsite individual to airborne radionuclides and toxic substances when gases build in tank due to a filter failure which fails due to particulate restriction, and the loosed filter media plugs the stack. When the force holding the filter media lodged in the stack are overcome by the pressure that has built up in the tank, the media is dislodged and an unfiltered release occurs.

F1 - S1

1. Potential exposure of occupational individual to airborne radionuclides and toxic substances when filters fail due to tank overpressure resulting when a riser in another tank connected to the AWF ventilation system is opened.

5.6 NODE 6 — MIXING PUMPS

F3 - S1

1. Potential exposure of onsite individual to radionuclides and toxic substances when tank containment is breached and tank contents are leaked to the soil column due to impact by missile ejected by mixer pump.

2. Potential exposure of onsite individual to airborne radionuclides and toxic substances when loss of power to exhaust fan, or exhaust fan failure, allows pressure to build up causing filters to fail which results in an unfiltered release.

5.7 NODE 7 — EQUIPMENT INSTALLATION AND REMOVAL

F3 - S1

1. Potential exposure of onsite individual to direct radiation and/or airborne radionuclides and toxic substances when removing or installing tank equipment.

2. Potential contamination of soil on top of tank resulting from a spill during tank equipment removal.

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Table 3A5-1. Summary of HazOp Study Consequence Severity and Frequency of Occurrence Indices.

Equipment/system	Severity	Frequency	No. of Events
Inlet to Existing Ventilation System	S2	F3	1
	S1	F3	1
Node 1	S0	F3	4
	S1	F2	1
	S2	F1	1
	S1	F1	2
Inlet to New Ventilation System	S1	F3	4
	S0	F3	7
Node 2	S2	F2	2
	S1	F2	1
	S0	F2	1
	S2	F1	1
	S1	F1	2
Waste Tank	S1	F3	6
	S0	F3	6
Node 3	S2	F2	8
	S1	F2	2
	S0	F2	1
	S2	F1	6
	S0	F1	2
	S3	F0	1
	S1	F0	4
	S0	F0	1
Old Exhaust Ventilation System	S2	F3	6
	S1	F3	1
Node 4	S2	F2	3
Old Exhaust Ventilation System	S3	F1	1
	S2	F1	2
Node 4	S1	F1	2
	S2	F0	1
New Exhaust Ventilation System	S2	F3	5
	S1	F3	3
Node 5	S0	F3	1
	S2	F2	3
	S2	F1	3
	S1	F1	1
Mixing Pumps	S1	F3	3
	S0	F3	6
Node 6	S0	F2	2
	S0	F1	1
Equipment Installation and Removal	S2	F3	4
	S1	F3	6
Node 7	S2	F0	1

Table 3A5-2. Event Severity Index.

Safety-Class category designation	Description
S3	Potential significant radiological dose consequences or chemical exposure to the offsite receptor.
S2	Potential significant radiological dose consequences or chemical exposure to the onsite co-located worker.
S1	Potential industrial injury, radiological dose consequences or chemical exposure to the facility worker.
S0	No effect outside the facility confinement systems and no safety concerns for the facility worker, the onsite worker, or members of the general public.

Table 3A5-3. Event Frequency Index.

Frequency category designation	Numeric definition	Word definition
F3	$> 10^{-2}$/year	Anticipated
F2	$> 10^{-4}$ to $\leq 10^{-2}$/year	Unlikely
F1	$> 10^{-6}$ to $\leq 10^{-4}$/year	Extremely unlikely
F0	$\leq 10^{-6}$/year	Beyond extremely unlikely

6.0 ACCIDENTS

The purpose of the accident analysis is to demonstrate assurance that the design and operations resulting from Project W-151 can be conducted in a manner that will limit risk to the health and safety of the public and employees and protect the environment. The safety analysis provides the analytical bases for the AWF Tank 241-AZ-101 Waste Retrieval System Safety Requirements. First the facility hazards were identified to determine, to the maximum extent practical, the range of potential accidents or process upsets the facility may experience. Categories of potential accidents were extracted from the hazards assessment and representative scenarios will be developed for each category. Next, dose consequences will be calculated for each scenario. The dose consequences will be compared to the risk acceptance criteria described in WHC-CM-4-46[1].

6.1 ACCIDENT SELECTION

The HazOp estimates were made for the likelihood of occurrence (Frequency) of each accident shown in the HazOp study tables. There are four Frequency Categories. Also shown are four Severity Categories. These categories were used along with common release mechanisms to group or bin accidents with common attributes. Bin or group numbers are shown on the HazOp study tables.

An accident scenario was developed which bounded all accidents assigned to a bin or group. Six groups or bins were identified. Therefore, six bounding (candidate) accident scenarios were developed. The Bounding candidate accidents are identified in the following section.

6.2 BOUNDING ACCIDENTS

Releases of airborne radionuclides and/or toxic materials that have a potential impact on the onsite and/or offsite individual result from ventilation HEPA filter failure, backflow through open tank risers, leakage via failed vent ducting, and installation or removal of tank equipment. Potential exposure of the soil column to tank contents and potential contamination of the ground water could result from a waste tank leak.

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[1]Refer to Appendix G, "Site-wide Controlled Manual Cross Reference Table," for crosswalk between Site-wide controlled manuals (e.g., WHC-CM-X-XX) superseded by Fluor Daniel Hanford, Inc. (FDH), procedures (e.g., HNF-PRO-XXX).

The following accidents are specific to Project W-151 and bound all other accidents resulting from hazards shown in the HazOp study tables.

1. Candidate accident that bounds all accidents listed for Bin 1. Radionuclide release resulting from filter failure due to overpressurization caused by:

   - Vacuum breaker fault
   - Aerosol generation from chemical reaction
   - Ignition of flammable gases in the dome void space
   - Increased aerosol generation due to mixer pump action and heat input
   - Plugging of filters with particulate or moisture
   - Tank Bump (sudden release of aerosol with the tank liquid volume).

2. Candidate accident that bounds all accidents listed for Bin 2. Radionuclide and toxic material release resulting from opening in top of tank due to reversal of flow caused by:

   - Wind (air flow over open riser draws aerosols from tank)
   - Causes for tank pressurization listed in 1 above while riser is open
   - Tank dome overload resulting in tank dome collapse and breach.

3. Candidate Accident that bounds all accidents listed for Bin 3. Radionuclide and toxic material release resulting from breach in ventilation ducting due to reversal of flow caused by:

   - Seismic event during equipment installation and operation
   - High wind during equipment installation and operation
   - Impact by construction equipment or vehicle.

4. Candidate accident that bounds all accidents listed for Bin 4. Breach of containment which allows tank contents to enter the soil column creating a potential for a pathway to the ground water beneath the tank caused by:

   - Excessive draw down
   - Pressure from flammable gas burn
   - Dropped equipment into tank during installation or removal

- Missile from pump
- Erosion during mixer pump operation.

5. Candidate accident that bounds all accidents listed for Bin 5. Radiological and toxicological material release resulting form overpressure due to Criticality caused by rearrangement of material due to:

   - Mixer pump action during operation or
   - Mixer pump action results after mixer pump shutdown.

   Criticality Safety Evaluation Report WHC-SD-W151-CSA-001, "CSER 96-014 Criticality Safety Of Project W-151, 241-AZ-101 Retrieval System Process Test," will evaluate the criticality safety aspects of the process test. The evaluation extends to the testing and operation of the mixer pumps and does not include the transfer of waste from the tank. The report provides justification that a nuclear criticality is extremely unlikely, if not impossible, in this tank.

6. Radiological and toxicological material release resulting from a seismic event.

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ATTACHMENT 1

HAZOP STUDY TABLES

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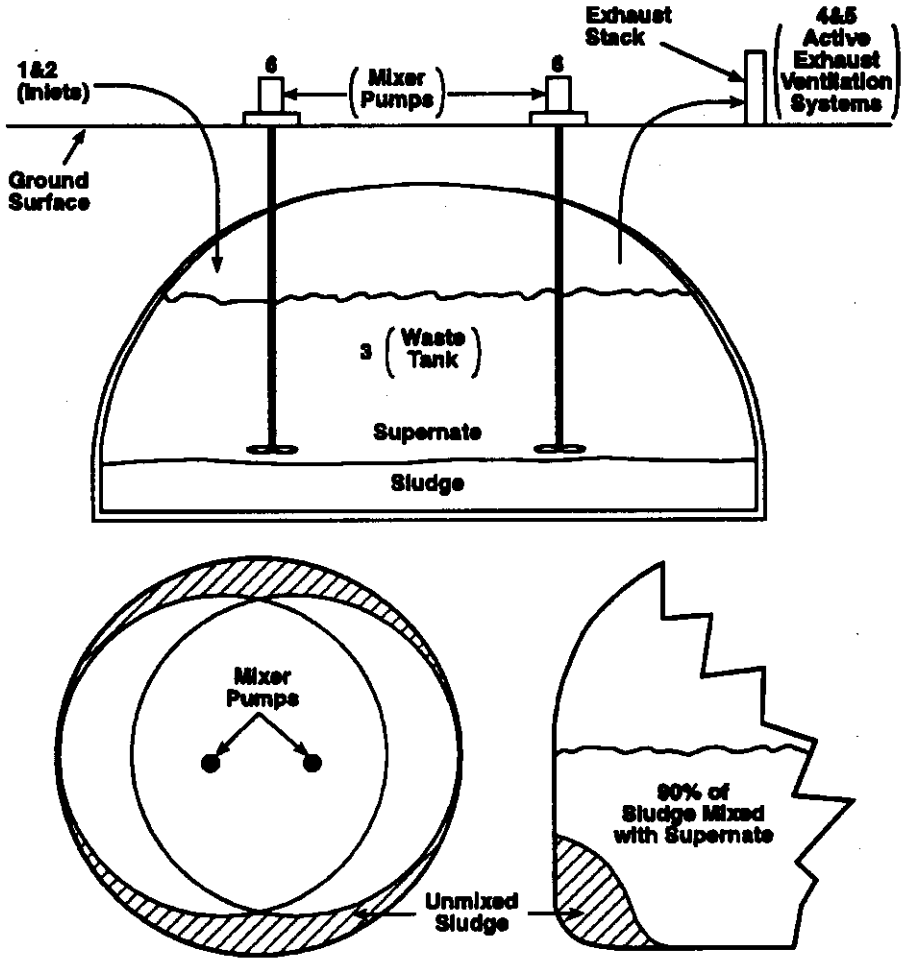
Figure ATT1-1. Project W-151 HazOp Nodes AWF Waste Tank 241-AZ-101 Mixer Pump Process Test.



Node Number	Node Description
1	Inlet to Old Ventilation System
2	Inlet to New Ventilation System
3	Waste Tank
4	Old Exhaust Ventilation System
5	New Exhaust Ventilation System
6	Mixing Pumps
7	Equipment Installation and Removal

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Table ATT1-1. Definition of HazOp Table and Hazard Summary Table Terms.

Term	Definition
Accident	An unplanned event or sequence of events that results in undesirable consequences.
Cause	That which produces the effect or consequence of an accident.
Consequence	Effect created by an accident resulting form a hazard condition: the result or effect of a release of hazardous material (radiological or chemical) usually expressed in terms of dose and exposure.
Defense-in-Depth Controls	Subset of all remaining engineering and administrative features identified in the hazards analysis that are not specified as "credited" in the Hazards Summary Table and which have been agreed as appropriate for inclusion in the safety documentation.
Detection	Engineering or administrative requirements that are either already there or that can be introduced to discover or discern a hazard that may lead to an accident
Guide word	A simple word or phrase used to qualify or quantify the design intention and associated parameters in order to discover design deviations or departures resulting in hazards leading to accidents
Hazard	A source of danger with the potential to cause illness, injury, or death to personnel; or damage to a facility or to the environment.
Mitigating Features	Engineering or administrative requirements that prevent or reduce the consequences resulting from an accident
Node	The point or location on a process diagram at which process parameters are investigated for deviations (or departures from design intent)
Parameter	Aspects of a process that describe it physically or in terms of what is happening
Rank	Accident severity and frequency of occurrence standing
Receptor	The individual affected by an accident
Remark	Comment or observation
Risk Bin Number	Obtained from the RISK MATRIX BIN NUMBERS Table and is a function of Consequence and Frequency.
HazOp Table	A detailed listing of the hazards identified with a qualitative evaluation of the consequences
Hazards Summary Table	A summary record of the information obtained during the hazards analysis process.

Table ATT1-2. Team Members — Hazards and Operability Study Project W-151. (February 13 - 15, 1996)

Team Member	NODE						
	1	2	3	4	5	6	7
DATES:	2/13/96	2/13/96	2/14/96	2/14/96	2/14/96	2/15/96	2/15/96
Henry Aguirre Jr.	X	X	X	X	X	X	X
Richard E. (Rich) Clayton	X	X	X	X	X		
Burton H. (Burt) Gilbert	X	X	X	X	X	X	X
Ronald J. (Ron) Kidder	X	X	X	X	X	X	
Roger M. Nelson	X	X	X	X	X	X	X
Edward M. (Ed) Nordquist	X	X	X	X	X	X	X
Gary R. Tardiff	X	X	X	X	X	X	X

Table ATT1-3. Ranking Criteria Hazards and Operability Study for Project W-151 Qualitative Accident Severity Levels.

Safety Consequence Category Designators	
Category designation	Description
S3	Potential significant radiological dose consequences or chemical exposure to the offsite receptor.
S2	Potential significant radiological dose consequences or chemical exposure to the on-site co-located worker.
S1	Potential industrial injury, radiological dose consequences or chemical exposure to the facility worker.
S0	No effect outside the facility confinement systems and no safety concerns for the facility worker, the onsite worker, or members of the general public.
Environmental Consequence Category Designators	
E3	Environmental discharges of hazardous material outside the Hanford Site Boundary or to the groundwater.
E2	Reportable environmental discharge of hazardous material within the Hanford Site boundary associated with an S2 Safety Consequence.
E1	Limited environmental discharge of hazardous material outside a facility associated with an S1 Safety Consequence.
E0	No environmental impact.

Table ATT1-4. Ranking Criteria Hazards and Operability Study For Project W-151.

Category designation	Numeric definition	Word definition
F3	$> 10^{-2}$ /year	Anticipated
F2	$> 10^{-4}$ to $\leq 10^{-2}$ /year	Unlikely
F1	$> 10^{-6}$ to $\leq 10^{-4}$ /year	Extremely Unlikely
F0	$\leq 10^{-6}$ /year	Beyond Extremely Unlikely

APPENDIX 3B

HAZARDS ANALYSIS SUMMARY

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Table 3B-1. Hazards Analysis Summary. (6 sheets)

Event category	Postulated event description	Significant causes or energy sources	Receptor	Credited prevention (attributes that lower frequency)	Event frequency		Credited mitigation (attributes that lower consequences)	Consequences		Risk bin number		Defense in depth controls
					Without prevention	With prevention		Without mitigation	With mitigation	Without prevent mitigation	With prevent mitigation	
Event 1 — Radionuclide and toxic release resulting from filter failure												
Internal event caused from within the facility	Release of radionuclides due to filter failure	Ventilation filter failure caused by:	Public	Engineered features: • Backup exhaust train Administrative features: • Tank head space monitoring during mixer pump operation • Controls for opening risers • Controlled startup of mixer pump • Work control procedure • Daily surveillance • Vent system maintenance • Waste compatibility program	F3	F2	Engineered features: • Backup exhaust system • Ventilation system condensers and heater Administrative features: • Ventilation system in operation during mixer pump use • Controlled startup of mixer pump	S2	S1	14	8	
			Co-located worker	Same as for Public			Same as for Public					
		• Vacuum break fault • Chemical reaction • Ignition of flammable gases • Plugged filter • Tank bump	Immediate worker	Same as for Public			Same as for Public					
			Potential for contamination of the environment:									

Table 3B-1. Hazards Analysis Summary. (6 sheets)

Event category	Postulated event description	Significant causes or energy sources	Receptor	Credited prevention (attributes that lower frequency)	Event frequency		Credited mitigation (attributes that lower consequences)	Consequences		Risk bin number		Defense in depth controls
					Without prevention	With prevention		Without mitigation	With mitigation	Without prevent mitigation	With prevent mitigation	
Event 2 — Radionuclide and Toxic aerosol release from tank opening												
Internal event caused from within the facility	Release of radionuclide and toxic aerosols from tank through opening in tank due to reversal of airflow (air is normally drawn into the tank then exhausted via HEPA filters)	• Wind (air) flow over open riser	Public	Engineered features: • HEPA filter differential instruments Administrative features: • Vent system maintenance • Controlled startup of mixer pump • Controls for opening risers • Tank Dome loading controls (equipment and materials) • Ventilation system surveillance • Tank head space monitoring during mixer pump operation	F3	F2	Engineered features: • Ventilation System Administrative features: • Controlled start of mixer pumps	S2	S1	14	8	
		• Chemical reaction resulting in tank pressurization	Co-located worker	Same as for Public			Same as for Public					
		• Vacuum breaker fault	Immediate worker	Same as for Public			Same as for Public					
		• Ignition of flammable gases • Plugged HEPA filters • Tank bump • Tank dome collapse due to overload	Potential for contamination of the environment:									

Table 3B-1. Hazards Analysis Summary. (6 sheets)

Event category	Postulated event description	Significant causes or energy sources	Receptor	Credited prevention (attributes that lower frequency)	Event frequency		Credited mitigation (attributes that lower consequences)	Consequences		Risk bin number		Defense in depth controls
					Without prevention	With prevention		Without mitigation	With mitigation	Without prevent mitigation	With prevent mitigation	
Event 3 — Radionuclides and Toxic aerosol release from breach in tank ventilation duct												
Internal event caused from within the facility	Radionuclides and toxic aerosols are released through a tank ventilation duct breach	• Seismic event during pump installation	Public	Engineered features: • Ducting designed to withstand designed based earthquake • Ducting designed to withstand high wind Administrative features: • Critical lift procedure for crane • Job controls	F1	F1	Engineered features: • None identified Administrative features: • None identified	S2	S2	9	9	
		• High wind during pump installation	Co-located worker	Same as for Public			Same as for Public					
Natural phenomena, wind, earthquake External event-- vehicle impact		• Impact by construction equipment or vehicle	Immediate worker	Same as for Public			Same as for Public					
			Potential for contamination of the environment:									

Table 3B-1. Hazards Analysis Summary. (6 sheets)

Event category	Postulated event description	Significant causes or energy sources	Receptor	Credited prevention (attributes that lower frequency)	Event frequency		Credited mitigation (attributes that lower consequences)	Consequences		Risk bin number		Defense in depth controls
					Without prevention	With prevention		Without mitigation	With mitigation	Without prevent mitigation	With prevent mitigation	
Event 4 — Radionuclides and Toxic material releases from tank												
Internal event caused from within the facility	Radionuclide enter the soil through a breach in the tank containment and enter groundwater	• Excessive draw down of tank level	Public	Engineered features: • Pump strain instruments Administrative features: • Critical lifting procedure • Controlled startup of mixer pump • Operating procedures • Waste Compatibility Program • Preventive maintenance • Surveillances • Pump speed control	F2	F2	Engineered features: • Energy absorption cylinder • Secondary confinement • Screen on pump intake Administrative features: • Controlled startup of mixer pumps	S2	S1	12	8	
		• Pressure resulting from flammable gas burn	Co-located worker	Same as for Public			Same as for Public					
		• Missile from pump	Immediate worker	Same as for Public			Same as for Public					
		• Erosion ring mixer pump operation • Equipment dropped into tank	Potential for contamination of the environment:									

Table 3B-1. Hazards Analysis Summary. (6 sheets)

Event category	Postulated event description	Significant causes or energy sources	Receptor	Credited prevention (attributes that lower frequency)	Event frequency		Credited mitigation (attributes that lower consequences)	Consequences		Risk bin number		Defense in depth controls
					Without prevention	With prevention		Without mitigation	With mitigation	Without prevent mitigation	With prevent mitigation	
Event 5 — *Radionuclide and toxic aerosols released from tank*												
Internal event caused by within the facility	Radionuclide and toxic aerosols released from tank due to overpressure	Criticality event	Public	Engineered features: • None identified Administrative features: • Criticality specifications	F1	F1	Engineered features: • None identified Administrative features: • Criticality specifications	S2	S2	9	9	
			Co-located worker	Same as for Public			Same as for Public					
			Immediate worker	Same as for Public			Same as for Public					
			Potential for contamination of the environment:									

Table 3B-1. Hazards Analysis Summary. (6 sheets)

Event category	Postulated event description	Significant causes or energy sources	Receptor	Credited prevention (attributes that lower frequency)	Event frequency		Credited mitigation (attributes that lower consequences)	Consequences		Risk bin number		Defense in depth controls
					Without prevention	With prevention		Without mitigation	With mitigation	Without prevent mitigation	With prevent mitigation	
Event 6 — Radioactive and toxic material release from tank												
Natural phenomena, seismic event	Radioactive and toxic material release to the soil with potential for entrance to the groundwater	Seismic event	Public	Engineered features: • Tank design • Ventilation system design Administrative features: • None identified	F1	F0	Engineered features: • Tank design • Ventilation system design Administrative features: • None identified	S3	S0	13	1	
			Co-located worker	Same as for Public			Same as for Public					
			Immediate worker	Same as for Public			Same as for Public					
			Potential for contamination of the environment:									

Table 3B-1. Hazard and Operability Study - Node 1. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/13/96					Node: 1		Page: 3A-7
Node Description: Inlet to existing ventilation system.							
Design Intention: Provide inlet air for tank dome space ventilation system (cooling and confinement of radioactive particulates). In backflow situations, exhaust is unfiltered.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
Low/No Flow	Overpressure event in tank (possibly because of a blockage to the exhaust system)	Possible equipment damage and/or loss of valve function (could lead to unfiltered release from breached filter, hydrogen buildup in tank). Unfiltered release, tank heat up.	Dome space pressure instruments and alarms Flow elements in exhaust system	Ventilation system operating while mixer pumps are on or equipment being removed	S0 F3	1	
	Breach of confinement in another location	Depends on breach size (either less negative pressure or atmospheric release)	Event is probably linked to construction or maintenance activity which will be known (i.e., visual).	Fix the problem (portable exhauster may be needed during construction). Established control for opening risers.	S0 F3	1	
	Exhauster failure	Tank head space pressure causes filters to breach leading to unfiltered release of contaminants to atmosphere.	Flow meters in the exhaust line and dp (differential pressure) instrument and alarms dp across exhaust HEPAs zero	Backup exhaust train	S2 F3	1	
	Icing	High negative pressure in tank if the exhaust fan continues to run Inadequate dome space gas mixing resulting in flammable gas pockets	Dome space pressure instruments and alarms	Work control procedures	S0 F3	1	
	Stack collapsing during wind storm	Same as exhauster failure.	Same as exhauster failure.	Design criteria for stack (wind, seismic, SDC4.1)	S1 F1	1	
	Failure in another tank (i.e., open riser)	Same as breach of confinement (overpressurization).	Dome space pressure instruments and alarm	Work control and procedures ventilation system operating	S1 F3	1	

Table 3B-1. Hazard and Operability Study - Node 1. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/13/96					Node: 1		Page: 3A-8
Node Description: Inlet to existing ventilation system. Design Intention: Provide inlet air for tank dome space ventilation system (cooling and confinement of radioactive particulates). In backflow situations, exhaust is unfiltered.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
High Flow	Vacuum break valve fault (fails open)	Unfiltered inlet	HEPA dp instruments and alarms (low dp on inlet HEPA filter)	Ventilation system operating; may need to increase tank farm ventilation flow rate.	S0 F2	1	Consider additional control for future multiple waste tank mixer pump operation.
	Ducting breach from seismic/high wind/ construction impact	Same as overpressurization in tank.	Same as overpressurization in tank.	Work control procedures; ventilation system operating.	S1 F2	1	
Reverse Flow	Wind or tornado	Release of radionuclides and toxic gases through open riser	Dome space pressure instruments and alarms	ventilation system operating Work controls and procedures	S1 F1	1	
More Temperature	Chemical reactions ignite flammable gases Heater faulty	Release of unfiltered radionuclides and toxic gases due to pressure and heat causing filters to fail	Dome space pressure instruments and alarms	Waste compatibility program	S2 F1	1	
Less Temperature	See icing under No Low	Release of radionuclides and toxic gases	Dome space pressure instruments and alarms	Daily surveillances visual	S0 F3	1	

Table 3B-1. Hazard and Operability Study - Node 2. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/13/96 Node: 2 Page: 3A-9

Node Description: Inlet to new ventilation system.

Design Intention: Provide inlet air for tank dome space ventilation system (cooling and confinement of radioactive particulates) and provide filtered exhaust in backflow situations (W-030 upgrade).

Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
Low/No Flow	Overpressure event in tank because of a faulty valve to the exhaust system.	Possible equipment damage and/or valve function leads to unfiltered release when valve remains closed allowing pressure buildup, then valve opens allowing pressure to fail filters causing an unfiltered release.	Dome space instruments and alarms Flow Alarm in inlet system	Inlet air filters and Condensers	S1 F3	1	
	Inlet HEPA plugging (water, condensation, debris)	High negative pressure in tank if the exhaust fan continues to run	Visual inspection of filter screens on inlet; HEPA dp indicators and alarms; dome space instruments and alarms	Daily surveillance and maintenance program	S0 F3	1	Differential pressure (dp)
		Inadequate dome space gas mixing resulting in flammable gas pockets	HEPA dp indicators and alarms; dome space pressure instruments and alarms	Daily surveillance and maintenance program	S0 F3	1	
	Breach of confinement in another location	Depends on breach size (either less negative pressure or atmospheric release)	Event is probably linked to construction or maintenance activity which will be known (i.e., visual).	Repair the problem (portable exhauster may be needed during construction). Instituted controls for opening risers.	S0 F3	1	
	Exhauster failure	Overpressure in the tank causing filter failure and potential atmospheric release	Flow meter in the inlet; pressure dome space instruments and alarms; HEPA dp instruments and alarms	Backup exhaust train; daily surveillance and maintenance program	S1 F3	1	
	Icing due to heater failure	Same as inlet HEPA plugging	visual inspection of filter screens on inlet; dp instruments across inlet HEPAs and alarms	System bypass available (vacuum break); daily surveillance	S0 F3	1	
	Stack collapsing during wind storm	Same as exhauster failure	Same as exhauster failure	Design criteria for stack (wind, seismic, SDC 4.1)	S1 F1	1	
	Damage to inlet due to dropped equipment	Same as Icing and HEPA plugging.	Same as Icing and HEPA plugging.	Heavy equipment lifting/movement is considered a critical lift and is treated on a case by case basis (NUREG 612); procedures.	S0 F3	3	Only inlet station is above ground.

Table 3B-1. Hazard and Operability Study - Node 2. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/13/96				Node: 2		Page: 3A-10
Node Description: Inlet to new ventilation system. Design Intention: Provide inlet air for tank dome space ventilation system (cooling and confinement of radioactive particulates) and provide filtered exhaust in backflow situations (W-030 upgrade).						
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
Low/No Flow (Continued)	Closed valve in inlet line	Same as inlet HEPA plugging	Same as inlet HEPA plugging.	Daily surveillance and PM	S0 F3	1	preventative maintenance (PM)
	Failure in another tank (i.e., open riser)	Same as breach of confinement and overpressurizing action.	Same as breach of confinement and overpressurizing action.	repair problem; work controls; portable exhauster	S1 F3	1	
High Flow	Vacuum break valve fault (fails open)	Unfiltered inlet	HEPA dp instruments and alarms (low dp on inlet HEPA filter)	Ventilation system operating; may need to increase tank farm ventilation flow rate	S0 F2	1	Consider additional control for future multiple waste tank mixer pump operation
	Ducting breach from seismic/high wind/ construction impact	Same as overpressurization in tank.	Same as overpressurization in tank	Work control procedures; ventilation system operating	S1 F2	1	
	Inlet HEPA failure	No potential release unless negative tank pressure lost (see reverse flow).	HEPA dp instruments and alarms; dome space pressure instruments and alarms	Maintenance, repair, and daily surveillance	S1 F3	2	
Reverse Flow	Natural draft (wind blowing across inlet with open riser)	Release of radionuclides and toxic gases	Dome space pressure instruments and alarms; inlet flow instruments and alarms	HEPA filters on inlet will filter reverse flow.	S1 F1	2	
	Ignition of flammable gases in the dome space melt inlet HEPAs	Release of unfiltered radionuclides and toxic gases due to heat and pressure which causes filter failure	HEPA dp instruments and alarms; stack flow instruments and alarms	work controls (mixer pump controlled startup)	S2 F2	1	Consider monitoring of gas concentration in tank head space prior to and during mixer pump operation.
More Temperature	Ignition of flammable gases in the dome space melt inlet HEPAs	Release of unfiltered radionuclides and toxic gases due to heat and pressure which causes filter failure	HEPA dp instruments and alarms; stack flow instruments and alarms	work controls (mixer pump controlled startup)	S2 F2	1	Consider monitoring of gas concentration in tank head space prior to and during mixer pump operation.
	Heat from chemical reactions ignite flammable gases. Heater fault ignites flammable gases	Release of radionuclides and toxic gases	HEPA dp instruments and alarms; stack flow instruments and alarms	Waste compatibility program; heater PM; daily surveillance; work controls	S2 F1	1	
Less Temperature	See plugging and icing under "No Flow."	Same as plugging	Visual and dp instruments and alarms	Heater PM and daily surveillance	S0 F3	1	

Table 3B-1. Hazard and Operability Study - Node 3. (5 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96 Node: 3 Page: 3A-11

Node Description: Waste Tank

Design Intention: Encompass tank liquid containment and vapor head space confinement.

Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	BIN NO.	Remark
High Level	Mixer pump seal failure (Bearing water drains to tank faster than normal.)	Increase in tank level	Tank level instruments and alarms	Administrative control on addition of water; daily surveillances; design features (disaster bushings, maximum flow orifice)	S0 F3	See remarks	Not binned because there is no release.
	Loss of spray water control during equipment removal from tank via riser	Increase in tank level	Tank level instruments and alarms	Limited volume (4,500 gal tanker truck)	S0 F3	Same as above.	Same as above.
	Mis-transfer due to mis-routing	Increase in tank level	Tank level instruments and alarms	Operating procedures	S0 F3	Same as above.	Same as Above.
	External flooding	release of tank contents to environment	Visual		S3 F0	Same as above.	External flooding is considered incredible.
	Mixer pump insertion	displacement of tank waste leading to increase in tank level (very small)	Level instruments and alarms	Level will be known prior to pump insertion. Tank surveillance requirements	S0 F3	Same as above.	Mixer pump displacement will be range of 500 gallons.
Low Level	Breach of containment due to equipment drop during installation or removal	Leakage of tank waste to soil column	Tank level instruments and alarms; Primary tank leak detection system (Annulus conductivity probes and continuous air monitor)	Critical lift work procedures and job controls Energy absorption cylinder Secondary containment (Annulus)	S3 F1	4	
	Missile ejection by mixer pump operation punctures primary tank	Leakage of tank waste to annulus	Primary tank leak detection system	Work control (controlled startup); Screened mixer pump intake	S3 F1	4	
	Breach of containment due to tank erosion caused by mixer pump action	Leakage of tank waste to annulus	Primary tank leak detection system	Work control (controlled startup); Screened mixer pump intake			
	Excessive draw down due to inadvertent startup of existing transfer pump	Violation of Low Level Limit (tank structural damage)					

Table 3B-1. Hazard and Operability Study - Node 3. (5 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96 Node: 3 Page: 3A-12

Node Description: Waste Tank

Design Intention: Encompass tank liquid containment and vapor head space confinement.

Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	BIN NO.	Remark
Low Negative Pressure	Energetic explosive events (same as reverse flow and ignition of flammable gas events)	Potential back flow through the inlet station (new) or pits (existing)	Dome space pressure and temperature instruments and alarms	Waste compatibility program Tank head space monitoring during mixer pump operations Work controls	S2 F2	1	
		Backflow of liquid waste to pits resulting in exposure to occupational workers when subsequent work is done in the pits	Pit leak detection instruments and alarms		S2 F2	1	
		Damage to HEPA filters resulting in unfiltered release	HEPA dp instruments and alarms		S2 F2	1	
		Possible impact to tank structure resulting in loss of containment and release to the environment	Dome space pressure instruments and alarms		S2 F2	4	
	Inadequate exhauster operation	Loss of confinement (potential unfiltered release)	Dome space pressure instruments and alarms, HEPA dp instruments and alarms	Proper system balance and maintenance, dp across filter banks, alarms, and shutdown ventilation system Redundant ventilation system	S1 F3	1	Consider backup/standby portable exhauster during operations.
	High volume input (Same as for High Flow in Node 2 vacuum break valve fault.)	Possible wetting of filters if continued long enough	Same as for High Flow in Node 2.	Control of transfer rate; HEPA dp would be an indication of success. Same as for High Flow in Node 2.	S0 F2	1	
	Events at tank or other tanks (opening risers)	Same as inadequate exhauster operation.	Same as inadequate exhauster operation.	Same as inadequate exhauster operation.	S1 F3	1	
	Excess gas release from mixer pump operation	Potential for greater concentrations of toxic substances, flammable gases and radionuclide particles resulting in overpressure that fails filter causing an unfiltered release.	Stack monitoring instruments and alarms	Controlled startup of mixer pumps	S1 F2	1	
	Mixer pump causes unexpected chemical reaction	Same as for "chemical reactions ignite flammable gases" in Node 2.	Same as for "chemical reactions ignite flammable gases" in Node 2.	Same as for "chemical reactions ignite flammable gases in Node 2.	S2 F1	1	
High Negative Pressure	Same as Node 1 No/Low Flow tank event.	Same as Node 1 No/Low Flow tank overpressure event.	Same as Node 1 No/Low Flow tank overpressure event.		S0 F3	1	

Table 3B-1. Hazard and Operability Study - Node 3. (5 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96 Node: 3 Page: 3A-13

Node Description: Waste Tank

Design Intention: Encompass tank liquid containment and vapor head space confinement.

Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	BIN NO.	Remark
Vapor Space Composition Change	Mixer pump operation	Increased aerosol loading from heat or splashing results in overpressurizing filters and an unfiltered release.	HEPA filter dp; monitoring of dome space activity	Controlled startup of mixer pumps	S1 F2	1	
		Potential higher activity in tank dome space	HEPA filter dp and stack monitor instruments and alarms Monitoring of ventilation exhaust during mixer pump operation Portable humidity monitor available	Controlled startup of mixer pumps	S1 F3	1	
		Potential higher concentration of flammable/toxic gases and heat resulting in overpressure causing filter failure and an unfiltered release	Gas samplers and activity monitors in the exhaust stack Monitoring of dome space concentrations during mixer pump operation	Controlled startup of mixer pumps; operation of ventilation system	S1 F3	1	
	Increase in vapor space as tank level is drawn down.	Stratification of the vapor resulting in a possible buildup of gas concentration due to decreased air sweep ability	Tank level indication	Consider increased ventilation system flow if conditions warrant it.	S0 F1	1	Assumed gas concentration as below 25% of LFL (dropped from OSD-0030 Appendix B).
More Temperature	Tank material rollover	Potential higher concentration of flammable/toxic gases; increased release of toxic gases via the exhaust system	Gas samplers and stack monitor instruments and alarms; vapor space flammable gas monitoring; dome space pressure instruments and alarms	Operation of ventilation system; controlled startup of mixers	S1 F0	1	With the current material composition in this tank rollover is not considered credible. This tank is not on watch list.
		Increased aerosol loading	Gas samplers and activity monitors in the exhaust stack; vapor space flammable gas monitoring; dome space pressure instruments and alarms	Operations of ventilation system; controlled startup of mixers	S1 F0	1	

Table 3B-1. Hazard and Operability Study - Node 3. (5 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96				Node: 3		Page: 3A-14
Node Description: Waste Tank Design Intention: Encompass tank liquid containment and vapor head space confinement.						
Parameter/ Guide word	**Cause**	**Consequence**	**Detection**	**Mitigating Features**	**Rank**	**BIN NO.**	**Remark**
More Temperature (Continued)	Tank material rollover (Continued)	Higher activity in dome space Gas samplers and activity monitors in the exhaust stack; vapor space flammable gas monitoring; dome space pressure instruments and alarms; operations of ventilation system; controlled startup of mixers S1 F01; excessive HEPA filter loading/airborne material/high activity from dome space failure of HEPA leading to unfiltered release					
			HEPA dp instruments and alarms; stack flow instrument and alarms	HEPA filter performance monitoring; standby exhaust system	S1 F0	1	
	Explosion event	Release of unfiltered radionuclides and toxic gases due to heat and pressure which causes filter failure	HEPA dp instruments and alarms; stack flow instruments and alarms	work controls (mixer pump controlled startup)	S2 F2	1	
	Fire event (deflagration)	See Node 1 More Temperature.			S2 F2	1	
	Increased temperature of the waste due to mixer pump heat input	See tank material rollover.			S1 F3	1	
	Extended low air flow in tank head space	Refer to exhaust/ inlet nodes (Node 4 Low Flow and Node 3 Low Negative Pressure).			S0 F3	1	
	Loss of cooling/heat exchanger failure	See Nodes 4 and 5 Less Temperature.				1	
	Chemical reaction	Overpressurization potential for fire and explosion	Dome space pressure instruments and alarms	Waste compatibility program	S2 F1	1	
		Over temperature of the tank structure (primary and concrete) resulting in tank breach and possible release to soil.	Thermocouples in waste and in tank wall, floor, exhaust stream	Work controls, controlled startup of mixer pumps; waste compatibility program	S2 F2	4	
	Redistribution of layers at the start of mixing	Potential release of flammable and toxic gases and radionuclides and steam causing filter failure and unfiltered release	Dome space pressure instruments and alarms Temp thermocouple indications; gas monitoring	Controlled startups; gas monitoring during mixer pump operation	S1 F3	1	

Table 3B-1. Hazard and Operability Study - Node 3. (5 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96					Node: 3		Page: 3A-15
Node Description: Waste Tank Design intention: Encompass tank liquid containment and vapor head space confinement.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	BIN NO.	Remark
Composition Change	What if one pump fails during operation?	Would not meet 90% criteria; insufficient mobilization of tank waste	Pump instruments thermocouples, gamma probes	Stop operations (option; install another pump).	S0 F3	See remarks	Not binned because there is no release.
More Viscosity	Excess evaporation	May not be able to mix due to increased viscosity	Increased load on pump will be noted if viscosity increases. Tank level instruments and alarms; Tank level surveillance	Water addition (e.g., condensate recycle)	S0 F1	SAME AS ABOVE.	Significant tank level decreases due to evaporation take three months. Not binned because there is no release.
Criticality	Rearrangement of material due to mixer pump action (and/or subsequent mixer shut down)	Release of steam and gases, aerosols, increased temp., high activity	Tank temperature and dome space pressure instruments and alarms; ventilation system instruments and alarms	Criticality specifications;	S2 F1	5	Critical Safety Report WHC-SD-W151-CSA-001, "CSER 96-014 Criticality Safety of Project W-151, 241-AZ-101 Retrieval, System Process Test," will evaluate the criticality safety aspects of the process test. The evaluation extends to the testing and operation of the mixer pumps only and does not include the transfer of waste from the tank. The report provides justification that a nuclear criticality is extremely unlikely, if not impossible, in this tank.
More Dome Loading	Increased load from newly installed equipment; unauthorized heavy equipment; dropped load; ash, snow and soil loading	Dome collapse; loss of confinement	Visual survey; dome space pressure instruments; stack flow instruments and alarms	Administrative controls (dome load control document)	S2 F2	4	

Table 3B-1. Hazard and Operability Study - Node 4. (3 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System	Date: 02/14/96	Node: 4		Page: 3A-16

Node Description: Old exhaust ventilation system.

Design Intention: Provide a flow path for the ventilation of the tank and flow of contaminated air to the filters.

Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
No/Low Flow	Blocked valve or damper	Flammable gas buildup in vapor space. Potential for flammable gas burn causing overpressurization of filters leading to unfiltered release. Potential for pressure release failing filters when valve opened resulting to an unfiltered release	Stack flow instruments and alarms	Administrative control of valve lineup/system balancing	S2 F3	1	
			damper position indication	Standby exhaust system; work controls (ventilation system operating during mixer pump operation)	S2 F3	1	
		Diminished cooling in tank leading to potential tank bump which causes overpressurization of filters leading to an unfiltered release.	Exhaust system instruments and alarms	Standby exhaust system; work controls (ventilation system operating during mixer pump EYEPIECE)	S2 F3	1	
		Decreased negative pressure in dome (i.e., loss of in leakage) leading to unfiltered unmonitored release of aerosols or particulate	Dome space pressure instruments and alarms	Standby exhaust system; work controls (ventilation system operating during mixer pump EYEPIECE)	S2 F3	1	
	Loss of power	Same as for blocked valve.	Same as for blocked valve.	PM (Preventive Maintenance): standby power	S2 F3	1	Preventative Maintenance (PM)
	Seismic event	Same as for blocked valve.	Same as for blocked valve.	Design features	S2 F1	1	
	Fan failure	Same as blocked valve.	Same as for blocked valve.	PM; daily surveillances	S2 F3	1	

Table 3B-1. Hazard and Operability Study - Node 4. (3 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96 Node: 4 Page: 3A-17

Node Description: Old exhaust ventilation system.

Design intention: Provide a flow path for the ventilation of the tank and flow of contaminated air to the filters.

Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
No/Low Flow (Continued)	Stack blockage	Flammable gases build up and ignite in tank. The burn results in pressure build up which cannot vent due to plugged stack. The tank breaches due to overpressure releasing contents to soil column. Potential for pressure to dislodge plug. Radionuclides and toxic substances released to atmosphere. Pressurized condition could occur even without flammable gas burn.	Same as for blocked valve	PM; daily surveillances	S3 F1	4	Blockage envisioned to occur from a burst HEPA filter
	Exhaust HEPA plugged by aerosols during mixing	HEPA filter failure due to high dp leading to unfiltered release of accumulated material	Flow indication on exhaust stack; HEPA filter dp instrumentation; dome space pressure instruments and alarms	HEPA monitoring and testing; backup HEPA filters in parallel train; standby exhaust system	S2 F2	1	
		Unacceptable concentrations of flammable gases in the dome space due to inadequate air removal	Same as HEPA failure flammable gas monitoring.	Same as HEPA failure.	S2 F2	1	
More Flow	Ductwork breach from external phenomena (seismic event, vehicle impact, tornado)	Unfiltered unmonitored release to the environment	Visual; exhaust stack flow instruments and alarms	Administrative controls; design of exhaust duct to withstand seismic event; low frequency of other events	S2 F1 Seismic S2 F1 Vehicle S2 F0 Tornado	3 3 3	

Table 3B-1. Hazard and Operability Study - Node 4. (3 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96					Node: 4		Page: 3A-18
Node Description: Old exhaust ventilation system. Design Intention: Provide a flow path for the ventilation of the tank and flow of contaminated air to the filters.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
More Flow (Continued)	Open riser	Same as Node 3 Low Negative Pressure.	Same as Node 3 Low Negative Pressure.		S2 F3	1	
Reverse Flow	Pressurization in interconnected tank that temporarily exceeds the exhaust system negative pressure	Same as Low/No Flow.	dome space pressure instruments and alarms	Work controls	S2 F1	1	
		mixing of gas streams forming undesirable products	dome space pressure instruments and alarms	Work controls	S2 F1	1	
More Temperature	See Node 3 More Temperature.						
Less Temperature	Not an issue for this node.						
More Moisture	See Node 3 Vapor Space Composition Change.						

Table 3B-1. Hazard and Operability Study - Node 5. (3 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96					Node: 5		Page: 3A-19
Node Description: New exhaust ventilation system Design Intention: Provide a flow path for the ventilation of the tank and flow of contaminated air to the filters.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
No/Low Flow	Blocked valve or damper	Flammable or toxic gas buildup in vapor space. Potential for flammable gas burn if ignited causing overpressurization of filter and failure leading to an unfiltered release.	Flow instruments and alarms; damper position indication	Procedural control of valve and system; redundant exhaust system	S2 F3	1	
		Diminished cooling in tank leading to potential tank bump (steam release) which causes overpressurization of filters and failure leading to an unfiltered release.	Exhaust system instruments and alarms	Procedural control of valve and system; redundant exhaust system	S2 F3	1	
		Decreased negative pressure in dome leading to unfiltered unmonitored release of aerosols or particulate	Dome space pressure instruments and alarms	Procedural control of valve and system; redundant exhaust system	S2 F3	1	
	Loss of power	Same as for blocked valve.	Same as for blocked valve.	PM (Preventive Maintenance); back-up power	S2 F3	1	Preventative maintenance (PM)
	Seismic event	Same as for blocked valve.	Same as for blocked valve.	Design features	S2 F1	1	
	Fan failure	Same as for blocked valve.	Same as for blocked valve.	PM	S2 F3	1	
	Stack blockage	Same as for blocked valve.	Same as for blocked valve.	PM, daily surveillances	S2 F1	1	Blockage envisioned to occur from burst HEPA filter.

Table 3B-1. Hazard and Operability Study - Node 5. (3 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96					Node: 5		Page: 3A-20
Node Description: New exhaust ventilation system Design Intention: Provide a flow path for the ventilation of the tank and flow of contaminated air to the filters.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
No/Low Flow (Continued)	Exhaust HEPA plugged by aerosols during mixing	HEPA filter failure due to high dp leading to unfiltered release of accumulated material	Stack flow instruments and alarms; HEPA filter dp instruments and alarms; dome pressure instruments and alarms	HEPA Monitoring and testing; backup HEPA filters in parallel train	S2 F2	1	
		Concentrations of flammable gases in the dome space exceed limit due to inadequate air removal. Ignition results in pressurization which causes filter failure and an unfiltered release.	Same as HEPA failure; flammable gas monitoring during mixer pump.	Same as HEPA failure; plus standby exhaust system; controlled start of mixer pumps.	S2 F2	1	
More Flow	Improperly balanced system	Increased negative pressure; breach HEPAs and lead to unfiltered release	Flow instruments and alarms	Control system/monitoring Redundant exhaust system	S0 F3	1	
	Overspeed on fan	Breach HEPAs and lead to unfiltered release	dp on HEPAs, stack monitoring, instruments and alarms	Redundant fan; preventive maintenance; operating procedures	S1 F3	1	
	Ductwork breach from external phenomena (seismic event, excavation)	Unfiltered, unmonitored release (tank pressurization)	Visual; stack flow instruments and alarms	Operational controls; design of exhaust duct to withstand seismic event.	S2 F1 seismic S2 F2 excava-tion.	1 1	(breach between tanks and HEPAs)

Table 3B-1. Hazard and Operability Study - Node 5. (3 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/14/96					Node: 5		Page: 3A-21
Node Description: New exhaust ventilation system Design Intention: Provide a flow path for the ventilation of the tank and flow of contaminated air to the filters.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
More Flow (Continued)	Open risers (harder for system to maintain negative pressure)	Same as for Node 3 Low Negative Pressure.	Same as Node 3 Low Negative Pressure.	Work controls	S1 F3	2	
Reverse Flow	Pressurization in interconnected tank that temporarily exceeds the exhaust system negative pressure	Same as for No/Low Flow, breach HEPAs.	Dome space pressure instruments and alarms in tank dome and in interconnected tank	Controlled startup of mixer pump	S1 F1	1	Consider backflow preventer in tank farm ventilation system.
More Temperature	See Node 3.						
Less Temperature	Heater shut down	Excessive moisture buildup in filters resulting in failure and potential unfiltered release	HEPA dp instruments and alarms across filters; flow instruments and alarms	Redundant exhaust trains	S1 F3	1	
More Moisture	Same as above. Also, see Node 3 Vapor Space Composition Change					1	

Table 3B-1. Hazard and Operability Study - Node 6. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/15/96					Node: 6		Page: 3A-22
Node Description: Mixing pumps. Design Intention: Mobilize Sludge.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
Low Flow	Loss of power and/or motor/VFD (Variable Frequency Drive)	Lack of mixing	Strain gauges; pump instruments (current, rpm); gamma probes	Design features, work controls, PM	S0 F3	Not binned since release.	Variable frequency drive (VFD) Preventative maintenance (PM)
		Potential failure of mission	Same as lack of mixing.	Design features, work controls, PM	S0 F3	See remarks.	Not binned because there is no release.
		Pressurization of tank, if power off long enough, results in filter failure and unfiltered release.	Same as lack of mixing.		S1 F3	1	
	Plugging of screen or pump intake	Catastrophic failure of pump (cavitation)	Pump instruments (current, rpm)	Design features, bowl flush capability	S0 F3	See remarks.	Not binned because there is no release.
	Mechanical failures of pump (catastrophic)	Potential damage of other equipment (instruments, tank, etc.)	Same as lack of mixing.	PM	S1 F3	Same as above.	Not binned because there is no release.
		Potential failure of mission	Same as lack of mixing.	PM	S0 F3	Same as above.	Not binned because there is no release.
		Missile from pump penetrates primary tank	Same as lack of mixing.	Design features, work controls, PM	S1 F3	Same as above.	Not binned because there is no release.
	Seismic event (causing deformation or failure of pump shaft)	Catastrophic failure of pump	Perceptions (e.g., movement of ground visual); pump instruments		S0 F1	6	Tank itself may be damaged in seismic event.

Table 3B-1. Hazard and Operability Study - Node 6. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 02/15/96					Node: 6		Page: 3A-23
Node Description: Mixing pumps. Design Intention: Mobilize Sludge.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
Low Flow (Continued)	Characteristics of the nonconnective layer leading to pump failure or degraded operation	Catastrophic failure of pump	Pump instruments (current, rpm)	Design features	S0 F2	See remarks.	Not binned because there is no release.
	Foreign object in flow stream gets past flow screen	See mechanical failure and/or plugging.		Design features (i.e., screen will stop items which will get stuck in impeller); work controls (controlled startup)	S0 F3	See remarks.	Not binned because there is no release.
High flow	Pump overspeed due to viscosity change	Tank erosion	Strain gages, pump instruments	Control pump speed; shut pump	S0 F2	4	
	Variable Frequency Drive failure (locked in overspeed)	Tank erosion	Strain gages, pump instruments	Shut down pump	S0 F3	4	

Table 3B-1. Hazard and Operability Study - Node 7. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 05/15/96 Node: 7 Page: 3A-24

Node Description: Equipment installation and removal.

Design Intention: Worker access to tank during equipment installation and removal; open risers to install and remove equipment.

Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
High Exposure	Removal of contaminated equipment	Personnel exposure to direct radiation	Dosimetry	Administrative and work controls on installation/ removal activities	S1 F3	See remarks.	Not binned; see section of test discussing work safety.
		Personnel contamination by direct contact	HPT (Health Physics Technician) survey	Health physics controls; decontamination showers/eyewash available	S1 F3	Same as above.	Same as above.
		Environmental contamination	HPT survey soil samples	Plastic sheeting work controls	S1 F3	Same as above.	Same as above.
	Spill from removal of contaminated components	Environmental contamination	HPT survey soil samples	Plastic sheeting work controls	S1 F3	See as above.	Same as above.
		Personnel exposure to airborne radioactive material via re-suspension	HPT survey	Temporary confinement such as greenhouse, wrapping, flexible receiver for equipment removal	S1 F3	Same as above.	Same as above.
	Overflow of waste from tank	See remarks			S2 F0		Not possible to overflow tank because the only additions for this project are with spray water supplied from a 4500 gallon tank truck.
	Reversal of air flow from tank to atmosphere through riser during installation or removal	Personnel exposure to airborne contaminants (toxic gases and radionuclides)	HPT monitoring; dome space pressure and exhaust flow instruments and alarms	Ventilation system operating; work controls	S1 F3	2	

Table 3B-1. Hazard and Operability Study - Node 7. (2 sheets)

Project: W-151, Tank 241-AZ-101 Waste Retrieval System Date: 05/15/96					Node: 7		Page: 3A-25
Node Description: Equipment installation and removal. Design Intention: Worker access to tank during equipment installation and removal; open risers to install and remove equipment.							
Parameter/ Guide word	Cause	Consequence	Detection	Mitigating Features	Rank	Bin No.	Remark
High Pressure Leak	Hose fault	Occupational worker injury	Visual High pressure spray pump instruments	Design features; work controls; distance	S1 F3	See remarks	Requires close proximity to point of discharge. Not binned; see section of text discussing worker safety.
	Pump Fault (catastrophic)	Same as hose fault.	Visual High pressure spray pump instruments	Design Features; work controls; distance	S2 F3	See remarks.	Not binned; see section of text discussing worker safety.
	Relief Valve fault	Same as hose fault.	Visual High pressure spray pump instruments	Design Features; work controls; distance	S2 F3	Same as above.	Same as above.
	Variable Frequency Drive fault (i.e., pump overspeed)	Same as hose fault.	Visual High pressure spray pump instruments	Design Features; work controls; distance	S2 F3	Same as above.	Same as above.

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